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CONTENT

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Modeling and Optimization of Traffic Dynamics on a Roundabout

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Abstract

This article focused on   traffic flow modeling and optimization on a roundabout using a macroscopic approach. The roundabout is modeled as a chain of junctions with one main lane and secondary incoming and outgoing roads. We systematically formulate a cost functional that measures the total travel time spent by drivers on the network section of the roundabout. The analytical expression of the cost functional is discussed. Then, through numerical simulations, the traffic dynamic is studied on the whole network section of a roundabout using Godunov scheme. The numerical approximations compare the performance of a roundabout for instantaneous optimization of the priority parameters and fixed constant parameters. The simulation result shows that instantaneous optimization strategy outperforms the other choice, in improving the performances of the roundabout.

Keywords: Traffic problems, conservation laws, simulation, optimization.

1. Introduction

The origins of macroscopic traffic flow models date back to 1950's, when the seminal works of Lighthill and Whitham [16] and Richards [18] proposed a fluid dynamic model for vehicular traffic flow on an infinite single road, commonly denoted as LWR. This model has been extended to road networks by several authors in most recent years, see [4, 5, 6, 9] and references therein. These models have also been utilized for the optimization of vehicular traffic flow on road networks through various approaches; see for example [2, 3, 13, 17]. Also, optimal controls of traffic flow on networks have been studied using different optimization techniques; see [11] and reference therein.

Hyperbolic conservation laws are nonlinear partial differential equations which may lead to non-convex or non-linear formulations of the corresponding optimization problem. In such cases fewer optimization techniques exist for the discretized version of the problems than for convex problems. One approach is to approximate the system with a relaxed version in order to use efficient linear programming techniques. The linearization approach was used in [10] for optimal ramp metering using Godunov discretization scheme.

However, nonlinear optimization techniques such as gradient descent method can be applied to the discretized system without any modification to the underlying dynamics. Gradient descent is a first order optimization algorithm which gives no guarantee for finding a unique global minimum. The idea of instantaneous control has been discussed in [12] for the optimization of traffic flow problems on road networks. The purpose is to minimize large storage requirements arising from the network structure and the strong coupling of adjoints and state equations by generating a sequence of optimal control problems of reduced dimension.

Modern roundabouts are now considered as an alternative traffic control device that can improve safety and operational efficiency at intersections when compared to other conventional intersection controls, usually for traffic flow management or to improve safety [7]. It can be seen as particular road networks and can be modeled as a chain of junctions. We consider a roundabout with arbitrary incoming and outgoing roads, , which are described as a chain of junctions with two incoming and two outgoing roads. In particular, each junction has one incoming main lane, one outgoing main lane

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and a third link with incoming and outgoing uxes. The third road is modeled by a buffer of infinite capacity for the entering flux and with an infinite sink for the exiting one. The main lane evolution is described by a scalar hyperbolic conservation law, whereas the buffer dynamics is described by an ordinary differential equation (ODE) which depends on the difference between the incoming and outgoing fluxes on the link.

In this article, we focus on modeling, and optimization of traffic dynamics on a roundabout. In contrast to [12], rather than generating a sequence of sub-optimal control problems, we compute the gradient of the cost function at each time step to obtain the optimal priority parameters.

The article is structured as follows. In Section 2 we describe the mathematical model for the roundabout and the governing equations. In Section 3 we present the solution of the Riemann problem at junctions. Section 4 details numerical scheme. In Section 5 we describe the optimization problem of PDE-ODE constrained system and the formulation of the instantaneous flow optimization. Section 6 is devoted to numerical simulations. Finally we give conclusions in Section 7.

2. Mathematical Model for the Roundabout

In this work we consider a roundabout joining roads, $\mathbb{N}$, , as illustrated in Figure 1.
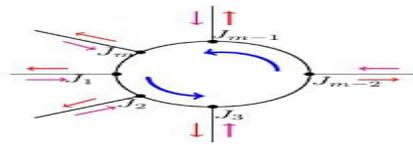
Figure 1: Schematic diagram for roundabout under consideration.

A roundabout can be seen as an oriented graph in which roads are represented by arcs and junctions by vertexes. Each link forming the roundabout is modeled by intervals
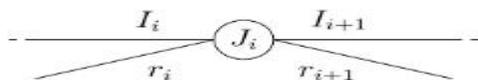
, , . Junction is located at for

Figure 2: Sketch of a roundabout junction.

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To recover the behavior of the roundabout periodic boundary conditions are introduced on the main lane such that. Each junction is composed of a main lane and by two links

Where is the mean traffic density, the maximal density allowed on the road. The

representing a lane with incoming flux () and a lane with outgoing flux (see Figure 2. The evolution of the traffic on the main lane segments is given by the scalar hyperbolic conservation law: (), (2.1)

flux function is given by the following flux-density relation:

With the maximal traffic speed, the critical density and the maximum flux value. We define the congested flow speed as: for . Throughout the paper, for simplicity, we will assume and Figure 3 shows an example of flux function satisfying the hypotheses. For the theory of scalar hyperbolic conservation laws we refer to [1].

Figure 3: Flux function.

The incoming lanes of the secondary roads entering the junctions are modeled by buffers of infinite size and capacity. This

choice is made to avoid backward moving shocks at the boundary. The evolution of the queue length of each buffer is described by the following ODE: - , (2.2)

where is the unique length, the flux entering the lane and the flux exiting the lane. The outgoing lane is considered as a sink that accepts all the flux coming from the roundabout. No flux from the incoming lane is allowed to turn back on the outgoing

stretch of the same road. The Cauchy problem to solve is then: (2.3)

for where are the initial densities on and the initial lengths of the buffers. This will be coupled with an optimization problem at the junctions that gives the distribution of traffic among the roads.

We define the demand function of the incoming lane for the secondary road, the demand function on the incoming roundabout segment at each junction, and the supply function on the outgoing main

lane segment at each junction as follows: (2.4)   (2.5)   (2.6)

for , where is the maximal flow on the incoming lane , Moreover, we introduce the split ratio of the outgoing lane and its flux ,

Definition 1 Consider a roundabout as in Figure 1. A 2m-tuple

is an admissible solution to (2.3) if
1.   satisfies the Kru entropy condition [14] on , that is, for every and for all , .

$$\int_{\mathbb{R}^+} \int_{I_i} (|\rho_i - k| \partial_t \varphi + \text{sgn}\,(\rho_i - k)(f(\rho_i) - f(k)) \partial_x \varphi) dx dt$$
$$+ \int_{I_i} |\rho_{i,0} - k| \varphi(0, x) dx \geq 0; \quad i = 1, 2, \ldots, m. \qquad (2.7)$$

2.   = ,
3.   The outgoing flux is maximum subject to
     and condition 2
4.   solves (2.2) for almost every .

Remark 1 A parameter is introduced to ensure uniqueness of the solution, that is, is a priority parameter that defines the amount of flux that enters the outgoing mainline from each incoming road. In particular, when the priority applies, is the flux allowed from the incoming mainline into the outgoing mainline, and the flux from the onramp.

3. Riemann Problem at a Junction

In this section we treat the construction of Riemann solver at each junction of a roundabout in order to match priority rules on the roundabout. We define the Riemann Solver at junction by means of a Riemann Solver: which depends on the instantaneous load of the buffer. For each, the Riemann Solver is constructed in the following way. For each, we fix and proceed:

1. Define , , ;
2. Consider the space and the sets = ;
3. Trace the lines = ; and ;
4. Consider the region   (3.1)

Different situations can occur depending on the value of

Demand-limited case:
        We set =, =   and as illustrated in Figure 4(a).
- **Supply-limited case:**

We set Q to be the intersection point of and If we set = Q and   see Figure 4(b);

if , we set and   where S is the point of the segment closest to the line , see Figure 4(c).

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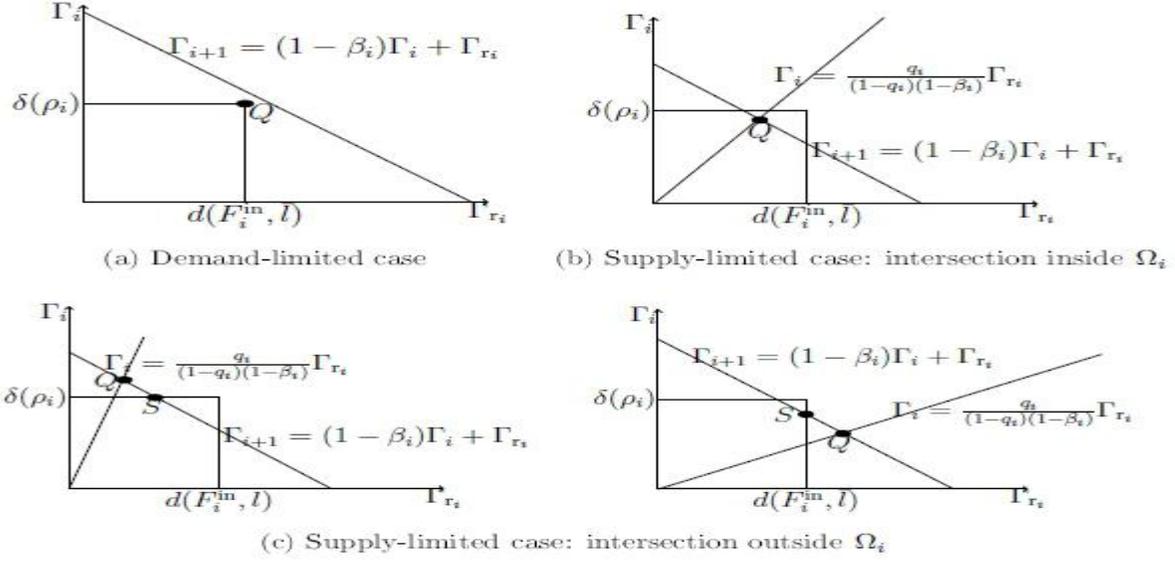
Figure 4: Solutions of the Riemann Solver at the junction.

We define the function as follows, for details see [8].

Definition 2 Let be the map such that
- for every ;
- for every

Theorem 1 Consider a junction and fix a priority parameter. For every and there exists a unique admissible solution satisfying the priority (possibly in an approximate way). Moreover, there exists a unique couple such that (3.2) and (3.3)

For the incoming road the solution is given by the wave (), while for the outgoing

road the solution is given by the wave (). Furthermore, for almost every t > 0, it holds = .

Proof. Existence and uniqueness follow directly by construction of the Riemann Solver presented under section 3. Recalling that the solution of the Riemann problem consists of a shock wave with a negative speed on the incoming road and positive speed on the outgoing road, the proof of the consistency of can be achieved as given in [6].

4. Numerical Scheme

To compute approximate solutions, we adapt the classical Godunov scheme to our problem with some adjustment due to the
- , are the cell interface;

presence of the buffer as detailed in Section 4.1. We use the following notation to define a numerical grid in]:

- represents the length of each segment of the roundabout and Dt is the time step, to be define according the CLF stability condition below;
- , are the time grid points.

4.1 Godunov Scheme at Junctions

In this work we consider the distance between two adjacent junctions of a roundabout as the fixed space grid size of the Godunov discretization and junctions as cell interfaces. This is because each link of the roundabout is reasonably short to fit the scheme discretization. In this setting, on the main road of the roundabout the traffic dynamics can be modeled as,   (4.1)

Where ,   (4.2)

The fluxes and stand respectively for inflow and outflow at junctions and on the main road of the roundabout. Under the Courant-Friedrichs-Lewy (CFL) condition [15],   (4.3)

where . This condition ensures that waves origination at an interface do not cross other interfaces before Dt. In (4.1), we model the dynamics of traffic on roundabout as a discretized PDE with stochastically random in flux at each junction which make it different from the model presented in [17].

4.2 Computing Buffer Length from ODE

We consider the buffer evolution described by (2.2) to compute the queue length on the secondary road of a roundabout. At each time step we update the new value of the queue length as follows:

1. If , the buffer length is increasing and we set,   (4.4)
2. If , the buffer length is decreasing and we set (4.5)

   the time at which the buffer empties.

      i. If , (4.6)

      ii. If , adjust by taking Dt and

Below, we explicitly detail and based on different cases of Riemann Solvers at junctions. The situation at junctions can be cases are detailed.

demand-limited or supply-limited. Both

(a) Demand-limited case at junction:

In this case we set $\hat{\Gamma}_i = \delta(\rho_{i-1})$ and $\gamma_{ri} = d(F_i^{im}, l_i)$. From this it is evident that those who demand to enter the junction can assess it without restriction.
Hence,

$$F_i^{n,+} = (1-\beta)\delta(\rho_i^b) + d(F_i^{im}, l_i^b) \quad (4.7)$$

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and at the instant time t^n, the flux at the left side of the junction reads as

$$F_i^{n,-} = \delta(\rho_i^n)$$ (4.8)

Besides, the dynamics of buffer length at the entrance of the roundabout is governed by

$$\frac{d}{dt} l_i^n(t) = F_i^{in} - d(F_i^{in}, l_i^n)$$,

This gives

$$l_i^{n+1} = l_i^n + (F_i^{in} - d(F_i^{in}, l_i^n))\Delta t$$ (4.9)

(a) Supply-limited case at junction:
We calculate the flux at the right hand side of the junction as

$$F_i^{n,+} = \sigma(\rho_{i+1}^n)$$ (4.10)

while on the left it becomes

$$F_i^{n,-} = \begin{cases} \delta(\rho_i^n) & \text{if } 1 \geq q_i > \min\{1, Q_2^i\} \\ \dfrac{q_i}{1-\beta_i}\sigma(\rho_{i+1}^n) & \text{if } \max\{0, Q_1^i\} \leq q_i \leq \min\{1, Q_2^i\} \\ \dfrac{q_i}{1-\beta_i}\sigma(\rho_{i+1}^n) & \text{if } 0 \leq q_i < \max\{0, Q_1^i\} \end{cases}$$ (4.11)

Where

$$Q_1^i = \frac{\sigma(\rho_{i+1}^n) - d(F_i^{in}, l_i^n)}{\sigma(\rho_{i+1}^n)} \quad \text{and} \quad Q_2^i = \frac{(1-\beta_i)\delta(\rho_i^n)}{\sigma(\rho_{i+1}^n)}$$ (4.12)

As in the previous case the dynamics of the buffer length is governed by

$$\frac{d}{dt} l_i^n = \begin{cases} F_i^{in} - (\sigma(\rho_i^n) - (1-\beta_i)\delta(\rho_i^n)) & \text{if } 1 \geq q_i > \min\{1, Q_2^i\} \\ F_i^{in} - (1-q_i)\sigma(\rho_{i+1}^n) & \text{if } \max\{0, Q_1^i\} \leq q_i \leq \min\{1, Q_2^i\} \\ F_i^{in} - d(F_i^{in}, l_i^n) & \text{if } 0 \leq q_i < \max\{0, Q_1^i\} \end{cases}$$,

which integrating yields

$$l_i^{n+1} = \begin{cases} l_i^n + (F_i^{in} - (\sigma(\rho_{i+1}^n) - (1-\beta_i)\delta(\rho_i^n)) & \text{if } 1 \geq q_i > \min\{1, Q_2^i\} \\ l_i^n + (F_i^{in} - (1-q_i)\sigma(\rho_{i+1}^n))\Delta t & \text{if } \max\{0, Q_1^i\} \leq q_i \leq \min\{1, Q_2^i\} \\ l_i^n + (F_i^{in} - d(F_i^{in}, l_i^n))\Delta t & \text{if } 0 \leq q_i < \max\{0, Q_1^i\} \end{cases}$$ (4.13)

5. Optimization of PDE-ODE Constrained System

We are interested in determining discrete instantaneous optimal priority parameters to minimize total travel time on the roundabout on a fixed time interval expressed by the cost functional (5.1)

where, is the time dependent vector of control variables.

We select instantaneous optimal control approach to minimize the total travel time on the networks of the roundabout under consideration. Given a time step compatible with the CFL condition (4.3), we introduce the instantaneous cost functional at time given as:

where the dependencies of and on are expressed by (4.7)-(4.9) in the demand-limited case and by (4.10)-(4.13) in the supply-limited situation. Within this framework, we treat both demand and supply-limited cases at junctions. In the computation of the gradient, we consider each cases based on the situation at the corresponding junction of the roundabout. The optimization problem can be formulated as (5.3)

subjected to constraints given by equations (2.1) and (2.2).

Remark 2. Note that the role of the control parameters is to force the priority to neither impose insufficient flows nor send excess vehicles than the carrying capacity of the main link of the roundabout.

Theorem 2 Consider junctions of a roundabout as in Figure 1 with two incoming and two outgoing roads at each junction. Suppose the instantaneous cost functional at time is given by equation (5.2). Then the optimal priority parameter exists and it is obtained at which is given by equation (4.12) and for each .

Proof. Note that the cost functional is piecewise linear and continuous with respect to the priority parameter . Furthermore, it is non-convex. Thus, computing straight forward partial derivatives with respect to , gives (5.4)

where and are as given by (4.12). This implies that is decreasing on the interval . Since is piecewise continuous and decreasing on the compact set , the optimal point exists by Weierstrass extreme value theorem. Consequently the values of optimal priority parameter is attained at for each

and for . Therefore, any choice of solves (5.3), resulting in the same flow dynamics.

The optimal parameter values are used to update the priority variables which is adjusted for each iteration n to produce local optimal solution that satisfies the given target.

6. Numerical Tests

In this section we detail the results obtained through numerical simulations for a roundabout modeled as a chain of four junctions with two incoming and two outing roads at a junction. We represent the roundabout as:

- 5 roads forming the roundabout: with and linked with periodic boundary conditions;
- 4 roads connecting the roundabout with the rest of the road network: 4 incoming and 4 outgoing lanes.

We want to compare the effectiveness of instantaneous optimal choices of the priority parameters given by with respect to fixed constant parameters using the cost functional (5.1) introduced in Section 5. For this, we compute the corresponding value of the discretized functional = (6.1)

With is piecewise constant on [, [, n = n_T, where we set = 0 and = T.

6.1   Simulation Characteristics

Below, we present the choice of simulation parameters. The numerical approximation of the hyperbolic conservation laws that describe the evolution of densities for each road of the roundabout is made using the Godunov scheme described in subsection 4.1. The time step is determined is determined by the CFL stability condition (4.3) with coefficient equal to 0.5. Periodic boundary conditions are imposed on the left and right of the computational domain. The ODE is discretized using an explicit Euler first order integration method. The roundabout traffic evolution is simulated on a time interval, with , long enough to obtain a stabilized situation.

At initial time, we assume that all the links and the buffers are empty, and we impose $F_i^{in} \neq 0$ at each junction given by:

$$F_1(t) = \begin{cases} 0.08 t f^{max} & if \ 0 \leq t \leq 10; \\ 0.8 t f^{max} & if \ 10 \leq t \leq 20; \\ -0.8 t f^{max} + 2.4 f^{max} & if \ 20 \leq t \leq 30; \\ 0 & if \quad t > 30; \end{cases}$$

$$F_2(t) = \begin{cases} 0.05 t f^{max} & if \ 0 \leq t \leq 10; \\ 0.5 t f^{max} & if \ 10 \leq t \leq 20; \\ -0.5 t f^{max} + 1.5 f^{max} & if \ 20 \leq t \leq 30; \\ 0 & if \quad t > 30; \end{cases}$$

$$F_3(t) = \begin{cases} 0.1 t f^{max} & if \ 0 \leq t \leq 10; \\ f^{max} & if \ 10 \leq t \leq 20; \\ -0.1 t f^{max} + 3 f^{max} & if \ 20 \leq t \leq 30; \\ 0 & if \quad t > 30; \end{cases}$$

$$F_4(t) = \begin{cases} 0.02 t f^{max} & if \ 0 \leq t \leq 10; \\ 0.2 t f^{max} & if \ 10 \leq t \leq 20; \\ -0.02 t f^{max} + 0.6 f^{max} & if \ 20 \leq t \leq 30; \\ 0 & if \quad t > 30; \end{cases}$$

where $F_1^{in}, F_2^{in}, F_3^{in}$ and F_4^{in} respectively are the influx traffic on the incoming external roads toward a roundabout. For simulation purpose, we set $\rho_{max} = V_f = 1, \ f^{max} = \rho_c = \frac{2}{3}, L_i = 1$ and $\gamma_{ri}^{max} = \frac{2}{3}$ for all $i = 1, \rightarrow 4$. Finally, we study different simulation cases based on fixed control parameters and traffic splitting rate

$β_r$ For each of them we perform two simulation cases: Instantaneous optimal priority parameters for which we used

$$q_i = Q_2^i, i = 1, \_, 4$$

to compute the corresponding value of and as a second case we considered fixed optimal priority parameters to calculate the corresponding total travel time on the network of a roundabout.

6.2 Simulation Results

We run simulations for the values of, optimal and fixed priority parameter. Then we compute total travel time for different fixed and optimal . For comparison purpose, we calculate the difference between these values of total travel time and analyses its percentage gain and loss. Figures 5-7 show the amount of vehicleswaiting on the incoming road network of a roundabout. The sizes of queue length indirectly estimate the nature of total travel time and the presence of shock wave on the network under consideration.
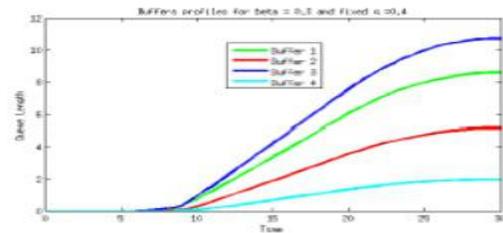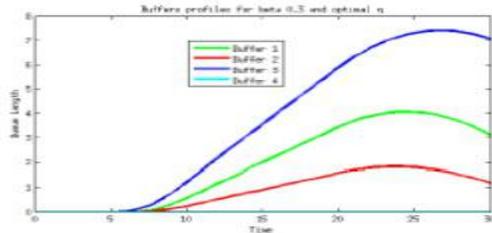
(a) Buffer Profiles for $\beta = 0.3$ and optimal q. (b) Buffer Profiles for $\beta = 0.3$ and fixed q =0.4.

Figure 5: Improvement in queue length using instantaneous optimal parameters compared to fixed parameter for the same distribution rate. It describes the dynamics of traffic evolution on the incoming roads of a roundabout
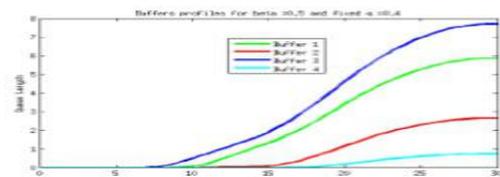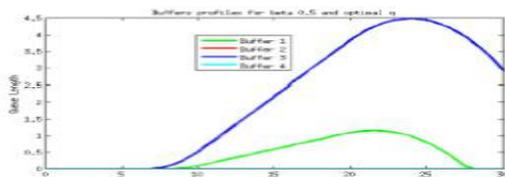
(a) Buffer Profiles for $\beta = 0.5$ and optimal q. (b) Buffer Profiles for $\beta = 0.5$ and fixed q =0.4.

Figure 6: Traffic evolution on the incoming roads of the roundabout for larger distribution rate.

For the same distribution rate and different influx at each junction, the simulation result reveals different scenarios as a consequence of our approach. Due to difference in the magnitude of queue length, the amount of vehicles waiting on the network is higher in the case of Figure 5b compared to Figure 5a. In particular, there is no vehicle waiting on the incoming external road 4 of a roundabout

in the case of Figure 5a while there is a queue in the case of Figure 5b which shows the presence of shock wave propagating backward. In both case, queue start building after fifth iteration time which is the actual physical phenomena for an empty road network at starting time.
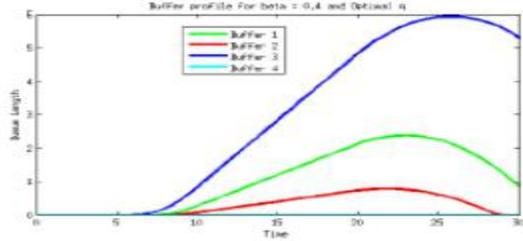
(a) Buffer profiles for optimal priority.
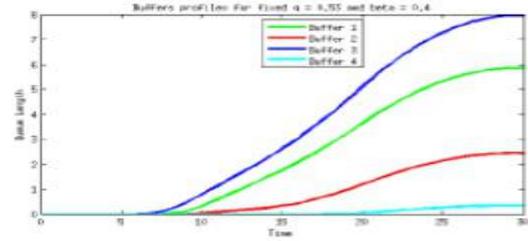
(b) Buffer profiles for qixed priority $q = 0.53$

Figure 7: Traffic dynamics on the incoming roads of the roundabout as we increase the values of fixed priority parameter.

From these figures, one can easily infer that, queue length decreases as the distribution rate increases and eventually clear from the network. Similarly, as we favor main-lane the buffer length get decrease in magnitude.
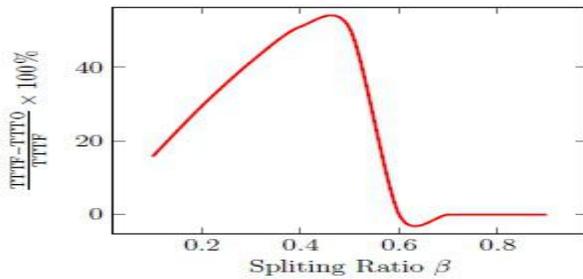
(a) Roundabout with pedestrians on the crosswalk (b) Roundabout without pedestrians on the crosswalk.
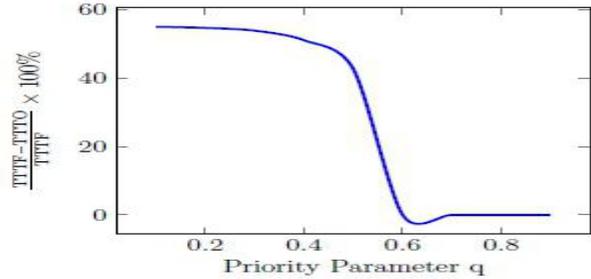
Figure 8: Traffic evolution on the outgoing roads of the roundabout.

As indicated in Figure 8a and 8b, the percentage gain in total travel time are almost nil in the case of demand-limited and both approaches give the same value. Additionally, when both distribution rate and the fixed priority parameters are greater than both behaves similarly. Approximately for, the percentage change in total travel time linearly increases and then tends to decline for. That is, as the traffic inflow increases on the incoming secondary roads at the entrance of the roundabout, sensible percentage gains is observable for both different fixed constant and optimal, and then diminish as the distribution rate increases. These situations correspond to

supply-limited cases on the main lane of the roundabout. This shows that, when a large population of vehicles remains on the main road of the roundabout, the instantaneous

For the fixed priority parameters greater than at each junction both approaches take the same values. This is due to the fact illustrated by Figure 4c in Section 3. That is, the junction solution is approximated by the point on the feasible set. Furthermore, as the optimal choice of priority parameter increases the performance of the roundabout compared to different fixed values of.

values of the fixed parameters decreases, the instantaneous choice of optimal parameter shows better performance in increasing traffic throughput. Compared to small fixed priority parameters, larger fixed values are better in optimizing traffic flux on the network portion, see Figure 8b.

7. Conclusion

In this paper, we present traffic flow model and optimization approach on a roundabout using scalar conservation laws. We first discretize the hyperbolic PDE via the Godunov scheme and the ODE using an explicit Euler first order integration method.

The simulation results show that instantaneous optimal choice of the priority parameters produce beneficial results in improving the performance of the roundabout compared to the fixed choice of priority parameters. In the case of fixed priority parameters, larger fixed values are better in optimizing traffic flux on the main lane of the roundabout relative to smaller values.

We compute the gradient of the cost functional that measures the instantaneous total travel time at each time step and find the optimal priority parameters. Numerical tests are conducted for a roundabout with four incoming and four outgoing roads.

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2D Optical Fiber Wave Guide Design For Multi Haul Applications

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Abstract

The optical communications had an exponential growth over the last few years, having a significant commercial market in optical systems and components. This growth has been extended across all application areas, from transcontinental and transoceanic distances to regional networks and lastly to campus and building wiring. This paper basically explains the concept of Optical fiber communication, the propagation of light inside the fiber and mainly the two dimensional design of optical fiber itself. The researchers discussed the parameters such as effective group delay, dispersion. Modes, Bending Loss, Material Loss, Mode field, Birefringence, Splice Loss, Polarization Mode Dispersion (PMD), Effect of nonlinear Refractive Index. Finally they designed the optical fiber with all the above mentioned parameters.

Key words: Group delay, Dispersion. Modes, Birefringence,Mode field, Polarization Mode Dispersion (PMD)

I.   Introduction

In the early stages of development of technology, fiber communication promised extremely high data rates, which allow large amount of data to be transmitted at a higher data rate. It also had the potential for transmission over long distances without a repeater. The bandwidth of the fiber optic communication system, determines the maximum data rate and the major components of the system. Fig.1 shows the block diagram of fiber optic communication system. The information signal that is to be transmitted may be computer data, video or voice. The first step is to convert the information into a form well suited with the communications medium. This is usually done by altering continuous analog signals such as TV (voice and video) signals into a series of digital pulses.

An A/D converter is used for this purpose. These digital pulses are then used to flash a powerful light source to off and on very rapidly. In a simple system for short distances, the light source is usually a light emitting diode. This is a semiconductor device that gives low intensity red light. Other colors are also used. Another commonly used light source is the solid state laser that generates an extremely high intense coherent light beam. This light beam pulses are then fed into a fiber cable where they are communicated over long distances. At the receiving end, a light sensitive device known as a light detector or photocell is used to detect the light pulses. This photo detector or photocell converts the light pulses into an electrical signal.
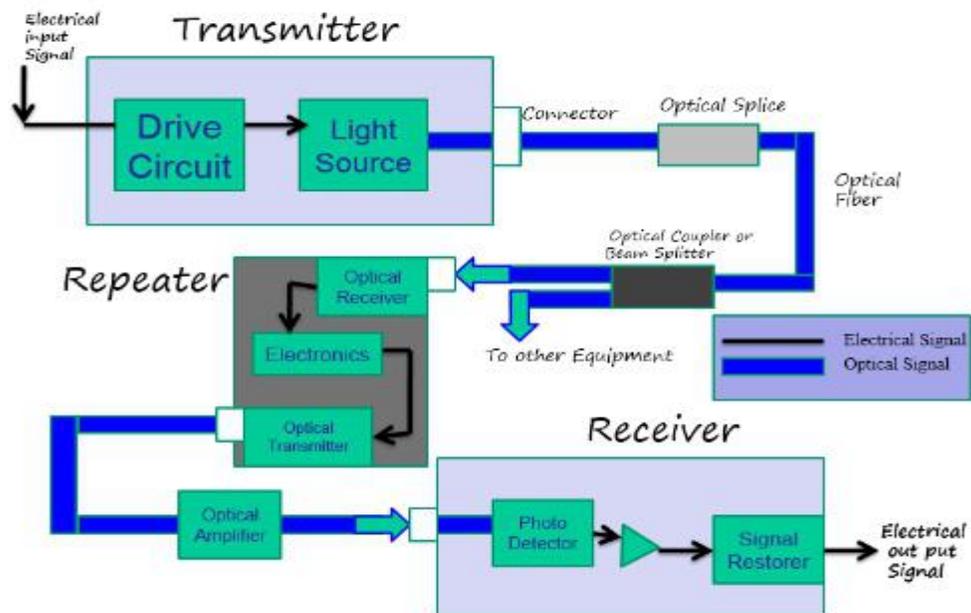
Figure 1: Block diagram of Optical fiber Communication

The electrical pulses are then amplified and reshaped back into digital form. Both the sources at the sending end and the detectors on the receiving end must operate at the same data rate. The device that drives the light source and the circuit that amplify and process the detected light must have suitable high-frequency response. The fiber itself must not garble the high-speed light pulses used in the data transmission.They are given as an input to a decoder, such as a D/A, where the original data is recovered. In very long transmission systems, repeaters are used along the way. Since the light is significantly attenuated when it travels over long distances, at some distance it may be too weak to be received constantly. To overcome this difficulty, special repeater stations are used to pick up light beam, they convert it back to electrical pulses that are amplified and then re-transmit them. Several stages of repeaters are desired over very long distances. This attenuation is due to so many parameters and are discussed in detail as follows.

I. Effective group delay

If the index of refraction of the fiber material varies with wavelength causing thegroup velocityto vary, it is represented as material dispersion.

The group delay T_g is given by the product of the transmission distance z by the first derivative of frequency of the propagation constant:

$$T_g = z\frac{d\beta}{d\omega} = z\frac{d\lambda}{d\omega}\frac{d(nk_0)}{d\lambda}$$; Where n is the refractive index; $\lambda = \frac{2\pi c}{\omega}$, $k_0 = \frac{2\pi}{\lambda}$;

We have $$T_g = \frac{-2\pi cz}{\omega^2}\left(k_o\frac{dn}{d_\lambda} + \frac{dk_0}{d_\lambda}\right) = \frac{z}{c}\left(n - \lambda\frac{dn}{d\lambda}\right)$$

The dispersion coefficient D is defined as $D = \frac{dT_g}{d\lambda}$; in bulk materials we have $D = -\frac{z}{c}\lambda\frac{d^2n}{d\lambda^2}$

Material dispersion of the fiber

We have an equation that the velocity of light in a medium is given by v = c/n. where *n* is the refractive index of the medium, which depends on the wavelength. This dependence of the refractive index on wavelength leads to *dispersion,* if a white pencil light beam incident on a prism. Since the refractive index of glass depends on the wavelength, the angle of refraction will be different for different colors. The incident light will therefore *disperse* into its constituent colors, the dispersion will become more evident at the second surface of the prism. The quantity

v defined is usually referred to as the *phase velocity*.

However, a pulse which is known as the *group velocity,* travels which is given by $v_g = c/n_g$; where n_g is known as the group index and, in most cases its value is slightly larger than n. In Table1 presents n and n_g for pure silica for varying wavelength between 700 nm and 1600nm.

Table 1: Refractive index and group index with varying wavelength

λ0 (nm)	n (λ0)	n_g (λ0)	Dm(ps/nm-km)
700	1.45561	1.47154	−172.902
750	1.45456	1.46924	−135.313
800	1.45364	1.46744	−106.609
850	1.45282	1.46601	−84.2077
900	1.45208	1.46489	−66.382
950	1.45139	1.46401	−51.9441
1000	1.45075	1.46332	−40.0577
1050	1.45013	1.46279	−30.1214
1100	1.44954	1.46241	−21.6951
1150	1.44896	1.46214	−14.4511
1200	1.44839	1.46197	−8.14213
1250	1.44783	1.46189	−2.57872
1300	1.44726	1.46189	2.38579
1350	1.44670	1.46196	6.86631
1400	1.44613	1.46209	10.9539
1450	1.44556	1.46229	14.7211
1500	1.44498	1.46253	18.2268
1550	1.44439	1.46283	21.5187
1600	1.44379	1.46318	24.6358
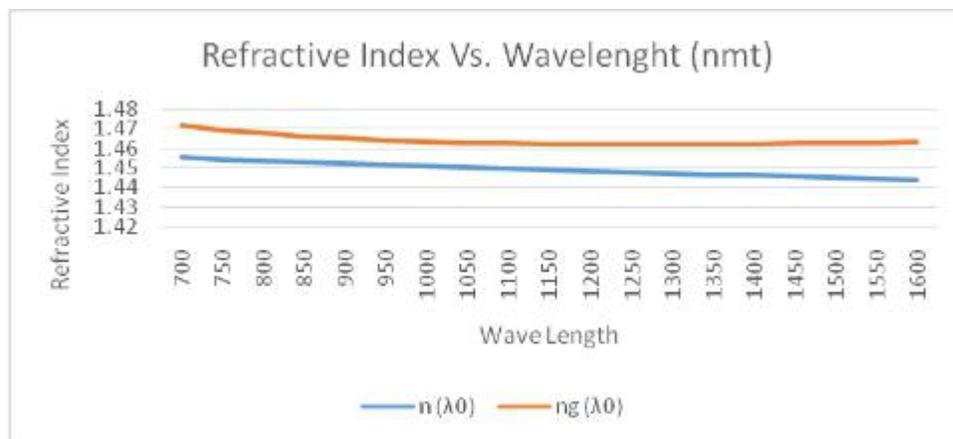
Figure: 2Refractive Index vs. Wavelength (nm)

In a fiber, the core and cladding are fabricated with different materials. We assume that there are L layers in the fiber cross-section, each layer has its own refractive index.

The total material dispersion of the optical fiber is calculated by: $D(\lambda) = -\frac{z}{c}\sum_{i=1}^{L}\Gamma_i\frac{d^2 n_i}{d\lambda^2}$ -- (1)

Where Γ_i is the confinement factor of each layer. The confinement factor is the portion of total power guided in the ith layer.

Waveguide dispersion of the fiber

Wavelength dependence of the effective refractive index N_{eff} of the fiber mode results in Waveguide dispersion. The waveguide dispersion is calculated by: $D_{wg} = -\frac{z}{c}\lambda\frac{d^2 N_{eff}}{d\lambda^2}$

Total dispersion of the fiber

The total dispersion is the total effect of different dispersions such as material and waveguide. First the material dispersion effect will be calculated. Then the mode solver calculates the mode effective index N_{eff}. The total dispersion of a fiber is: $D_{tot} = -\frac{z}{c}\lambda\frac{d^2 N_{eff}}{d\lambda^2}$ --- (2)

I.   **Mode Field Diameter and Mode Area Definitions**

Mode field diameter and area importance

The Mode Field Diameter is an important parameter related to the optical field distribution in the fiber. It has been shown that MFD provides useful evidence about the fiber cabling behavior, such as possible joint, macrobending, and microbending losses. The actual area of the fibers has a relation to the nonlinear distortions in long fiber links.

Near-field diameter definition

The near-field Mode Field Diameter is also known as the "Petermann I" diameter. It is defined as the diameter at which the near field power falls to $\frac{1}{e^2}$ of its maximum value. It can be calculated by [1]: $d_n = 2\sqrt{2}\left(\frac{\int_0^{\infty} E^2(r)r^3 dr}{\int_0^{\infty} E^2(r)r dr}\right)^{1/2}$ --- (3)

Where E(r) is optical mode field distribution.

Far-field diameter definition

The far-field Mode Field Diameter is also known as the "Petermann II" diameter. It is defined as the diameter at which the far field power falls to $\frac{1}{e^2}$ of its maximum value. It can be calculated by [1]: $d_n = 2\sqrt{2}\left(\frac{\int_0^{\infty} E^2(r)r dr}{\int_0^{\infty} [E'(r)]^2 r dr}\right)^{1/2}$ --- (4)

Where E(r) is the optical mode field distribution, and prime denotes the first derivative of E(r)

Effective mode area definition

The effective Mode Area is calculated as $A_{eff} = \frac{\left[\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}|E(x,y)|^2 d_x d_y\right]^2}{\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}|E(x,y)|^4 d_x d_y}$ --- (5)

Where E(x,y) is the optical mode field distribution

Effective mode field diameter definition

Effective Mode Field Diameter defined as:

$d_{eff} = \frac{2\sqrt{2}\int E_i^2 r dr}{\left[\int E_i^4 r dr\right]^{\frac{1}{2}}} \Rightarrow d_{eff} = \frac{2}{\sqrt{\pi}}\sqrt{A_{eff}}$ --- (6)

Where E(r) is the optical mode field distribution

I.   Fiber Loss Models

Fiber propagation loss definition

The total fiber loss can be divided into fiber induced losses and material losses. Material losses include Rayleigh scattering, ultraviolet, infrared absorption, and hydroxyl absorption losses. Material losses are the restraininglosses in fibers. Fiber loss is defined as the ratio of the output optical power P_{out} from a fiber of length L to the input optical power P_{in}. The symbol α is commonly used to express loss in $\frac{dB}{Km}$; $\propto = \frac{10}{L} log\left(\frac{P_{in}}{P_{out}}\right)$ --- (7)

Rayleigh scattering model

Light transmitted through the fiber suffers scattering loss due torough appearance of atoms or molecules of the glass fiber, which is known as Rayleighscattering loss. The fiber loss is expressed in $\frac{dB}{Km}$ through [2]: $\propto_s = \frac{A}{\lambda^2}$; for a single-component glass such as Sio2 $A = \frac{8\pi^3}{3}n_0 P^2 \beta kT$; Where n_0 is the refractive index, p is the photoelastic coefficient, β is the thermal compressibility, k is the Boltzmann coefficient, and T is the absolute temperature ofthe sample.

Macrobending loss model

The macrobending loss is a radiative loss occurs when the fiber bend radius is large compared to the fiber diameter. It is defined as usual by $P(Z) = P(0)e^{-\gamma z}$; where $P(0)$ is the input power and $P(Z)$ is the output power at distance z respectively.

There are two models for Macrobending. The first uses the closed-form integral formula[3]. Using this the macrobending powerloss

coefficient is expressed as a function of the bending radius R_b in the form:

$$\gamma = \frac{\sqrt{\pi}(\frac{P_{clad}}{P})}{2sr_c[K_{v-1}(W)K_{v+1}(W)-K_v^2(W)]} \frac{exp\left(\frac{-4\Delta W^3}{3r_cV^2}R_b\right)}{W\left(\frac{WR_b}{r_c}+\frac{v^2}{2\Delta W}\right)^{\frac{1}{2}}} \quad \text{--- (8)}$$

The parameters appearing above are given by:

$$V = K_0 r_c \sqrt{N_{max}^2 - N_{clad}^2}$$ is the normalized dimensionless frequency;

$$W = r_c\sqrt{\beta^2 - (k_0N_{clad})^2}; \quad \Delta = \frac{(N_{max}^2 - N_{clad}^2)}{2N_{max}^2};$$

where r_c designates the fiber core radius, N_{max} is the maximum refractive index and N_{clad} is the cladding refractive index, β is the mode propagation constant, K_0 is the propagation constant in vacuum, v is the azimuthal mode number, $s = 2$ if $V = 0$ or $s = 1$ if $V \neq 0$ and K_v is the modified Bessel function of the second kind of order v. Second macrobending loss model is expressed as [4]:

Where F_0 is the radial field of the fundamental mode.

$$f = \frac{N_{max}^2 - N(R)^2}{N_{max}^2 - N_{clad}^2};$$ and N(R) is the refractive index profile of the fiber. The other parameters are given above. The two models give similar results for step-index fibers. The loss coefficient γ can be converted to loss in $\frac{dB}{Km}$ units as follows:

$$\gamma = \left(\frac{\pi v^3}{16r_cR_bW^3}\right)^{1/2} exp\left(\frac{-4\Delta W^3 R_b}{3r_cV^2}\right)\frac{[\int_0^{-\infty}(1-f)F_0RdR}{\int_0^\infty F_0^2RdR} \quad \text{--- (9)}$$

$$\propto_{macro} = \frac{10}{L} Log\left(\frac{P_{in}}{P_{out}}\right) = \frac{10}{L}log[exp(\gamma L)] = \frac{10}{ln(10)}.\gamma \quad \text{--- (10)}$$

Microbending loss model

Microbending loss is also a radiative loss in fiber resulting from mode coupling caused by random microbends, which are repetitive small fluctuations in the radius of the curvature of the fiber axis. An approximate expression for the attenuation coefficient is given by [5]:

$$\propto_{micro} = A(kn_1d_n)^2)(kn_1 d_n^2)^{2p};$$ Where A is a constant, d_n is the near field diameter, n_1 is the core refractive index, k is the free space wavenumber, and p is the exponent in the power law.

Splice loss model

A splice is a joint (dielectric interface between two optical fibers). Any refractive index mismatch will produce reflection and refraction at any point in this interface. For splicing calculations, it is assumed that the mode field of single-mode fiber is nearly Gaussian. The coupling losses for the splice can be calculated by evaluating the connection between two misaligned Gaussian beams. Based on the above model, the coupling loss between two single mode fibers is given by [6]:

$$\alpha_{splice} = -10 \log \left[\left(\frac{16 n_1{}^2 n_2{}^2}{(n_1+n_2)^2} \right) \frac{\sigma}{q} exp \left(\frac{-\rho u}{q} \right) \right] \quad \text{--- (11)}$$

Where $\rho = \frac{(kw_1)^2}{2}$; $q = G^2 + \frac{(\sigma+1)^2}{4}$

$$u = (\sigma+1)F^2 + 2\sigma FG\,\sin\theta + \sigma \left(G^2 + \frac{\sigma+1}{4} \right) \sin^2\theta \; , \; F = \frac{x}{kw_1{}^2} ; \; G = \frac{z}{kw_1{}^2} ; \; \sigma = \left(\frac{w_2}{w_1} \right)^2 ; \; k = \frac{2\pi n_2}{\lambda}$$

Where n_1 is Core refractive index of the fiber, n_2 is Refractive index of the medium between the two fibers, λ is Wavelength, w_1 is Near field mode field radius of transmitting fiber, w_2 is Near field mode field radius of receiving fiber, x is Lateral offset, z is Longitudinal offset, θ is Angular misalignment

I. Fiber Birefringence Models

Fiber birefringence definition

The difference between the propagation constants of the polarization Eigenmodes is defined as fiber

birefringence, that is: $\Delta\beta = \beta_x - \beta_y$.

The Differential Group Delay per unit length is defined by: $\partial\tau = \frac{\partial\Delta\beta}{\partial\omega} = -\frac{\lambda^2}{2\pi c} \frac{\partial\Delta\beta}{\partial\lambda}$ --- (12)

Intrinsic perturbations birefringence

Intrinsic perturbations generally have a huge impact in step index fibers only and they exist during the manufacturing process and are permanent feature of the fiber. They include a noncircular core and nonsymmetrical stress fields in the glass around the core region. A noncircular core results in geometric birefringence, whereas a nonsymmetrical stress field results instress birefringence.

Elliptical core birefringence definition

The geometrical variation of a non-circular core introduces a linear birefringence inthe optical fiber. This birefringence depends strongly on normalized frequency V, at which the fiber is being operated. The ellipticity (non circularity) of the core is defined by the

parameter ε and $\varepsilon = 1 - \frac{a}{b}$ Where a, b are the minor and major axis of the elliptical core respectively. The birefringence induced by an elliptical core is linear.

In the case of a step index fiber, the birefringence $\Delta\beta_{ell} = \beta_x - \beta_y$ is given by [7]:

$$\Delta\beta_{ell} = \varepsilon n_1 k_0 \Delta^2 \, G(V) \text{--- (13)}$$

Where $\Delta = \frac{n_1 - n_2}{n_1}$ is the refractive index difference between the core and the cladding.

The wave propagation constant is $k_0 = \frac{2\pi}{\lambda}$; the function $G(V)$ in the birefringence formula is

$$G(V) = \frac{w^2}{v^4}\left[U^2 + (U^2 + W^2)\left[\frac{J_0(U)}{J_1(U)}\right]^2 + UW^2\left[\frac{J_0(U)}{J_1(U)}\right]^3\right] \text{--- (14)}$$

With the following definitions of waveguide parameters $U = a\sqrt{n_1^2 k_0^2 - \beta^2}$ --- (15)

$$W = a\sqrt{\beta^2 - n_2^2 k_0^2} \text{ --- (16)}; \quad V = \sqrt{U^2 + W^2} = a k_0\sqrt{n_1^2 - n_2^2} \text{ --- (17)}$$

Where a is the core radius.

The Differential Group Delay per unit length is $\partial\tau_{ell} = \frac{\varepsilon n_1 \Delta^2}{c} \frac{d}{dV}[VG(V)]$ --- (18)

where c is the speed of light in vacuum.

Extrinsic perturbations birefringence

Birefringence can also be formed in a fiber when it is imperiled to external forces in handling or cabling. Such extrinsic sources of birefringence comprise of lateral stress, fiber bending and fiber twisting. All three of these mechanisms are usually present to some extent in coiled and field-installed telecommunications fiber.

Lateral stress birefringence definition

When two forces of equal and opposite in magnitude 'p' act across an axis of a fiber with a diameter d, the birefringence persuaded is linear. The firm axis of birefringence is aligned with the axis represented by the two opposite forces. The birefringence is given by [7]:

$$\Delta\beta_{lateral\,stress} = -8\frac{C_p k_0}{\pi d}\left[1 - \left(\frac{a}{d}\right)^2 H(V)\right] \text{ ---}$$

(20)

Where 'C' is Photoelastic constant, 'p' is Lateral force, k_0 is Wave propagation constant in vacuum, 'd' is The outer diameter of the fiber, 'a' is the average core radius.

Internal stress birefringence definition. The Differential Group Delay per unit length $\partial\tau_{lateral\ stress}$ is:

$$\partial\tau_{lateralstress} = -8\frac{c_p k_0}{\pi c d}\left[1 - \left(\frac{a}{d}\right)^2 H(V) + V\frac{dH(V)}{dV}\right]$$

--- (21)

Bending birefringence definition

Linear birefringence is a result of bending on a fiber with a bending radius R >> a (fiber core). The firm axis of birefringence is at a right angle to the bending plane.

The slow axis is aligned with the bending radius

.The birefringence is given by [7]:

$$\Delta\beta_{Bending} = -\frac{1}{8}\left(\frac{d}{R}\right)^2\frac{EC k_0}{\pi d}\left[1 - \frac{1}{3}\left(\frac{a}{d}\right)^2 H(V)\right]$$

--- (22)

With 'R' being the bending radius, and 'd' is the outer diameter of the fiber, 'E' is The Young modulus, 'C' is Photoelastic constant, $'k_0'$ is Wave propagation constant in vacuum, 'a' is the average core radius and, the Differential Group Delay per unit length is:

$$\partial\tau_{Bending} == -\frac{EC}{8c}\left(\frac{d}{R}\right)^2\left[1 - \frac{1}{3}\left(\frac{a}{d}\right)^2\left[H(V) + V\frac{dH(V)}{dV}\right]\right]$$
--- (23)

I. Polarization Mode Dispersion Models

Polarization mode dispersion

Propagation constants of the two polarization Eigen modes that are degenerate in ideal single-mode fibers in real telecommunications fibers, perturbations performance on the fiber in a way that it induces a birefringence. Consequently, when a pulse is made to transmit through a fiber, it results in a differential group delay between the two polarization Eigen modes. The stochastic behavior of these perturbations results in a phenomenon of random mode coupling which makes impossible about differential group delay.

Principal states of polarization

The Principal States of Polarization model [8] is based on the observation that at any given optical frequency, there occurs a set of two mutually perpendicular input principle states of polarization for which the corresponding output states of polarization are independent of frequency. The Differential Group Delay resulting from Polarization Mode Dispersion is then defined between the two output Principal States of Polarizations.

The birefringence in telecommunication single-mode fibers varies arbitrarily along the

fiber length, a product of variation in the drawing and cabling process. Furthermore, due to the temperature dependence of many of the fluctuations that present in the fiber during manufacturing, the transmission properties typically change as ambient temperature changes. In practice, these perturbations in temperature strongly affect Polarization mode dispersion time evolution. To assess properties of long fiber distances, one can adopt a statistical approach. In this case of long distance fibers, the polarization Eigen states can only be defined nearby and the birefringence vector has to be stochastic.

Dispersion vector

In the time domain, the Polarization Mode Dispersion induces a time shift between the two Principal States of Polarization. In the frequency domain, the output PSPs undergoes a rotation on the Point care sphere about an axis connecting the two PSPs.

The rate and direction of rotation is given by the dispersion vector $\Omega(\omega, z)$ given by:

$$\Omega(\omega, z) = \Delta\tau . P_b \text{--- (24)}$$

where P_b represents the negative output principal state.

The strength of the dispersion vector $\Omega(\omega, z)$ is equal to the differential delay time $\Delta\tau$ between the two output principal states, where its combined Stokes vector corresponds to the Stokes vector of the negative output principal state. The direction of the Dispersion Vector Ω defines an axis whose two intercepts with the surface of the Poincare sphere correspond to the two principal states of polarization at the fiber output.

The Poincare sphere is a graphical tool that allows convenient description of polarized signals and polarization transformations during propagation. A point within a unit sphere can uniquely represent any state of polarization, where circular states of polarization are located at the poles. The coordinates of a point within or on the Poincare sphere are the normalized Stokes parameters.

Effect of nonlinear Refractive Index

Usually one of the design goals when constructing a fiber is to minimize its nonlinearities. The effective nonlinear coefficients of optical fibers depend on the nonlinear indices of the bulk materials building the fiber and on its wave guiding properties: shape of modes, degree of confinement, etc. As a result it can vary within broad limits. The effective nonlinear coefficient are represented as

[9]: $$n_2{}^{eff} = \frac{\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} n_2(x,y)|F(x,y)|^4 dxdy}{\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}|F(x,y)|^2 dxdy} \text{ ;--- (25)}$$

where $n_2(x, y)$ is the user-defined spatially dependent nonlinear refractive index of the various fiber layers and $F(x, y)$ is the normalized mode field pattern.

II.   Simulation

The simulation is done having the view of the following parameters

Refractive Index Profile; Four regions are considered; Wave Length 1.3 μm

Region 0

Starting Index: 2.4437, Ending Refractive Index 1.6673, Width 4.2μm, user function

Position 4.2 μm with linear function and steps 20

Material Properties

Host- pure Silica, Dopant + is 3.1% germanium doped silicon,

Dopant – is 1% Fluorine doped silica

Region 1

Starting Index: 1.4437, Ending Refractive Index 1.4437, Width 2.5μm, with constant function and Refractive Index 1.4437, Position 6.7 μm linear function steps 1

Region 2

Starting Index: 1.44778, Ending Refractive Index 1.44778, Width 6.75μm, with user function and Position 13.45 μm linear function steps 30

Region 3

Starting Index: 1.44692, Ending Refractive Index 1.44692, Width 49.05 μm, with constant function and Refractive Index 1.4437.Position 62.5 μm linear function steps 1

As it is know for step index fibre there is always a sudden change in the refractive index profile at the interface between core and cladding materials, which is considered during the manufacturing of the fibre. This can be clearly observed in the fig 3.

Modal Index defines the phase delay per unit length for optical energy propagation in a

waveguide. In optical fibre, the guided Light experiences a phase delay along the propagation direction which depends on both Index of Refractions of the Core and the Cladding material. The variation of Modal Index with wavelength can be seen in fig 4.

Group delay is the time delay of the amplitude envelopes of the various frequency components of a signal through an optical fibre. Fig 5 plots the variation of Group delay with wavelength.

In optical fibres we have two types of dispersions namely wave guide and material, from the observation it has been seen that there is a maximum in total dispersion which is the

sum of the above two types of dispersions at almost 1.47 μm of wave length depicted in fig 6.

The MFD is used to expect fiber splice loss, bending loss, cutoff wavelength, and waveguide dispersion of an optical fiber, it is determined from the mode-field distribution of the fundamental fiber mode and is a function of the optical source wavelength, which is represented in fig 12.

The variation of Micro and macro bending loss is clearly represented in fig 9. When a pulse is transmitted through the single mode fiber it has to be completely confined within the fiber itself, which has been represented in fig 11.

The average value of all differential group delays is known as polarization mode dispersion and how this varies with wavelength is shown in fig. 14.
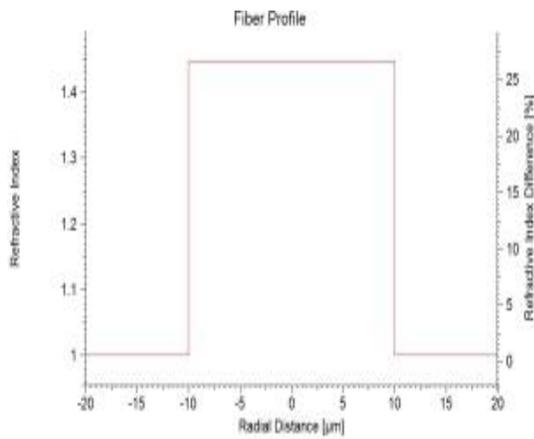
Figure 3: Refractive Index Profile
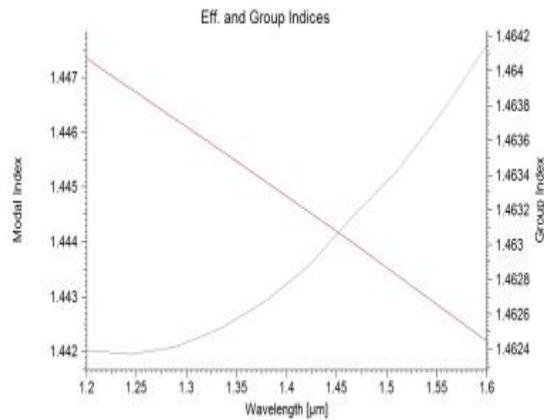
Figure 4: Modal Index Vs. Wavelength
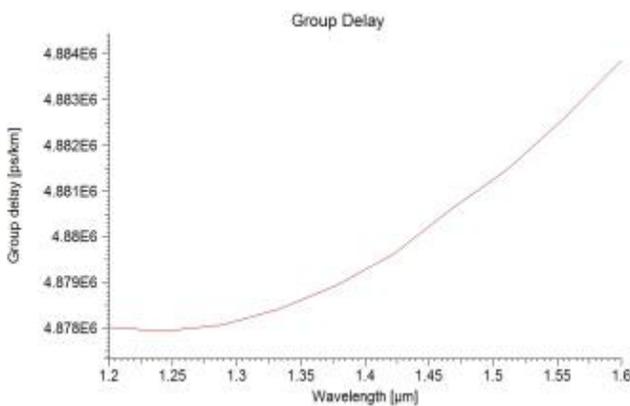
Figure 5: Group delay Vs. Wavelength
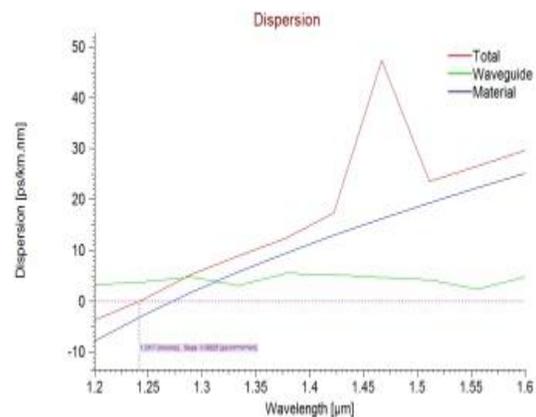
Figure 6: Dispersion vs. Wavelength

29
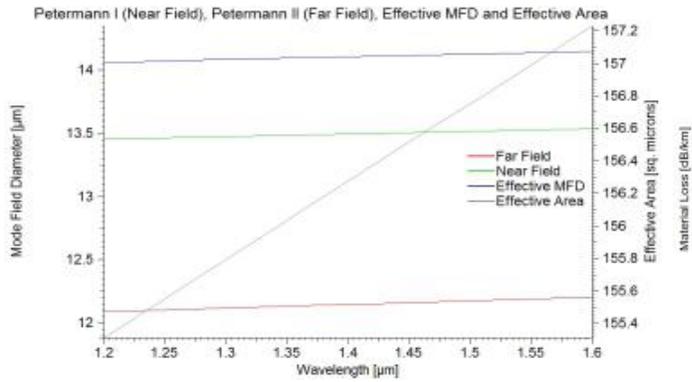
Figure 7: Mode Field vs. Wavelength
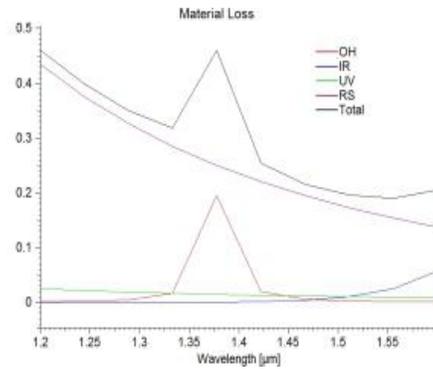
Figure 8: Material Loss vs. Wavelength
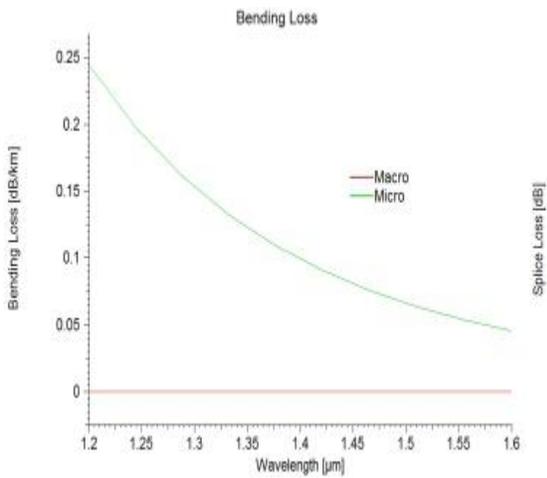
Figure 9: Bending Loss vs. Wavelength
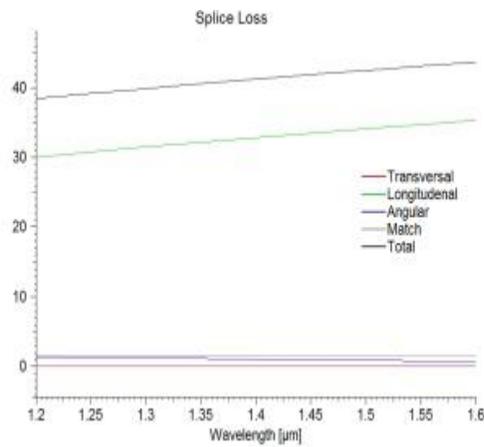
Figure 10: Splice Loss vs. Wavelength
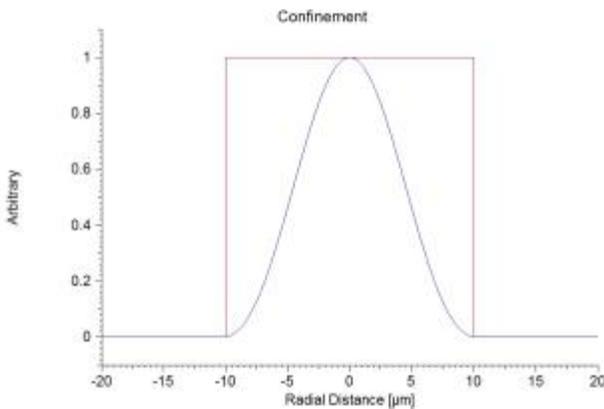
Figure 11: Confinement
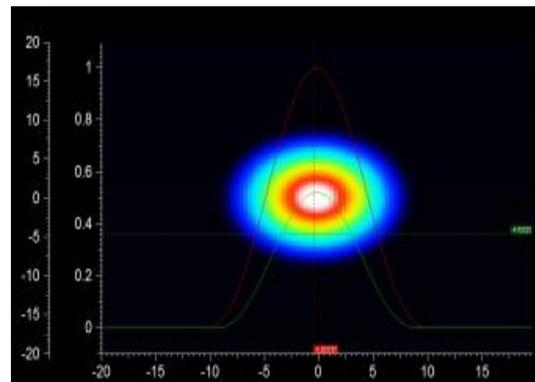
Figure 12: Mode field Diameter.
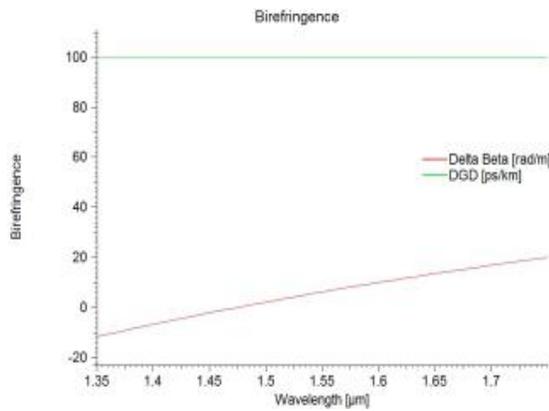
Figure 13: Birefringence vs. Wavelength
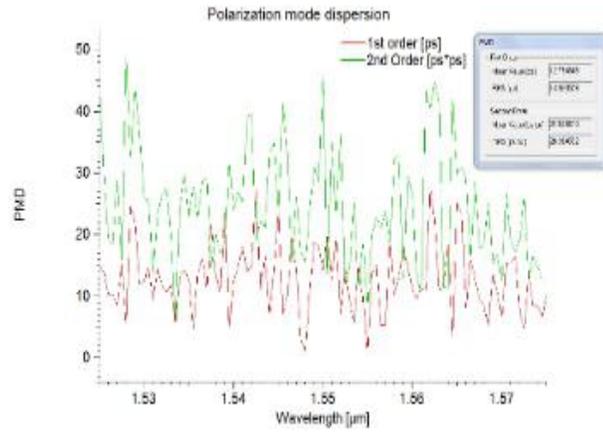
Figure 14: Polarization Mode Dispersion vs. Wavelength
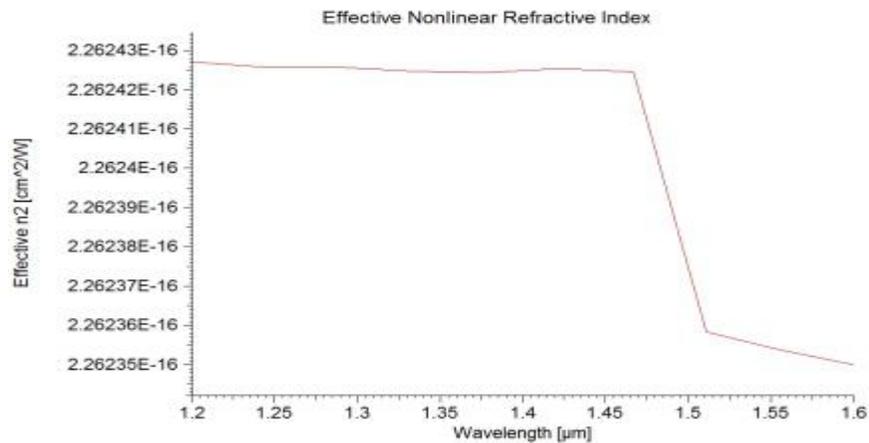
Figure 15: Effective Cladding Refractive Index vs. Wavelength

I.   Conclusion:

In this paper the concept of propagation of light with the two dimensional design of optical fiber has been explained. The parameters such as effective group delay, dispersion. Modes, Material Loss Bending Loss, Splice Loss, Mode field, Birefringence, Polarization Mode Dispersion (PMD), and Effect of nonlinear Refractive Indexare have been clearly elaborated and finally the optical fiber model with all the above mentioned parameters has been designed.

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Enzymatic Synthesis of Glucose Vernolates in a Mixture of Ionic liquid and Organic Solvent

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Abstract

In this study the synthesis of epoxy fatty acid esters of glucose (glucose vernolate) by the reaction of D-glucose with vernolic acid, (cis-12, 13-epoxy-cis-9-octadecenoic acid) using Candida antarctica lipase B (CALB) as enzyme catalyst in the presence of ionic liquid, 1-Butyl-3-methylimidazolium bromide, [BMIM]Br and organic solvent, DMSO as a reaction medium was investigated. Under current reaction conditions, a yield of 76 % was obtained at temperature of 50 °C after 72 h. The optimum enzyme load in this study was 0.2 g. Moreover, the reaction media applied could be recycled and reused. The synthesis of the glucose vernolate was confirmed by the presence of carbonyl signal in the FTIR and NMR spectra. The result revealed that the enzymatic route of synthesis of glucose vernolate in ionic liquids was found to be successful under the given reaction conditions.

Key words: *Glucose vernolate, Vernolic acid, Ionic liquids, Candida Antarctica*

1. Introduction

Sugar fatty acid esters, usually called sugar esters, are non-ionic and biodegradable surfactants that have very good emulsifying, stabilizing, or conditioning effects (Sarney and Vulfson, 1995). They are widely used in the food, cosmetic, pharmaceutical, and detergent industries. Sugar esters are synthesized by esterification of sugars or sugar alcohols with fatty acids. Sugar fatty acid esters (SFAE) represent a large group of compounds and consist of two abundant agricultural raw materials, namely; sugars and fatty acids derived from fats or oils (Yang and Huang, 2012).

Vernonia galamensis has potential to become an important industrial oilseed crop. It was identified in 1964 for the first time in Eastern Ethiopia by researchers from Perdue University, USA (Perdue *et al.*, 1986)]. The seed of *Vernonia galamensis* is productive in terms of triglyceride yield; typical oil yield varies from 35 to 40 wt %. *Vernonia* oil is uniquely a naturally epoxidized seed oil with trivernolin contributing for about 60% of the triglycerides. The multiple chemical functionality of Vernonia oil makes it a unique candidate for derivatization in order to synthesize high value-added products and synthetic intermediates (Grinberg *et al.*, 1994)]. Saponifiation of Vernonia oil results in about 72-80% of

naturally epoxidized fatty acid, vernolic acid (cis-12, 13-epoxy-cis-9-octadecenoic acid) (Carlson *et al.*, 1981).

Synthesis of sugar fatty acid esters can be carried out either chemically or enzymatically. The chemical process occurs with a low selectivity and leads to a mixture of sugar esters with different degrees of esterification. Furthermore, the reactions involve the use of toxic organic solvents and high temperatures, which could cause coloration of the final products. Nowadays, the use of a biological catalyst such as lipase in the synthesis of sugar esters has become a promising method to overcome these problems. The main advantage of enzymatic synthesis is that its high regioselectivity leads mainly to monoester. In addition, the enzymatic method can be performed under mild reaction conditions; thus, denaturation of substrate and/or products can be avoided (Sarney and Vulfson, 1995).

The most challenging issue in enzymatic synthesis of sugar esters is selection of suitable solvents. Solvents that can dissolve the sugar might have deactivating effect on the enzyme or solvents compatible with enzyme may have less sugar dissolving capacity [Ganske and Bornscheuer, 2005]. Accordingly, less harmful organic solvents such as acetonitrile, acetone, t-butanol, and 2-methyl-2-butanol or mixtures of

organic solvents are commonly used in the enzyme-catalyzed synthesis of fatty acid sugar esters with a partially dissolved or a solid-phase system (Cao *et al.*, 1997).

Recent studies show the attention given to the use of ionic liquids (ILs) as solvents in the enzymatic synthesis of sugar fatty acid esters (Ganske and Bornscheuer, 2005, Lee *et al.*, 2008). Room-temperature ionic liquids (RTILs) have become more and more important as desirable green solvents and reaction media for a wide variety of processes (Welton, 1999). ILs could be an alternative to conventional organic solvents for enzyme-catalyzed synthesis because of their negligible vapor pressure, excellent solvent properties, high chemical and thermal stability, recoverability and recyclability. Moreover, because of their specific physicochemical characteristics, ionic liquid have the ability to dissolve many kinds of compounds including polar (carbohydrates) or non-polar (fatty acids) organic compounds (Yang and Pan, 2005). It was reported that anhydrous ILs containing $[BF_4]^-$, $[PF_6]^-$, and dicyanamide, $[DCA]^-$ can be used as alternative reaction media for biotransformation of sugars (Ganske and Bornscheuer, 2005). It was also observed that the use of these ILs as reaction media enhanced the selectivity and stability of enzymes, while the activity of enzymes in pure ILs was usually lower than those in conventional organic solvents used for the synthesis of sugar ester (Degn and Zimmermann, 2001). There are a number of reports on the synthesis and characterization of sugar esters. However, less attention has been given to synthesis of epoxy fatty acid sugar esters.

In this study, *Candida antarctica* lipase B (CALB) catalyzed synthesis of epoxy fatty acid esters of glucose (glucose vernolate) by reacting glucose with vernolic acid, (cis-12, 13-epoxy-cis-9-octadecenoic acid) derived from native *Vernonia galamensis* oil in the presence of ionic liquid, 1-Butyl-3-methylimidazolium bromide, [BMIM]Br and DMSO as solvents was successfully carried out.

Materials and Methods

2.1 Materials

D-Glucose was procured from Sigma–Aldrich. The glucose was dried for 24 h at 105°C in vacuo to ensure that the concentration of residual water was below 2%, by weight, before use. Vernolic acid was prepared following literature procedures (Smith *et al*, 1959) using *Vernonia* oil extracted from *Vernonia galamensis* seed, donated by Adet Agricultural Research Centre, Ethiopia. Immobilized CaLB was donated by Novozymes, Spain. 1-Butyl-3-methylimidazolium bromide, [BMIM]Br was prepared via literature procedures (Huddleston, 2001). AnalaR grade DMSO was purchased from Sigma–Aldrich.

2.2 Characterization Techniques

FTIR analysis was performed on a Nicolet model Protégé 460 magna IR spectrometer. The analysis of the glucose vernolate was carried out in KBr pellets using the transmission mode. ^{13}C solid-state CPMAS NMR analyses were recorded on a Bruker 850MHz instrument. TGA analyses were performed using a Perkin Elmer TGA Q500 in a temperature range between 50 and 500°C, with a heating rate of 10°C/min and nitrogen gas flow of 50mL/min.

2.3 Experimental Procedures

The esterification of D-glucose was carried out using standard procedure with slight modifications (Ganske and Bornscheuer, 2005). In 100 mL round bottom flask with magnetic stirrer by dissolving 0.5 g (2.78 mmol) of D-glucose in 20 % DMSO and 80 % 1-Butyl-3-methylimidazolium bromide, [C₄mim]Br and 0.82 g (2.78 mmol) of vernolic acid (VOAc). The reaction started by adding 0.2 g of lipase from *C. antarctica* (CAL-B), Novozym SP-435 as catalyst and 0.4 Å molecular sieve to remove the byproduct water. The reaction temperature was kept at 50 °C for 72 h.

After completion of the reaction, the product was isolated by washing first with water to remove the ionic liquid, unreacted glucose and filtered off to remove the lipase and molecular sieve. Then the product was further extracted with acetone and chloroform. The white solid product obtained was dried in oven at 60 °C for 24 h.

1. Results and Discussions

In the current study, to improve the solubility of D-glucose in pure ionic liquids, DMSO was used as co-solvent which has led to increased solubility of glucose. It has been also found that adding DMSO as co-solvent improved the reaction by decreasing the viscosity of ionic liquids and improving activity of the lipase enzyme. The positive effects of DMSO on the enzyme activity observed may be explained by an increased solubility of glucose rather than by a direct effect of DMSO on the enzyme (Degn and Zimmermann, 2001). The enzyme Lipase B from *Candida antarctica* (CAL-B) is the most active and frequently used enzyme for sugar ester synthesis in organic solvents (Degn and Zimmermann, 2001). It was also found to be active in solvent systems containing ionic liquids (Lau *et al*., 2000). Ganske and Bornscheuer (2005) also reported that commercially available CAL-B showed no activity in the synthesis of sugar esters in pure ionic liquids. The water which is the byproduct of the esterification reaction was successfully removed by using molecular sieves.

The optimum enzyme load in this study was 0.2 g. The reaction temperature was maintained at 50 °C. Increasing temperature above 50 °C showed no increase in the product which might be due to inactivation of the enzyme at higher temperatures. This observation is in close agreement with other literature reports (Sung *et al*., 2010) in which they reported that the increasing enzyme load up to 100 mg/ml increased the conversion at 2 h, but further increase of enzyme load had little effect on conversion during lipase-catalyzed glucose ester synthesis in ionic liquids and increasing temperature resulted in decreasing conversion as the highest conversion they obtained was at 50 °C indicating enzyme instability above 60 °C. A yield of 76 % was obtained after 72 h. The glucose vernolate obtained as white solid was insoluble almost in all of the solvents tested for solubility (Table 1). The compound melts at 285-287 °C. This is a clear indication of product formation as the melting point of glucose; the starting material was 153-156 °C.
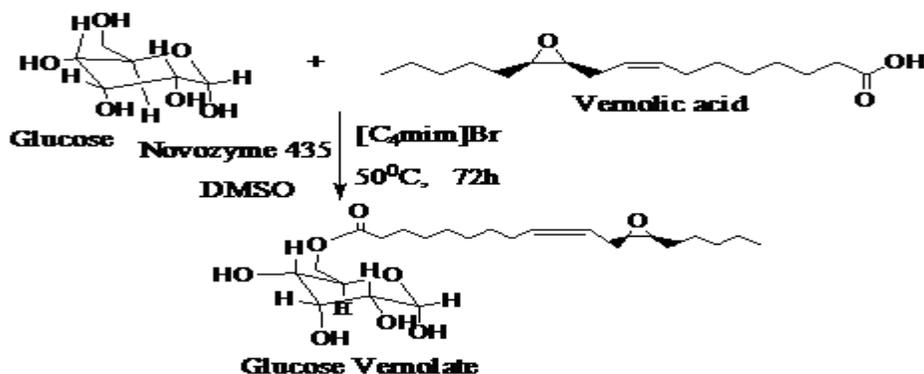
Scheme 1: *Schematic representation of synthesis of glucose vernolate*

Table 1: *Solubility of starting materials and product in different solvents*

Solvents	Compounds		
	Glucose	Vernolic acid	Glucose vernolate
Hexane	-	+	-
DMSO	+	+	-
Chloroform	-	+	-
Methanol	+/-	-	-
Water	+	-	-
Acetone	+/-	-	-

Soluble =+, Insoluble = - , partially soluble = +/-

The characterization of the product was carried out using FTIR spectroscopy, Solid state NMR spectroscopy, and TGA.

3.1 FTIR Spectrum of glucose vernolate

The FTIR spectroscopic analysis result indicates that the enzyme catalyzed esterification of glucose dissolved in ionic liquid and DMSO as co-solvent mentioned was successful. Some of the major IR (cm^{-1}) peaks are listed in the table below.

Table 2: FTIR spectral dataof glucose vernolate

No	Frequency (cm^{-1})	Functional group	Mode of vibration	Intensity
1	3458	O-H	stretching	m
2	2961	-C-H (CH_3)	Stretching (a)	m
3	2853	-C-H (CH_2)	Stretching (s)	vs
4	1731	-C=O (ester)	Stretching	w
6	1377	-C-H (CH_3)	Bending (s)	m
7	954-1200	-C-O, C-C (in sugar ring)	Stretching	m
8	844	-C-O (epoxy group)	Stretching	w
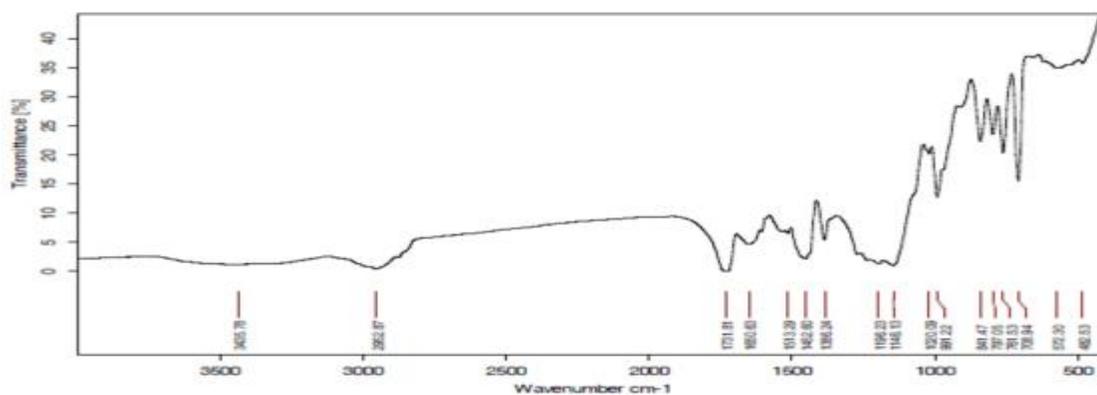
Figure 1: FTIR spectrum of glucose vernolate
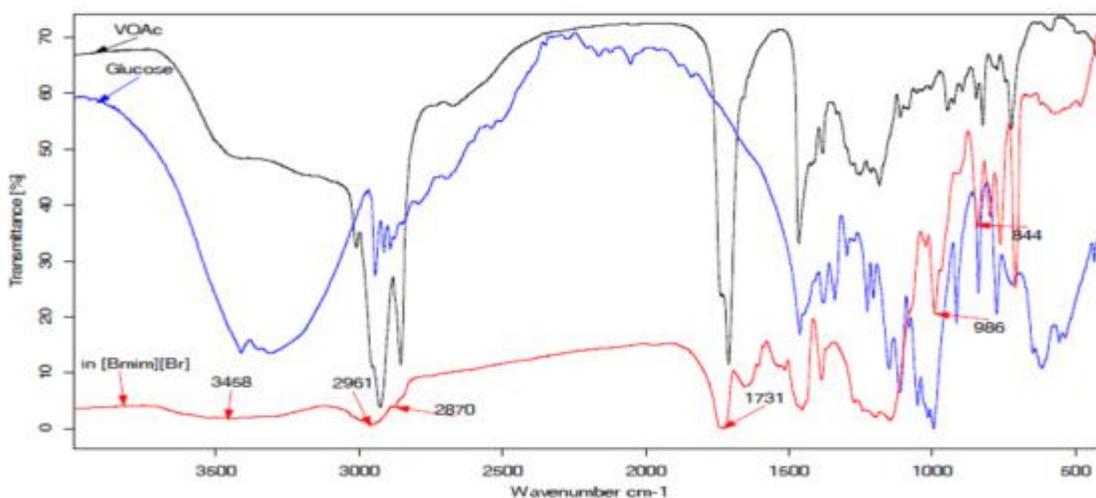
Figure 2: Comparison of glucose (middle), VOAc (top) and glucose vernolate (bottom)

The FTIR spectrum presented in the Fig.1 and Fig.2 depicts that the carbonyl (C=O) peak obtained at 1731 cm^{-1} is due to the introduction of an ester functionality into the glucose structure. The presence of epoxy C-O-C stretching band observed at 844 cm^{-1}, characteristic of vernolic acid, could be another confirmation for the grafting of epoxy fatty acid on to the glucose structure. The OH peak intensity of the glucose vernolate has decreased as compared to unesterified glucose which could be a supporting evidence for the substitution of glucose hydroxyl groups by vernolyl moiety achieved. As compared to the starting vernolic acid, the C=O peak in the spectrum is characteristic of an ester functionality with a shift from 1710 cm^{-1} (for vernolic acid) to 1731 cm^{-1} in the glucose vernolate.

3.2 Thermogravimetric (TGA) Analysis

TGA curves were used to examine the changes in thermal stability caused by esterification. The TGA thermogram of glucose and glucose vernolate is shown in Figure 3. The initial weight loss in the glucose started just at lower temperature corresponding to water absorption as glucose is hydrophilic and can absorb moisture under normal room conditions. The major degradation of glucose starts at 203 °C. The thermogram reveals that glucose vernolate with the degradation onset temperature of 341 °C, has more thermal stability than glucose. This implies that esterification of glucose has increased thermal stability of glucose.
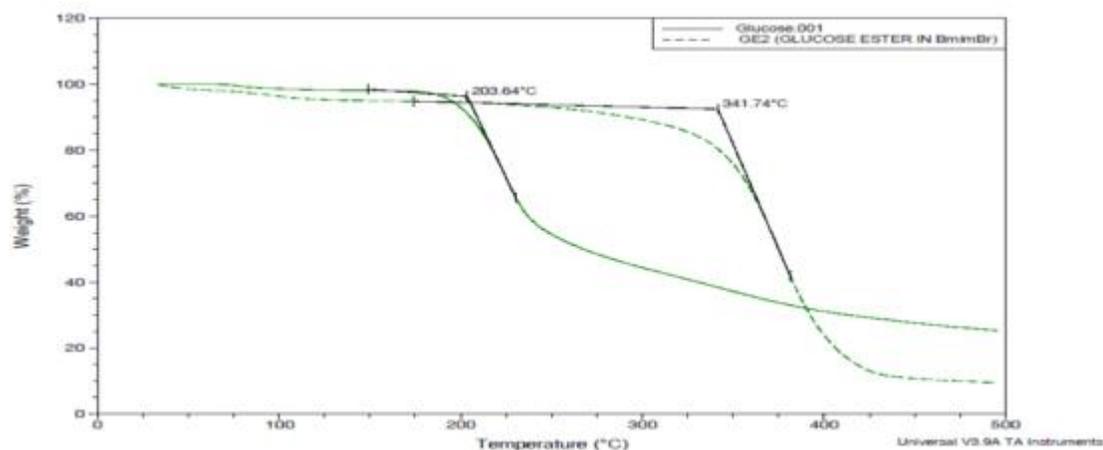
Figure 3: Comparison of TGA of glucose with glucose vernolate

3.3 Solid state (CP/MAS ^{13}C-NMR) spectrum

The solid state (CP/MAS ^{13}C-NMR) spectrum of the product showed the success of the synthesis of glucose vernolate in which carbon peaks from both glucose and the introduced vernolyl moiety were found in their respective positions. Peaks in the range of δ 64-103 ppm correspond to carbons of glucose while those in the range δ 14-58, 128-132, and 178 ppm are due to carbon of vernolyl moieties grafted on glucose.
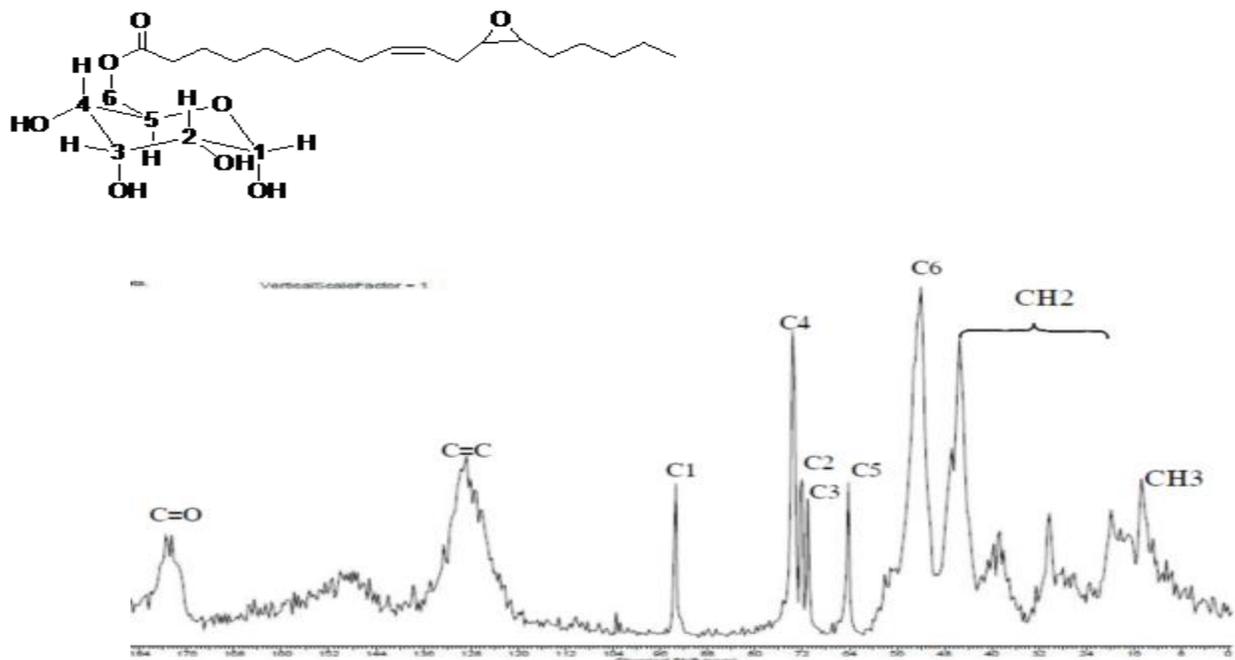
Figure 4: ^{13}C CP/MAS ^{13}C-NMR spectrum of glucose vernolate

40

3.4 Conclusion

A Glucose epoxy fatty acid ester (glucose vernolate) has been successfully synthesized via the enzymatic esterification of D-glucose using a mixture of DMSO and ionic liquid (IL) as reaction medium and *Candida antarctica* (CAL-B), Novozym SP-435 as a catalyst. The IL-based medium provides high solubility for the starting materials and high activity of the enzyme. The new glucose vernolate is insoluble in water (and many other solvents) and retains the functionalities present in the vernolic acid such as the epoxy and the double bond. The study also demonstrates that the enzymatic esterification of glucose with epoxy ring containing vernolic acid is a valuable approach for the development of biodegradable materials that will offer an environmentally benign alternative to petroleum based materials and will widen the scope of application of vernonia oil and its derivatives in the synthesis of value added products.

Acknowledgment

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SPECTROSCOPIC TECHNIQUES FOR THE DETERMINATION OF UNSATURATION IN EDIBLE OILS

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ABSTRACT

In this study, spectroscopic techniques were used to assess relative unsaturation in edible oils. UV-Visible, infrared (IR) and nuclear magnetic resonance (^{13}C NMR) spectroscopic methods were used to characterize edible oils based on their unsaturation. In UV-Visible analysis the absorbance around 233 nm arises from unsaturation sites. The existence and intensity of absorption at about this wavelength evidences the presence of unsaturation and its extent, respectively. The IR absorbance around 3009 cm^{-1} is usually due to C-H stretching of a double bond C=C-H group and stretching at 1655 cm^{-1} arises due to the presence of a double bond. In ^{13}C NMR spectrum chemical shifts in the range 121-141ppm are for unsaturations due to C=C. Accordingly, the study was conducted on eleven edible oil samples (soybean, rice bran, palmolein, groundnut, sunflower, mustard, sesame, nigerseed, rapeseed, cottonseed and coconut oils) to assess the extent of unsaturation. The absence of absorption peak at 233 nm (in UV-Visible) and absence of IR peaks at 3009 cm^{-1} and 1655 cm^{-1} as well as presence of only few peaks in the ^{13}C NMR chemical shift in the range 121-141 ppm suggested very low unsaturation in coconut oil. Similarly, palmolein exhibited a weak IR absorption band at 3009 cm^{-1} and there was no peak at 1655 cm^{-1} for the oil is less unsaturated as compared to the other oils. Palmolein oil also showed less unsaturation in the ^{13}C NMR, next to coconut oil, as compared to the other edible oil samples followed by groundnut oil. This is quite in good agreement with the observed iodine value of the edible oils.

Key words: *Edible oil, spectroscopic techniques, UV-Vis, IR, ^{13}C NMR, unsaturation, triacylglycerol, , iodine value.*

INTRODUCTION

Most of the refined edible oils contain at least 98% triglycerides, 0.5% diglycerides, 0.1% free fatty acids, 0.3% sterols, 0.1% tocopherols and trace amounts of phospholipids and various pigments. The number of double bonds, the position of the double bonds in the carbon chain, and their configuration determine the physical and chemical properties of the fatty acids as well as their nutritional importance (Gunstone, 2004; Gunstone, 2008).

An oil or fat is usually termed as saturated, mono unsaturated, or polyunsaturated fat based on the predominant fatty acid present. The saturated fatty acids are used by the liver to produce cholesterol and it is responsible for the increment of the level of low density lipoporoteins known as LDLs or bad cholesterol. Polyunsaturated fatty acids have the ability to reduce the total cholesterol level, both the low density lipoprotein (bad cholesterol) and high density lipoprotein (good cholesterol) levels. The monounsaturated fatty acids are good in that they decrease the bad cholesterol leaving the good ones unaffected (Whitney and Rolfes, 2008).

Unsaturation is not related only to nutritional value but also to oxidative stability of oils. Various studies on application of single spectroscopic technique to assess fatty acid profile, adulteration, unsaturation and oxidation of edible oils are conducted (Miyake *et al*., 1998; Zahir *et al*., 2014; Carmona *et al*., 2014; Castejon *et al*., 2016). In this study, evaluations of edible oils with combined UV-Visible, [13] C NMR and FT-IR spectroscopic methods are reported.

MATERIALS AND METHODS

1. Sample Collection

Edible oil samples were collected from local markets. Soybean Oil, Rice Bran Oil, Groundnut Oil, Sunflower Oil, Mustard Oil, Sesame Oil, Coconut Oil, Cottonseed Oil, Nigerseed Oil, Rapeseed oil and Palmolein were purchased and stored in a dark cool place until the analyses.

2. Ultra violet –visible (UV-Vis) spectroscopy

Unicam UV-500 double beam spectrophotometer with Vision pro software, from Thermo Electron Scientific Instruments, USA, with a grating of 0.2 nm band width, equipped with temperature controlled (water pelitier system) cell compartment with an accuracy of $\pm$ 1°C was used for recording UV-Visible spectra of all the samples. A 1 cm quartz

cuvette equipped with air tight Teflon cap was used for recording the spectrum.

About 0.1g of sample was taken and dissolved in 10 mL of cyclohexane. The clear filtered solution obtained after filtering through Whatman 42 filter paper, which was also further diluted as required, was used for taking the UV-Visible spectrum in the wavelength range of 200-750 nm. Spectroscopic grade cyclohexane was used to dissolve the liquid edible oils.

3. Fourier transform-infrared (FT-IR) spectroscopy

FT-IR spectra were recorded using FT-IR spectrometer, PerkinElmer, USA, equipped with spectrum-100 software. KBr cell was used as a sample holder for the determination of neat edible oil samples. Each spectrum was derived from 16 single averaged scans collected in the mid IR region of 400-4000cm^{-1} at a spectral resolution of 2.0 cm^{-1}.

4. Nuclear magnetic resonance (^{13}C-NMR) spectroscopy

^{13}C NMR spectra were taken using Bruker AV-300 NMR spectrometer. ^{13}C NMR spectra of edible oil samples were taken at a carbon frequency of 100.6378524 MHz using deuterated dichloromethane solvent in 5.0 mm sample tube. A pulse delay of 2.0 s, acquisition time 1.36 s, and pulse width 12.4 µs were used for 2000 repetitive scans.

RESULTS AND DISCUSSION

The UV-Visible absorbance variations observed in the edible oils arise from the differences in fatty acid compositions. The absorbance around 213 nm, which characterizes all edible oils, may be due to the ester functional group of the triglycerides, and it is found in all saturated and unsaturated oils. The absorbance around 233 nm arises from unsaturation sites, especially of linoleic acid, in edible oils which are prone to conjugation through the peroxide formation mechanism (Souza *et al.*, 2011)

All edible oils, except coconut oil, as it is shown in Figure 1 and Table 1, show absorbance around 233 nm with varying intensity depending on the extent of unsaturation. Soybean, sunflower, groundnut, cottonseed, and rice bran oils show strong absorbance followed by nigerseed, rapeseed, and sesame oils with mustard and palmolein oils exhibit least intensity. Table 1 shows the absorbance observed by each oil sample at different wavelengths while Figure 1 illustrates the comparison of UV-Visible spectra of sesame seed and coconut oils.
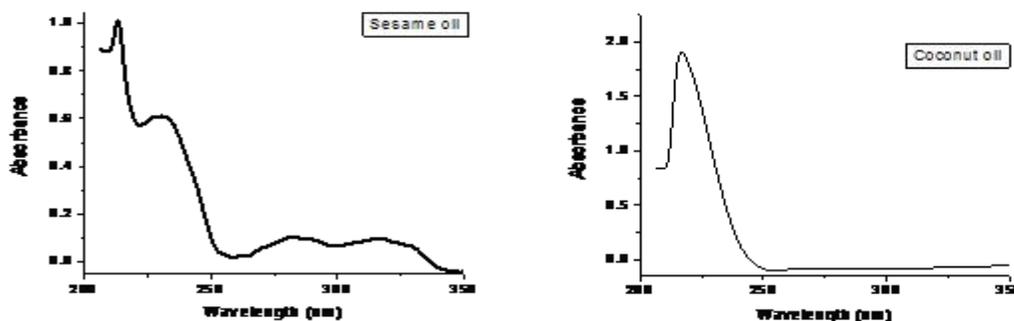
Figure 1. Typical UV-Visible spectrum of sesame and coconut oil samples

Table 1. UV-Visible spectroscopic data of selected edible oil samples

Soybean Oil		Ricebran Oil		Palmolein		Groundnut Oil		Sunflower Oil		Mustard Oil	
λ (nm)	A	λ (nm)	A	λ(nm)	A	λ(nm)	A	λ(nm)	A	λ(nm)	A
213	1.1	213	0.9	213	1.1	213	0.96	213	1.0	213	1.00
234	1.0	233	0.8	228	0.8	233	0.82	235	0.9	230	0.3
270	0.1	270	0.1	270	0.1	270	0.1	270	0.1	269	0.1
280	0.1					280	0.1	280	0.1		

Sesame Oil		Coconut Oil		Cotton seed Oil		Niger seed Oil		Rape seed Oil	
λ (nm)	A	λ (nm)	A	λ(nm)	A	λ(nm)	A	λ(nm)	A
213	1.00	217	1.9	212	0.9	211	0.8	213	1.07
230	0.61			234	0.9	233	0.7	234	0.7
280	0.1							261	0.1
316	0.1								

The extent of unsaturation can be predicted from the absorbances obtained and it is also well correlated with the iodine values for most of the edible oils. The absence of absorption peak at this wavelength suggests very low unsaturation in coconut oil. Soybean, rice bran, sesame, sunflower, mustard, and rapeseed oils show further weak absorbances at higher wavelengths which may be due to more unsaturation and further conjugation by minor constituents of the oils. Similar conclusions are also arrived in iodine values.

The FT-IR bands at 2854 cm^{-1} and 2925 cm^{-1} are due to C-H stretching of saturated bonds. This is also well supported by the absorbance at 1378 cm^{-1} and 1465 cm^{-1} which are due to C-H

deformation and the weak absorbance at 722 cm^{-1} due to bending mode of C-H bond. All these absorption peaks are observed in all the edible oils. The C=O stretching of esters is signified by the absorbance at 1746 cm^{-1}. Absorption bands at 1099 cm^{-1}, 1163 cm^{-1}, and 1238 cm^{-1} are accounted for the C-O stretching of an ester. All these absorption bands, which are characteristics of esters, are also observed in all of the edible oils as they are basically composed of triglycerides.

The absorbance at 3009 cm^{-1} is due to C-H stretching of a double bond C=C-H group and C=C stretching at 1655 cm^{-1} arise due to the presence of a double bond. All the edible oils, except coconut oil, show absorbance at these frequencies. The absence of the peaks at 3009 cm^{-1} and 1655 cm^{-1} from the spectrum of coconut oil, as it is shown in Figure 2, signifies small or

Sample	v (cm^{-1})							C=C stretching	C=O stretching	-C-H stretching		=C-H stretching
	CH$_2$ rocking		C-O stretching of ester			CH$_2$ and CH$_3$ bending						
Soybean oil	666	721	1099	1162	1238	1378	1465	1655	1746	2855	2926	3009
Rice bran oil	666	722	1098	1163	1238	1377	1465	1655	1746	2854	2925	3008
Palmolein	666	721	1117	1163	1239	1378	1466	-	1746	2854	2925	3006
Groundnut oil	666	722	1099	1163	1238	1378	1465	1655	1747	2854	2925	3008
Sunflower oil	666	722	1099	1163	1238	1378	1465	1656	1747	2855	2926	3009
Mustard oil	665	722	1100	1163	1240	1377	1465	1656	1747	2854	2925	3008
Sesame oil	666	722	1099	1163	1240	1378	1465	1656	1747	2855	2925	3008
Coconut oil	666	722	1112	1160	1230	1378	1466	-	1746	2854	2925	-
Cottonseed oil	666	722	1100	1163	1238	1378	1465	1656	1747	2855	2925	3009
Nigerseed oil	666	722	1100	1163	1238	1378	1465	1655	1746	2855	2926	3009
Rapeseed oil	666	722	1100	1163	1238	1377	1465	1655	1747	2854	2925	3008

undetectable amount of unstaturation in the oil. Che Man and Rohman (2013) also reported likewise.

Similarly, palmolein exhibits a weak absorption band at 3009 cm^{-1} and there is no peak at 1655 cm^{-1} for the oil is less unsaturated as compared to the other oils. Thus, the FT-IR studies not only indicate the presence of esters, acids, and other functional groups but also indicate the extent of unsaturation in the edible oils. Table 2 shows absorption frequencies (wave numbers) of the different oil samples. Figure 2 shows the two different spectra of coconut and sesame oils.

Table 2. FT-IR spectroscopic data of selected edible oil

samples   Spectrum Name   :   AU-NSR-DR-027.sp

Spectrum Name   :   —   AU-NSR-DR-026.sp
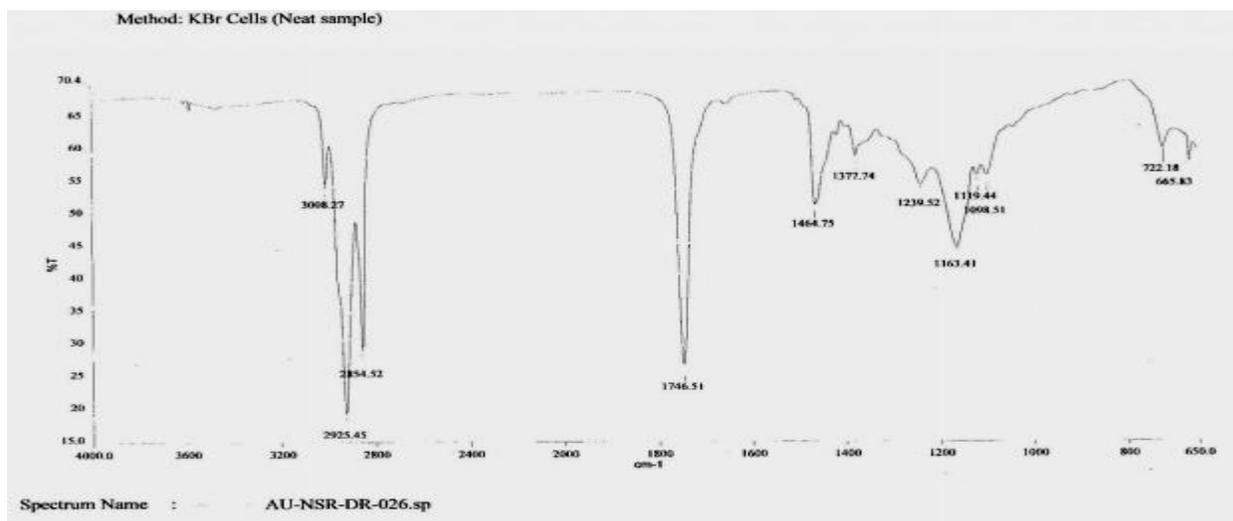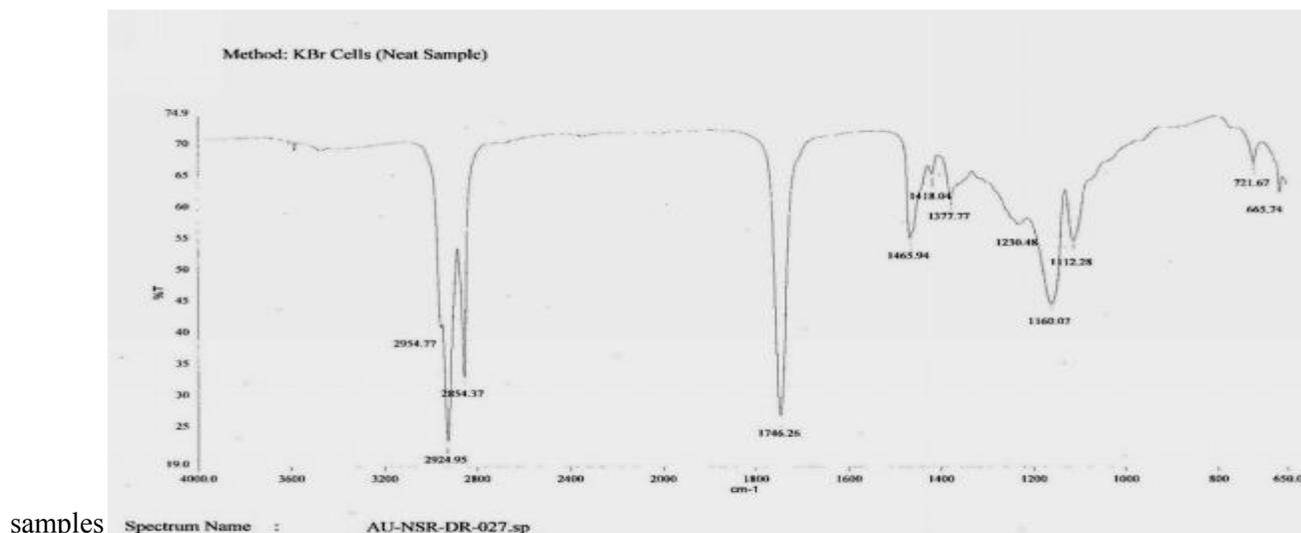
Figure 2. Typical FT-IR spectra of coconut oil (above) and sesame oil (below) samples

The [13] C NMR peaks of edible oils represent mainly four types of carbons (Vlahov, 1999; Zamora, 2002). The chemical shifts that cover 10-35 ppm represent the first type, the aliphatic carbons; the second group, the glycerol backbone carbons, are represented by the chemical shift in the range 60-72 ppm; the third category is for unsaturated carbons in the chemical shift range of 121-141 ppm; and the fourth type, carbonyl carbons, are represented by the chemical shifts ranging from 172-178 ppm.

Table 3 lists the [13] C NMR chemical shifts of the selected edible oils. As it can be seen from the table, all the edible oil samples show carbon chemical shifts within the range of the four

aforementioned types. Depending on the nature of the dominant fatty acids that formulate the oil, the chemical shifts show variations in terms of chemical shift position and number of carbon atoms. All the edible oils show chemical shifts in the aliphatic carbon region. Many peaks are observed in this region suggesting long chains of carbons in the edible oils. Chemical shifts of the carbonyl (C=O) and C-O carbons in all the edible oils are due to their ester nature. Even

The peak at 53.8 ppm is observed due to the deuterated methylene chloride solvent. All the edible oil samples show chemical shifts within the range of 52-55 ppm. These chemical shifts though the edible oils show chemical shifts in the unsaturated carbon region, variations are observed in the intensity and number of peaks. Soybean and niger seed oils show 15 peaks and mustard oil shows 14 peaks in the chemical shift range of 127-133 ppm. Rape seed, rice bran, sunflower, and sesame oils show 7 to 10 peaks. Palmolein shows four peaks while coconut oil two weak chemical shifts in this unsaturated carbon region, in the range 127-133 ppm.

occur due to the solvent and other components of edible oils other than the triglycerides. These chemical shifts are reported as unknown by Zamora et al. (2002).

Sample Name	Aliphatic carbons (H₃C-, H₂C-) (14-35 ppm)	Glycerol backbone carbons (C-O) (60-72 ppm)	Unsaturated carbons (C=C) (127-133 ppm)	Carbonyl carbons (C=O) (172-178 ppm)
Soybean oil	31 peaks	2 peaks	15 peaks	2 peaks
Rice bran oil	20 peaks	4 peaks	9 peaks	3 peaks
Palmolein	27 peaks	3 peaks	4 peaks	2 peaks
Groundnut oil	31 peaks	2 peaks	5 peaks	3 peaks
Sunflower oil	28 peaks	2 peaks	7 peaks	2 peaks
Mustard oil	31 peaks	2 peaks	14 peaks	2 peaks
Sesame oil	30 peaks	4 peaks	8 peaks	3 peaks
Coconut oil	28 peaks	2 peaks	2 peaks (very weak peaks)	2 peaks
Sunflower oil (E)*	29 peaks	2 peaks	8 peaks	2 peaks
Cottonseed oil (E)*	30 peaks	2 peaks	8 peaks	3 peaks
Nigerseed oil (E)*	39 peaks	3 peaks	15 peaks	2 peaks
Rapeseed oil (E)*	19 peaks	2 peaks	10 peaks	2 peaks

Table 3. [13] C NMR chemical shifts of selected edible oil samples

The other variation out of the triglyceride set of chemical shifts is observed in sesame oil. As it is displayed in Figure 3, sesame oil exhibits weak chemical shifts in the range 72-120 ppm which is not the chemical shift region of the triglycerides. The occurrence of these chemical shifts may be related with the presence of sesamol, sesaminol, and sesaminol dimer that contain aromatic structure and cyclic oxygen attached to carbon in their structure in sesame oil.

Similar to the results observed in the UV-Visible and FT-IR analyses, the [13] C NMR analysis of coconut oil shows lack of chemical shift within the range of 121-141 ppm. This can be seen clearly by comparing sesame oil and coconut oil spectra of Figure 3. As it can be seen in Figure 3, sesame oil (this is also the case for all the rest of the analyzed edible oils as can be witnessed from Table 3) displays a number of chemical shifts in this region of unsaturation

while coconut oil shows weak (less intense) and few chemical shifts in the unsaturated carbon region (121-141 ppm). Shiao and Shiao (1989) reported low intensity peaks for coconut oil in this chemical shift region. Table 3 also lists only two values for coconut oil in the unsaturated carbon column suggesting coconut oil is highly saturated. Palmolein oil also shows less unsaturation, next to coconut oil, as compared to the other edible oil samples followed by groundnut oil.

This is quite in good agreement with the observed iodine value of the edible oils (data not shown). The iodine values of coconut oil, palmolein, and groundnut oils are 8.2, 57.2, and 96, respectively, which are low as compared to the iodine values of the other edible oils. These oils are also observed to exhibit less chemical shifts in the [13] C NMR analysis. Accordingly, soybean oil with high iodine value (125) exhibits a number of [13] C NMR chemical shifts in the unsaturated carbon region, as it can be seen in Table 3.

CONCLUSION

Spectroscopic techniques are important tools in the study of unsaturation of edible oils. They are easy to handle and analyse edible oils. Instead of using a single spectroscopic method, multiple analyses are found to be important in conforming and increasing the confidence level of the analyst. The presence and absence of chemical shifts (in NMR) and absorbance peaks (in UV-Vis and IR) are crucial in the determination of unsaturation. It is found from the analyses that one may categorize the edible oils as saturated and unsaturated based on the spectroscopic data.
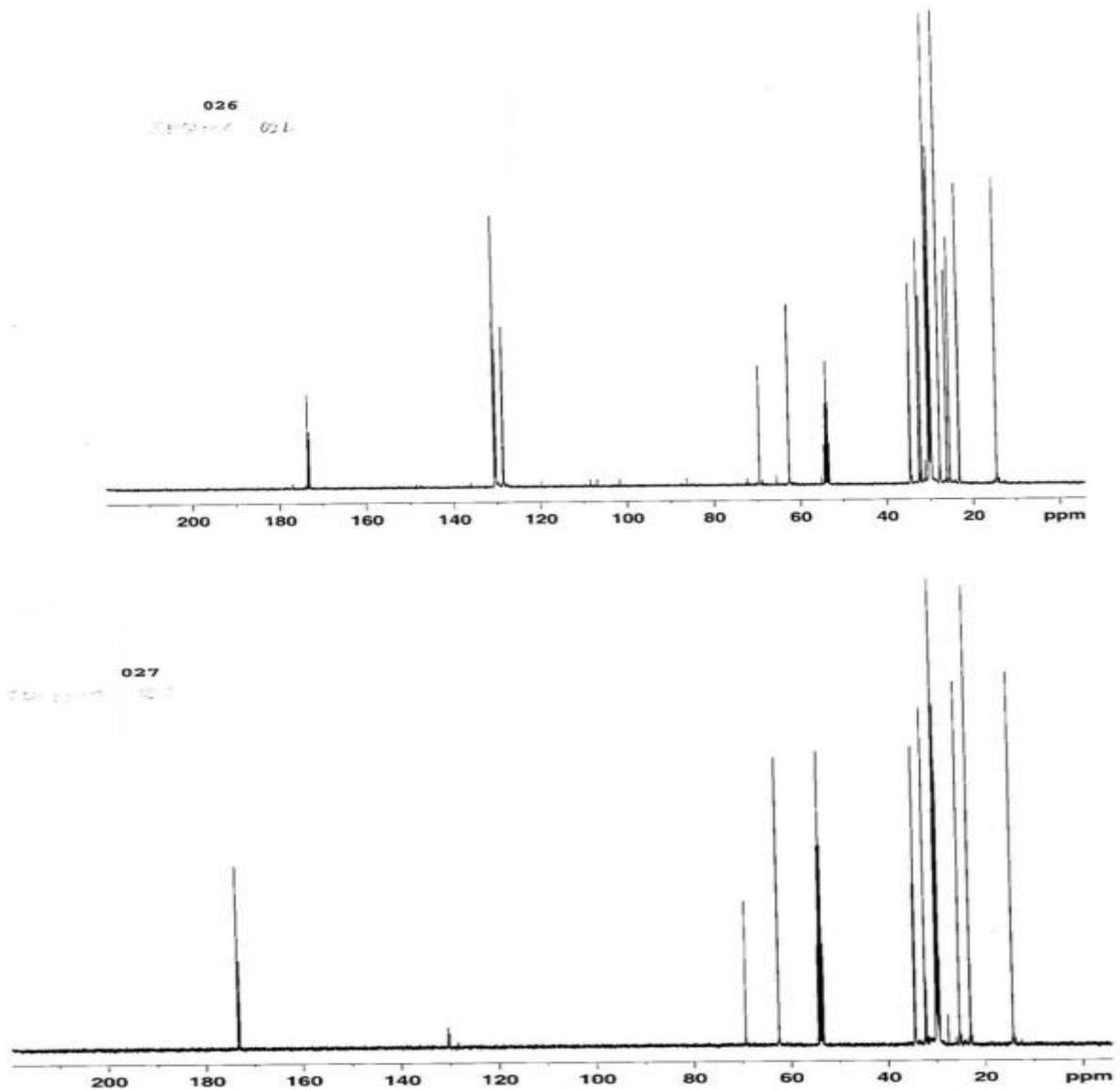
Figure 3. Typical ^{13}C spectrum of sesame oil (above) and coconut oil (below) samples

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Productivity Enhancement by Implementing Lean Manufacturing in Gafat Armament Industry

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ABSTRACT

Lean manufacturing has received a great deal of attention in its application to manufacturing companies. It is a set of tools and methodologies that aim for increasing productivity. The amount of rework and reject of parts and costly processes have been recognized as the critical source of wastages.Depending on long processing time and large number of rework and rejection registered in manufacturing yearsfive parts have greater wastage are separated as barrel, breach block, extractor, fore sight frame and rare sight frame. Barrel production is identified as the bottleneck part in manufacturing processe;, the source of each problem and the root causes are identified and forwarded solution and implementation of lean tool kanban system.By implementing the kanban system on production of barrel, the existing cycle time of the barrel 266 min, can be reduced to 197min, this leads to 26% improvement of the cycle time of a single parts.The existing production capacity of the barrel is 6 parts per day, after implementing the kanban system it increased to 36 parts per day; thus the improvement of production capacity of the barrel is 83 % per day. High work in processes inventory and waiting time on the production line can also be eliminated by implementing kanban system.

Key words: Bottleneck, Lean Manufacturing, Productivity, Waste

1. INTRODUCTION

Productivity is about the effective and efficient use of all resources including time, labor, information, finance, equipment, space, energy, materials, inputs of capital, land, etc. This places industries all over the world under tremendous pressure to reduce their costs, increase their productivity and supply goods of superior quality. In order to meet these goals and remain more competitive, organizations embark on the use of many different tools, techniques and strategies to make their production processes more efficient. In addition, manufacturing industries are always searching for optimization tools to improve productivity.

According to Cutler (2005), Lean manufacturing is a process of improving manufacturing and service operations, reducing wastages, improving quality, and driving down costs. Activities that consume resources but generate no redeeming value in the eyes of customers are wastes that must be eliminated in the lean paradigm (Womack and Jones, 1996). The lean manufacturing methodology is also described as a series of techniques that allow product producing one unit at a time, at a formulated rate, and eliminating non-value-adding time, queue time or other delays. (Hobbs, 2003,) Carroll (2010) argues that lean manufacturing is a systematic approach to identify and eliminate waste non-value added activities through continuous improvement at the pull of the customer in pursuit of perfection. (Boone, 2010)

2. METHODOLOGY

In this study work both primary and secondary data were used. Primary source contain raw, original, uninterrupted and unevaluated information, discussion, interview and questionnaires are techniques that were used for gathering primary information and relevant data for the study. The secondary data sources were technical documents, technological processes chart, daily-monthly and yearly inspection report and annual reports that help to cross check the official information and to get details concerning the study.

Documentation on recording of existing data from each shop about production quantity, methods of production and types of production are collected from the industry. In addition to this, data indicate causes of defect and the magnitude of their effect on industry productivity based on lean manufacturing are collected.

3. LEAN TOOLS

3.1 Kanban System

Kanban is a pull replenishment system whose aims is zero stock outs, shorter lead times, and reduced inventory with minimal manual supervision. Instead of waiting for an MRP plan to release materials down the supply chain, with kanban each operation pulls the materials it needs from its source when it needs them, signaling with a replenishment signal or a kanban that it needs to do so[12].

Kanban became an effective tool in support of running a production system as a whole and it proved to be an excellent way for promoting improvement. Problem areas were highlighted by reducing the number of kanban in circulation. One of the main benefits of Kanban is to establish an upper limit to the work in progress inventory, avoiding overloading of the manufacturing system [12].

3.2 Kanban Card

Kanban cards are a key component of kanban and they signal the need to move materials within a production facility or to move materials from an outside supplier in to the production facility. The kanban card is, in effect, a message that signals depletion of product, parts or inventory that, when received, the kanban will trigger the replenishment of that product, part or inventory [12].

3.3 Kanban Operation

One key indicator of the success of production scheduling based on demand "pushing" is the ability of the demand-forecast to create such a "push". Kanban, by contrast, is part of an approach where the "pull" comes from demand. Re-supply or production is determined according to the actual demand of the customer. Taiichi Ohno stated that to be effective, kanban must follow strict rules of use. Toyota, for example, has six simple rules, and close monitoring of these rules is a never-ending task, thereby ensuring that the kanban does what is required [9].

Six Rules
- Later process picks up the number of items indicated by the kanban at the earlier.
- Earlier process produces items in the quantity and sequence indicated by the kanban.
- No items are made or transported without a kanban.
- Always attach a kanban to the goods.

- Defective products are not sent on to the subsequent process.
- Reducing the number of kanban increases the sensitivity.

3.4 Kanban Location

The kanban location for a kanban item is the designated location where that item is stored (and where replenishment is delivered). Sometimes, the kanban location is part of regular inventory. Often, however, kanban implementations use sub-inventory locations for kanban items, so that each work center has a small stock of the parts it needs. In these implementations, the sub-inventory location is the kanban location [9].

3.5 Kanban Size

Kanban size refers to the number of items in each kanban. Because a kanban is only replenished when it's empty, the kanban size should be a multiple of the lot size. For example, if you would normally order an item in lots of 20, you should not make the kanban size less than 20 because the supplier would not be able to fulfill such an order.

3.6 Advantages of Kanbn

i. Optimize inventory and reduce product obsolescence.

Since component parts are not delivered until just before they are needed, there is a reduced need for storage space. Should a product or component design be upgraded, that upgrade can be included in the final product ASAP (As Soon as Possible). There is no inventory of products or components that become obsolete.

ii. Reduces waste and scrap

With Kanban, products and components are only manufactured when they are needed. This eliminates overproduction. Raw materials are not delivered until they are needed, reducing waste and cutting storage costs.

iii. Increases Output

The flow of Kanban (cards, bins, pallets, etc.) will stop if there is a production problem. This makes problems visible quickly, allowing them to be corrected ASAP. Kanban reduces wait times by making supplies more accessible and breaking down administrative barriers. This results in an increase in production using the same resources.

iv. Reduces Total Cost

The Kanban system reduces our total costs by:
- ✓ Preventing over production
- ✓ Reducing and eliminating amount of rework and reject
- ✓ Developing flexible work stations
- ✓ Reducing waste and scrap
- ✓ Reducing inventory costs

4. DATA COLLECTION AND ANALYSIS
4.1 Production Overview

Gafat Armament Industry it has six factories: small arms production factory, medium calibre production factory, rocket launcher and mortars production factory, heavy artillery and howitzer factory, armament spare parts manufacturing factory and precision casting factory, among those factories this research paper focuses on the main product of the factory produced on part production factory. This part production factory has seven production shops from those six shops are produce the main product automatic rifle (AkM-103 or model ET97/1 and ET97/2). The seventh shops produce commercial products and other part for particular need like part of the machine for maintenance of the industry and other industry governed under metals and engineering cooperation. From this main products in shop one 13 parts are produced in shop two 9 parts are produced in shop three 54 parts are produced in shop four 21 parts are produced in shop five and six 18 parts are produced. Inspection point, sub assembly bench and stores are available in each shop on the factory.

4.2 Identify Bottleneck Parts in all Shops

Analysis for identifying bottle neck parts in all shop regarding Over Processing and defect to be produced. First was done the five long processing operation was identified in each shop in armament part production factory and computing the effect on overall production processes. This analysis is very essential to identify the special parts that need an attention and special schedule in order to fix the required quantity to be produced at the right time.

The selection of five parts depends on factor such as:-
- ✓ The requirement of the total processing time.
- ✓ Parts with more defect and rework during processing.

Because the greater processing time of some parts in the industry exposed to waste like;

- ✓ Defect because each operation and steps introduces error.
- ✓ Waiting the parts on processes and assembly.
- ✓ Over production (producing simple part more and complex part small amount).

The productivity bottle necks of armament part production factory of the two main products ET 97/1 and ET 97/2 on paper work, the amount of the total rework and reject of thirty selected parts are identified as shown in Table1.

Table 1: Percent of reworks and rejects of thirty selected bottleneck part in APPF.

S/ No.	Parts Name	Part Code	Rework Qty	Reject In %	Rework Qty	Reject In %
1	Ass. Receiver body	Ps11-1b	8	0.59	0	0
2	Breech block	11-2	38	2.85	151	10.80
3	Barrel base	11-9	1	0.07	44	3.15
4	Barrel	11-10a	556	41.49	104	7.46
5	Muzzle break	29-1c	35	2.61	37	2.65
6	Piston Frame	13-1	8	0.59	35	2.51
7	Bolt	3-4	4	0.29	72	5.16
8	Firing pin	3-9	0	0	1	0.07
9	Piston rod	13-2	1	0.07	18	1.29
10	Extractor	3-6	159	11.86	88	6.31
11	Sight leaf	22--1a	0	0	4	0.28
12	Trigger	10--8	0	0	0	0
13	Ass guide	ps14a	0	0	0	0
14	Screw driver	Λ2--1	0	0	0	0
15	Sear	0..o0--9	0	0	0	0
16	Receiver Cover	10-1a	0	0	0	0
17	Receiver body	11-1b	0	0	0	0
18	Safety sear	10-5	0	0	0	0
19	Ass. upper hand	11-2	0	0	0	0
20	Hammer Spring	0-3	0	0	0	0
21	Bolt device body	100-13	0	0	3	1.16
22	Percussion hammer	100-03	0	0	0	0
23	Safety lever	200-18	0	0	0	0
24	Sight frame	300-25	0	0	0	0
25	Barrel	400-44	0	0	0	0
26	Mounting frame	400-45	0	0	0	0
27	Lock	200-19	0	0	0	0
28	Rear sight frame	300-28	0	0	33	12.74
29	Fore sight frame	300-23	0	0	28	10.81
30	Trigger	100-06	0	0	23	8.88

The thirty parts identified as long processes (select five parts have large cycle time in each shop) and marked the maximum amount of rework and reject in those parts.

As tabulated in table 1 from the total part reworked in 2013 about 41.49% rework are Barrel (11-10a) and also from the total parts rejected in the same manufacturing year 7.46% of this single part totally rejected. This indicates the industry is great challenged to produce this part and it require a great attention and solution to reduce the percent of rework and reject of this part.

Table 2: Total rework and reject cost of five bottleneck parts.

S/ No	Part Name	Part code	No. of processes	Unit Man. Cost/birr	Rework	Rework Cost/ birr	Reject	Reject Cost /birr
1	Breech block	11-2	21	313	38	11,894	151	47,263
2	Barrel	11-10a	50	253.97	556	141,207.32	104	26,412.88
3	Extractor	3-6	36	89	159	14,151	88	7,832
4	Rear sight frame	300-28	36	50.71	0	0	33	1,673.43
5	Fore sight frame	300-23	26	140.39	0	0	28	3,930.92
				Total	753	167,257	404	87,112.23

Total manufacturing cost = material cost + labor cost +overhead cost +power consume

As indicated in Table, 2 the factory loss 254,369.23 birr due to rework and rejection of the five bottle neck parts in these manufacturing years and therefore, it requires special consideration and follow up to fix the problem.

As guidance of the five special parts selected in all shops from the shop one barrel was higher amounts of reworks and rejects are scored in total reworks and rejects of the manufacturing year.
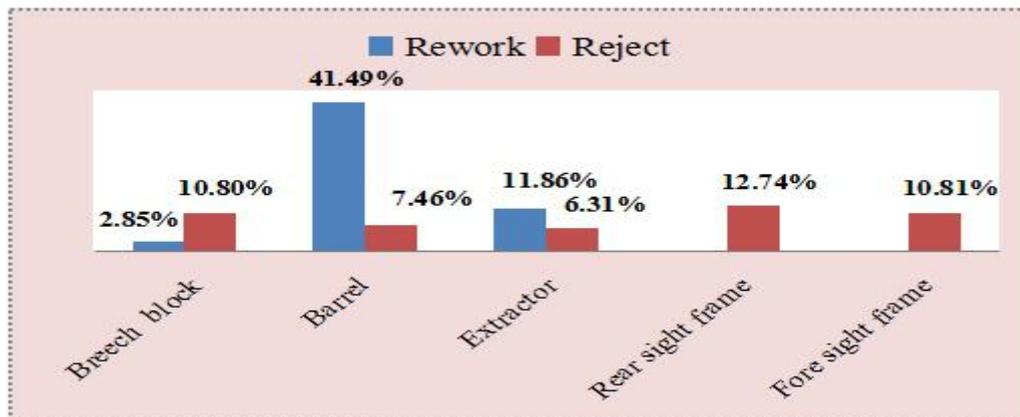
Figure 1, Percentage of rework and reject.

4.3 Barrel production as a bottleneck processes

The total cost of rework and reject of the five critical parts 254,369.23 birr. The factory production bottle neck was barrel which is higher number of reject and rework, with a total cost of 167,620.20 birr loss registered in the base year. This shows the barrel production in the factory is the major source of wastage causing the factory higher production losses.
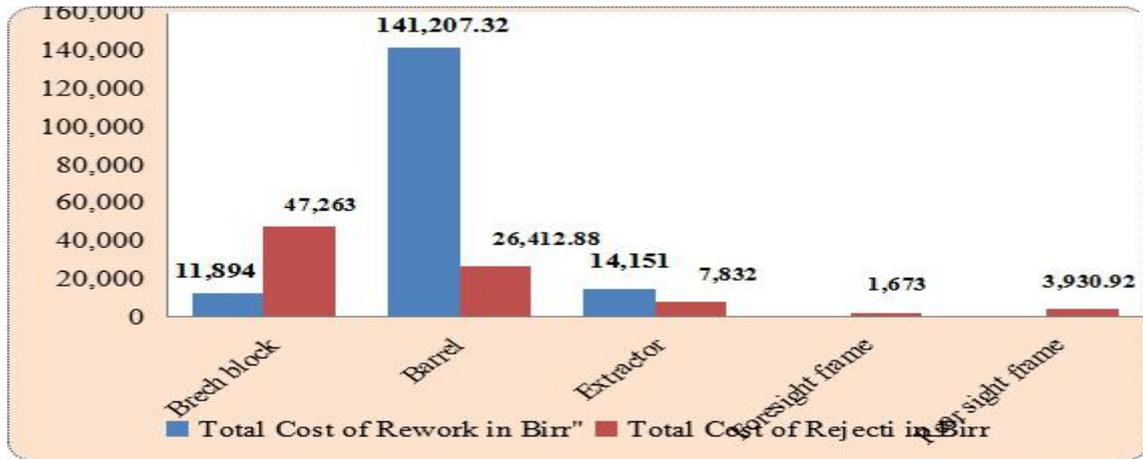
Figure 2, Total cost of rework and reject

5. LEAN TOOL IMPLEMENTATIONS AND SOLUTIONS

The findings of the study are identification of critical problems that are bottleneck of the operation for productivity losses in the factory. Accordingly there are source of resource wastage identified and the solution to solve this are forwarded as follows.

5.1. Eliminating waiting time by implementing kanban system

Kanban works by limiting the inventory between each step in production processes cards are created for each processes step. Work cannot begin at a particular step until that step receives a card from upstream processes. Works therefore does not build up between work centers because the numbers of cards are limited kanban the ultimate form of a 'pull' production because every step works from the downstream step to signal or pull material rather than just produce what is placed in front of the processes.

The Kanban card and cage box is designed as shown in Figure 3 and 4,which contains photograph of that part, part code, shop to be produced, process number, quantity to be processed starting time and finishing time.

Figure 3, Kanban Card.

Figure 4, Cage Box for Kanban System

The cage box is very important in order to use the product for better material handling. The one problem of the quality especially surface finishing problems comes from poor material handling can be also solved by using these methods. For the weight and strength of the cage box it produced from molded plastics. And cards prepared from hard papers.

The number of kanban cards depends on the physical size and number of the parts. The standard calculation is:

Small size product use cage box for those parts attach one kanban card on the box. For large size parts it need individual card to control the manufacturing procedure.

One of the most important tasks of a kanban planning system is determining the optimal number of kanban cards, average daily demand for the kanban item, and the lead time to replenish one kanban.

Where: - *DP = Daily planned (units)*

LT = Replenishment lead time (days)

SS = Statistically calculated safety stock (units)

TB = Time bucket of the safety stock data points (days)

KB = Quantity per cage box (units)

EPEI = Supplier's replenishment interval (days)

Table 3, Number of Kanban card and cage box requirement tables (sample).

S/ No.	Part Name	Part code	Kanban Card	Cage box
1	Ass. Receiver body	Ps 11—10		
2	Barrel	11--10a		
3	Muzzle break	29--1c		
4	Rear sight base	11—21		
5	Gas chamber	11--29a		

5.2 The Kanban System Application on Barrel

Because of barrel as bottle neck processes of the factory it needs the implementing kanban system for this product.

- Processing time means considered as the addition of machining time and set up time.
- Cycle time considered as he sum of processing, waiting and inspection time.
- Processing time = 192 min. (Appendix II).
- Total cycle time of barrel = 266 min. (Appendix IV).
- Cumulative Waiting time of barrel = the sum of waiting time between each processes = 69 min. (Appendix I).

5.2.1 Existing Cycle time of barrel

- ◆ *Processing time = Machining time + Set up time = 192 min.*
- ◆ *Waiting time = 69 min.*
- ◆ *Inspection time = 5 min.*
- ◆ *Total cycle time = Processing time + waiting time + inspection time.*
- ◆ *Total cycle time = 192 + 69 + 5 = 266 min.*

5.2.2 After implementation of Kanban system, Cycle time of barrel

The cumulative waiting time of barrel part can eliminate by implementing Kanban system, by saving of waiting time the free time of machine and labor can be utilized in the production of other parts.

- ✓ *Processing time = Machining time + Set up time = 192min.*
- ✓ *Waiting time = 0 min.*
- ✓ *Inspection time = 5 min.*
- ✓ *Total cycle time = Processing time + waiting time + inspection time.*
- ✓ *Total cycle time = 192 + 0 + 5 = 197 min.*
- ✓ *26 % improvement of cycle time.*

The larger processing time of barrel is Honing Hole Finishing processes it takes 13 minutes (appendix I). Accordingly the factory maximum production capacity of barrel is 36 parts per day.

- ✓ Then kanban system pull the production process instead of pushing because of this the last operator request 36 parts per day.

- ✓ Labors distributed to the other activities/work instead of waiting one operation, this is leads to balance the work load in whole manufacturing process.

5.3 Eliminating work in processes inventory by implementing Kanban system

The main causes of the waste of inventory is that of the waste of overproduction, poor layout and lack of balance in workflow causing inventory to build up before or after different processes. This is a good indication of poor flow within the processes. Implementation of Kanban systems ensure that we balance our processes and prevent the buildup of inventory.

5.3.1 Existing WIP inventory in barrel (Appendix II)

As taken the investigation more work in processes inventory happened at the large processing time, as study on the barrel the work in processes inventory identified as:-

➢ WIP Inventor at processes number 2- work piece section machining 116 parts per day.
➢ WIP Inventor at the processes number 5- reaming operation 78 parts per day.
➢ WIP inventory at the processes number 12 honing hole finishing 11 parts per day.
➢ Total work in processes inventory per day is 227 pieces.

5.3.2 After Kanban implementation WIP inventory in barrel (Appendix III)
  ✓ Totally eliminate WIP Inventory.

5.3.3 Productivity improvement after implementation of kanban system
  ✓ The production capacity of barrel before kanban system is 6 pieces per day.(The amount of parts reaches the final processes per day) (See appendix II)
  ✓ After application of kanban system the production capacity of a single part increase to 36 pieces per day, the amount of the final processes request/reached per day.(See Appendix III)

6. CONCLUSION

In this study, the major source of waste and non value added activities are identified for whole manufacturing flow of AkM-103(Model ET97/1 and ET97/2) and implement lean tools "Kanban system" to reduce and eliminate the source of waste.

These main source wastes are waiting time, over processing, defects, rework and reject parts are evaluated and pointed out from total parts manufactured in all shops at Gafat Armamen Part Production Factory. In order to identify which activities add value to the product and which do not. It was considered from the analysis depending on;-

  ✓ Long processing parts that are most costly and

✓ Number of defective, rework and rejected parts.

The current manufacturing methods were first evaluated, and then process flow of the factories was investigated. Based on which the analysis conducted the researcher reached on the following conclusions.

Production bottle necks parts were identified in each shop regarding the source of wastage long processing, number of rework and rejected parts are; - Breech block, Barrel, Extractor, Rear sight frame and for sight frame.

The factory cost of rework and reject of this five critical parts was great with total amount in birr 254,369.23 was high causing production decline and profit loss. Barrel is the most production bottle neck among the five selected parts with yearly cost of rework 141,207.32 Birr and cost of reject 26,412.88 Birr in this factory that has to be solved and also waiting time as critical sources of waste registered.

- As researcher taken to solve the existing waiting time of barrel 69 min. by implementing kanban system it can be eliminated totally.
- The existing cycle time of barrel is 266 min. can be reduced to 197min; this is 26% improvement of the cycle time of a single part.
- The existing production capacity of barrel is 6 parts per day, after implementing the kanban system it possible to increase 36 parts per day, the improvement of production capacity of barrel to 83 % per day.

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8. Appendixes

Appendix I - Processing and waiting time of barrel

319-1	Part code	Part Name	Time in minute		
	11-10a	Barrel	Pro. & Ins.Time	Wait Time	Cumulative wait time
No	Process No	Processes Name	Pro. & Ins.Time	Wait Time	Cumulative wait time
1	1	Work piece cutting	2	0	0
2	2	Work piece section machining	4	0	0
3	3	Center groove machining	3	1	1
4	4	Both center machining(1-3)	3	0	1
5	5	Reaming	11	0	1
6	6	External roughing(1-10)	6	5	6
7	7	External finishing(2-13)	3	3	9
8	8	Forging chuck head step machining	6	0	9
9	9	Forging axis head step machining	4	2	11
10	10	Both step slop machining	5	0	11
11	11	Slop machining by profile ruler	4	1	12
12	12	Honing hole finishing	13	0	12
13	13	Barrel cartridge ,rifle washing	2	11	23
14		Inspection after 13 processes	1	1	24
15	14	Cold forging	7	0	24
16		Inspection after 14 processes	1	6	30
17	15	Cartridge cutting and chamfering	3	0	30
18	16	Muzzle cutting	3	0	30
19	17	Muzzle center groove machine	3	0	30
20	18	Cartridge external machining by profile ruler	6	0	30
21	19	External finishing	2	4	34
22	20	Cartridge chamber section finishing	4	0	34
23		Inspection after 20 processes	1	3	37
24	21	Middle part profile machining	7	0	37
25	22	Barrel extractor roughing	3	4	41
26	23	Barrel extractor finishing by profile ruler	2	1	42
27	24	Cartridge chamber extractor machining	6	0	42
28	25	Cartridge chamber extractor R machining	4	2	44
29	26	Cartridge chamber slope machining	6	0	44
30		Inspection after 26 process	1	5	49
31	27	Barrel extractor correcting	3	0	49
32	28	Muzzle grinding	2	1	50
33	29	Muzzle assembling part grinding	5	0	50
34	30	Grinding for 11-29	3	2	52
35	31	Grinding for 11-27	2	0	52
36	32	Grinding for 11-21	2	0	52
37	33	Cartridge chamber grinding	5	0	52
38	34	Buff grinding	3	2	54
39	35	Muzzle cutting	4	0	54
40	36	Rough muzzle R machining	6	0	54
41	37	Muzzle part chamfering	2	4	58
42	38	Cartridge chamfer edge machining	3	0	58
43	39	Rough machining R of muzzle and cleaning	6	0	58
44	40	Straitening the barrel bore	4	2	60
45	41	Stamping	1	3	63

46	42	Barrel cartridge rifle washing	1	0	63
47	43	Oiling and cleaning the chamber barrel bore	1	0	63
48	44	The chrome plating the barrel bore and chamber	3	0	63
49	45	Intensity test by special high – pressure bullet	1	2	65
50	46	Crack test	2	0	65
51	47	Removing the power gas from the barrel bore	1	1	66
52	48	Hard cleaning the barrel bore	2	0	66
53	49	Coloring and cleaning	3	0	66
54	50	Hard cleaning the barrel bore	2	1	67
55	51	Straightening and cleaning the barrel bore	3	0	67
56		Inspection after 52 processes	1	2	**69**
57		Finish			

Appendix II – Existing Amount of Work in Processes Inventory of Barrel

Pro No	Processes Name	Pro. & Ins.Time	CWT	Total (PT+CWT)	Daily capacity	Inventory /day
1	Work piece cutting	2	0	2	232	-
2	Work piece section machining	4	0	4	116	116
3	Center groove machining	3	1	4	116	0
4	Both center machining(1-3)	3	1	4	116	0
5	Reaming	11	1	12	38	78
6	External roughing(1-10)	6	6	12	38	0
7	External finishing(2-13)	3	9	12	38	0
8	Forging chuck head step machining	6	9	15	31	7
9	Forging axis head step machining	4	11	15	31	0
10	Both step slop machining	5	11	16	29	3
11	Slop machining by profile ruler	4	12	16	29	0
12	Honing hole finishing	13	12	25	18	11
13	Barrel cartridge ,rifle washing	2	23	25	18	0
	Inspection after 13 processes	1	24	25	18	0
14	Cold forging	7	24	31	15	3
	Inspection after 14 processes	1	30	31	15	0
15	Cartridge cutting and chamfering	3	30	33	14	1
16	Muzzle cutting	3	30	33	14	0
17	Muzzle center groove machine	3	30	33	14	0
18	Cartridge external machining by profile ruler	6	30	36	12	2
19	External finishing	2	34	36	12	0
20	Cartridge chamber section finishing	4	34	38	12	0
	Inspection after 20 processes	1	37	38	12	0
21	Middle part profile machining	7	37	44	10	2
22	Barrel extractor roughing	3	41	44	10	0
23	Barrel extractor finishing by profile ruler	2	42	44	10	0
24	Cartridge chamber extractor machining	6	42	48	9	1
25	Cartridge chamber extractor R machining	4	44	48	9	0
26	Cartridge chamber slope machining	6	44	50	9	0
	Inspection after 26 process	1	49	50	9	0
27	Barrel extractor correcting	3	49	51	9	0
28	Muzzle grinding	2	50	52	8	1
29	Muzzle assembling part grinding	5	50	55	8	0
30	Grinding for 11-29	3	52	55	8	0
31	Grinding for 11-27	2	52	54	8	0
32	Grinding for 11-21	2	52	54	8	0
33	Cartridge chamber grinding	5	52	57	8	0
34	Buff grinding	3	54	57	8	0
35	Muzzle cutting	4	54	58	8	0

36	Rough muzzle R machining	6	54	60	7	1
37	Muzzle part chamfering	2	58	60	7	0
38	Cartridge chamfer edge machining	3	58	61	7	0
39	Rough machining R of muzzle and cleaning	6	58	64	7	0
40	Straitening the barrel bore	4	60	64	7	0
41	Stamping	1	63	64	7	0
42	Barrel cartridge rifle washing	1	63	64	7	0
43	Oiling and cleaning the chamber barrel bore	1	63	64	7	0
44	The chrome plating the barrel bore and chamber	3	63	66	7	
45	Intensity test by special high – pressure bullet	1	65	66	7	0
46	Crack test	2	65	67	6	1
47	Removing the power gas from the barrel bore	1	66	67	6	0
48	Hard cleaning the barrel bore	2	66	68	6	0
49	Coloring and cleaning	3	66	69	6	0
50	Hard cleaning the barrel bore	2	67	69	6	0
51	Straightening and cleaning the barrel bore	3	67	70	6	0
	Inspection after 52 processes	1	69	70	6	0
Total		**192+5**				**227**

Appendix III – Enhanced Amount of Work in Processes Inventory of Barrel

Pro No	Processes Name	Pro. & Ins.Time	WT	Total (PT+WT)	Daily capacity	Inventory /day
1	Work piece cutting	2	0	2	36	0
2	Work piece section machining	4	0	4	36	0
3	Center groove machining	3	0	3	36	0
4	Both center machining(1-3)	3	0	3	36	0
5	Reaming	11	0	11	36	0
6	External roughing(1-10)	6	0	6	36	0
7	External finishing(2-13)	3	0	3	36	0
8	Forging chuck head step machining	6	0	6	36	0
9	Forging axis head step machining	4	0	4	36	0
10	Both step slop machining	5	0	5	36	0
11	Slop machining by profile ruler	4	0	4	36	0
12	Honing hole finishing	13	0	13	36	0
13	Barrel cartridge ,rifle washing	2	0	2	36	0
	Inspection after 13 processes	1	0	1	36	0
14	Cold forging	7	0	7	36	0
	Inspection after 14 processes	1	0	1	36	0
15	Cartridge cutting and chamfering	3	0	3	36	0
16	Muzzle cutting	3	0	3	36	0
17	Muzzle center groove machine	3	0	3	36	0
18	Cartridge external machining by profile ruler	6	0	6	36	0
19	External finishing	2	0	2	36	0
20	Cartridge chamber section finishing	4	0	4	36	0
	Inspection after 20 processes	1	0	1	36	0
21	Middle part profile machining	7	0	7	36	0
22	Barrel extractor roughing	3	0	3	36	0
23	Barrel extractor finishing by profile ruler	2	0	2	36	0
24	Cartridge chamber extractor machining	6	0	6	36	0
25	Cartridge chamber extractor R machining	4	0	4	36	0
26	Cartridge chamber slope machining	6	0	6	36	0
	Inspection after 26 process	1	0	1	36	0
27	Barrel extractor correcting	3	0	3	36	0
28	Muzzle grinding	2	0	2	36	0
29	Muzzle assembling part grinding	5	0	5	36	0

30	Grinding for 11-29	3	0	3	36	0
31	Grinding for 11-27	2	0	2	36	0
32	Grinding for 11-21	2	0	2	36	0
33	Cartridge chamber grinding	5	0	5	36	0
34	Buff grinding	3	0	3	36	0
35	Muzzle cutting	4	0	4	36	0
36	Rough muzzle R machining	6	0	6	36	0
37	Muzzle part chamfering	2	0	2	36	0
38	Cartridge chamfer edge machining	3	0	3	36	0
39	Rough machining R of muzzle and cleaning	6	0	6	36	0
40	Straitening the barrel bore	4	0	4	36	0
41	Stamping	1	0	1	36	0
42	Barrel cartridge rifle washing	1	0	1	36	0
43	Oiling and cleaning the chamber barrel bore	1	0	1	36	0
44	The chrome plating the barrel bore and chamber	3	0	3	36	0
45	Intensity test by special high – pressure bullet	1	0	1	36	0
46	Crack test	2	0	2	36	0
47	Removing the power gas from the barrel bore	1	0	1	36	0
48	Hard cleaning the barrel bore	2	0	2	36	0
49	Coloring and cleaning	3	0	3	36	0
50	Hard cleaning the barrel bore	2	0	2	36	0
51	Straightening and cleaning the barrel bore	3	0	3	36	0
	Inspection after 52 processes	1	0	1	36	0
	Total	**192+5**	**0**			**0**

Appendix IV - Total Processes and Cycle Time of Part Produced in Shop One

S/No	Part Name	Part code	Total processes	Cycle time (min.)
1	Ass. Receiver body	Ps11-1b	103	644
2	Breech block	11-2	21	91
3	Barrel base	11-9	21	87
4	Ass. selector	11-30	7	18
5	Change lever	11-13	6	18
6	Selector Washer	11-4	7	23
7	Selector lever washer	1-35	2	2
8	Ass. Stock Support	Ps11-7	12	26
9	Stock support Reinforcement Plate	11-7	9	22
10	Stock support	11-3fr	7	19
11	Grip screw frame	11-8	11	31
12	Barrel	11-10A	50	266
13	Muzzel Break	29-1c	20	74

Phytochemical and Antimicrobial Studies of Henna (*Lawsonia inermis* Linn) Leaves

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ABSTRACT

The study focused on isolation and characterization of bioactive compounds from Chloroform/methanol extract of L. inermis of Ethiopian origin. The fresh plant material was shade dried in laboratory and crushed in to appropriate size. The powdered plant sample was extracted with n-hexane, Chloroform/methanol (1:1), Methanol and water. Phytochemical screening of L. inermis extracts showed the presence of most important phytoconstituents. The medicinal value of the plant can be correlated due to the presence of various bioactive chemical constituents. The chloroform/MeOH (1:1) extract shows the presence of alkaloids, flavonoids and tannins and absence of saponins. The methanol extract showed the presence of alkaloids, flavonoids, saponins and taninins. The water extract showed the presence of the presence of alkaloids, saponins and tannins and absence of flavonoids. The antimicrobial activity of the extracts were done using standard pathogenic organisms such as Staphylococcus aureus, Escherichia coli, S. pyogen , and Salmonella typhimurium. The n-hexane extract of the plant leaves showed some antibacterial activities against S. pyogen and did not show any activity against Staphylococcus aureus, Escherichia coli and S. typhimurium. Other crude extracts tested did not show any activity against these strains. In general we found that the crude extracts of the plant did not show any promising activity against the tested strains.

One compound was isolated from the plant leaves CHCl$_3$/MeOH (1:1) extract using column chromatography. The compound was characterized as (3'-methylpentyl-3'',6''-dimethylpentyl)phthalate. Additionally, the water extract of the plant leaves yielded lawsone which was identified by comparison of its R$_f$ value on TLC and MP with that of previously reported values in the literature.

Key words*: Henna, Lawsonia inermis, Phytochemicals, Lythraceae*

INTRODUCTION

Lawsonia is monotypic genus, represented by *L. inermis,* native of North Africa and South-West Asia, widely cultivated in tropical regions of the world in Sudan, Egypt, China and India as an *Lawsonia alba* ornamental and dye plant. *L. inermis (FamilyLythraceae)* is commonly called as Henna and the synonym is Linn. For centuries, henna leaves were renowned as the most extensively used natural hair dying and tattooing agent in many civilizations and cultures.

Henna is not a sacred plant as such, but it is supposed to symbolize prosperity, fertility and happiness. It is widely used in a variety of religious and social ceremonies in India.The plant has got several vernacular names e.g. *Ligusturum egypticum* which is the Latinized English synonym for henna. It arises from the common name for the same plant in England, namely of the Egyptian privet (Mikhaeil, 2004). In India, it is known by various names in different languages *vit.*, Mehndin in Hindi, Mendika, Rakigarbha in Sanskirt, Mailanchi in Malayalam, Maruthani in Tamil, Benjati in Oriya, Mayilanchi in Kannada, and Mehedi in Bengali. Henna plant grows on any type of soil, from light loam to clay loam, but does best on heavy soils, which are retentive of moisture. It tolerates a little alkalinity in the soil.

Propagation is carried out through seeds and cuttings.

In Ethiopia, *L. inermis* is traditionally used to develop a red or black coloring to hands, feet and hair in some occasions such as weddings and religious festivals, especially in the Eastern and Northeastern parts of the country.

Several researchers have reported the different biological actions of *L. inermis* in various *in-vitro* and *in-vivo* test models. Henna leaves, flower, seeds, stem bark, roots have been found to exhibit antioxidant, antidiabetic, hepatoprotective, hypoglycemic, antimicrobial, anticancer and wound healing properties (Gupta *et al.* 1991).

Henna is an important source of phytochemicals of immense medicinal and pharmaceutical significance such as naphthoquinone derivatives, aliphatic components, triterpenes, sterols, phenolic derivatives, coumarins, xanthones, flavonoids, gallic acid, hennotannic acid and mannitol which are effective as Immunomodualtory and other allied agents. (Gupta *et al.* 1991).

L. inermis Linn is one such plant known since with healing attributes and is now the subject of intense scientific study (Singh and Singh, 2001; Azaizeh *et al.,* 2003; Mitscher *et al.,* 1972;

Hanke and Talaat, 1961; Malekzadeh and Shabestari, 1989). This hair care plant is reported to possess immunomodualtory, antiviral, antibacterial, antifungal, nootropic, antifertility, hepatoprotective, tuberculostatic activity, antimitotic, analgesic and anti-inflammatory, anticarcinogenic and antioxidant properties. The leaves are used traditionally for treatment of wounds, ulcers, cough, bronchitis, lumbago, rheumatagia, inflammations, diarrhoea, dysentry, leucoderma, scabies, boils, anaemia, haemorrhages, fever, falling of hair and greyness hair (Burkhill, 1996; Vaidyratnam, 1995).

Previously, we have reported isolation bisabolene of from *n*- hexane extract of henna (Kebede *et al.*, 2013). Our GC-MS analysis result revealed that the presence of at least twenty eight of components in *L. inermis*

leaves. Nine compounds were indentified; representing 80.56% of the total oil which include eugenol (17.61%), hexadecanoic acid (15.07%), Phytol (10.17%), α-terpineol (8.36%) and Etherphenylvinyl (6.67%) ((Kebede *et al.*, 2013). In the earlier report, from the essential of *L. inermis* leaves, α-terpineol (Oyedeji, 2005) and Phytol (Asmah *et al*, 2006) were reported as the major constituents. It is necessary to point out that the chemical compounds of any plant essential oil can vary greatly depending upon geographical region, the age of the plant, local climate, seasonal variations; experimental conditions and genetic difference are responsible for the changes in the types of chemical compounds (Daferara *et al.*, 2000). To the best of our knowledge there was no phytochemical study on polar fraction of henna of Ethiopian origin which initiated us for the study.

Bisabolene
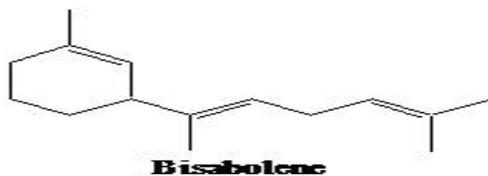
MATERIALS AND METHODS

1. Collection of the Plant Material

The leaves of *L. inermis* were collected from Eastern part of Ethiopia, Dalolebu District, Mechara kebele,which is located in West Hararghe of Oromia regional state, about 431 km from Addis Ababa.

2. Materials and Apparatus

The materials and apparatus used in these study were silica gel, n-hexane, ethyl acetate, chloroform, methanol, DMSO, distilled water, Iodine crystals, TLC plates, beaker (different size), flasks (different size), electronic balance, rotary evaporator, UV light cabinet, TLC chamber, column, measuring cylinder, separator-funnel and Clevenger's apparatus.

3. Sample Preparations and Identification of the Plant

All the leaves had been removed from the stems immediately upon picking the leaves had been washed under running tap water thoroughly, manually peeled and cut into smaller size. The smallest strips of leaves will then spread evenly onto a tray lined approximately 50 cm by 50 cm with aluminum foil. The tray was then placed in an open air allowed at room temperature. The botanical plant specimen was taken to Biology Department, Science Faculty, Addis Ababa University for identification. The plant was identified by Prof. Ensermu Kelbesa and Mr. Melaku Wondafrash and the botanical specimens were deposited at the National Herbarium, Addis Ababa University. The one in red above should be taken under plant collection and identification

4. Extraction and isolation methods

Extraction and Isolation of the Plant Leaves

The air dried and powdered leaves of *L. inermis* Linn. (432 g) was first soaked in 1.5 L n-hexane for 72 h. The marc was extracted further with chloroform; methanol (1:1) for 48 h. Similarly, the marc after chloroform: methanol (1:1) was extracted with methanol. The extracts were concentrated using Rotary evaporator ($40^{\circ}C$) to dryness under reduced pressure to afford 5.4 g n-hexane extract, 8.2 g $CHCl_3$: Methanol (1:1) extract and 14.3 g of Methanol extract (Scheme 1).

Scheme. 1. Outline of the Extraction of *Larsonia inarmis* Leaves

Additionally, the dried ground henna leaves (40 g) was placed in a 2 L Erlenmyer flask containing a magnetic bar and distilled water (2 L) was added. The suspension was stirred on a magnetic stirrer with heating while the temperature was kept around 80 °C. After 1 h, the colour of the green suspension turned brown (Ashnagar and Shiri, 2011). After 6 hrs, solid NaHCO₃ (8.5 g) was added. The suspension was filtered by gravity filtration with filter paper. The filtrates were combined and acidified to pH 3 by addition of 0.12 M HCl. At this stage, the brown extract turned slightly cloudy. The filtrate was extracted with diethyl ether (4 × 200 mL). The combined ethereal phases were washed with water (3 × 50 mL) and dried over anhydrous Na₂SO4. After the removal of ether on a rotary evaporator, a reddish solid material was obtained as crude product (0.4 g).

Isolation of compounds

Isolation of the pure compounds was performed by column chromatography of the extracts on silica gel. The progress of the separation was monitored by TLC. The components were detected by exposing TLC plates to UV light (254 nm and 365 nm) and by iodine vapor. For the compounds which have been isolated, ¹H NMR, ¹³C NMR, and DEPT NMR data were used to characterize their structures.

Fractionation of Chloroform : Methanol extract

5 g of the Chloroform: Methanol (1:1) extract was adsorbed on 20 g of silica gel 60 (0.040 – 0.063 mm) (230 - 400 mesh), by dissolving the sample with Chloroform. After drying the solvent, the dry sample was applied on a column (34 cm x 35 cm), packed with 200 g of silica gel. It was eluted with 200 ml of Chloroform followed by Chloroform: Methanol mixture with increasing amount of Methanol (Table 1). The effluent was collected in 50 ml fractions each where a total of 52 fractions were collected. Each fraction was concentrated to a small volume. Fractions that showed the same R_f value and the same characteristic color on TLC were combined. Fractions (3 – 6) were combined and revealed the presence of one spot and coded as **LICM₁**and analyzed by NMR.

Table. 1. Fractions collected from column chromatography of chloroform:methanol crude extract

Solvent Systems	Ratio (%)	Fractions	Code
Chloroform	100	1 – 15	(Fr 3-6) **LICM₁**
Chloroform: MeOH	95:5	16 – 18	
Chloroform: MeOH	90:10	19 – 39	
Chloroform: MeOH	80:20	40 – 41	
Chloroform: MeOH	50:50	42-43	
Chloroform: MeOH	10:90	44 – 47	
Methanol	100	48 – 52	

Maceration of the plant leaves powder with water

Ground leaves of henna (40 g) was placed in a flask containing a magnetic bar and distilled water (2 L). The suspension was stirred on a magnetic stirrer with heating while the temperature was kept around 75°C. After around 1 h, the colour of the green suspension turned brown. After around 5 hrs, solid NaHCO3 (8 g) was added. The suspension was filtered under gravity filtration. The filtrates were combined and acidified to pH 3 by addition of 0.12 M HCl. At this stage, the brown extract turned slightly cloudy. The swollen plant material was discarded. The filtrate was extracted with diethyl ether (4 × 200 mL). The combined ethereal phases were washed with water (3 × 50 mL) and dried over anhydrous MgSO4. After the removal of ether on a rotary evaporator, a reddish solid material was obtained kas crude water extract (0.5 g). The

crude water extract (0.5 g) was dissolved in 10 mL of the eluent, EtOH:EtOAc (1:2 v/v)

and placed at the top of the column and the elution was started. Fractions of 20 mL were taken. 30 fractions 40 ml each were collected. The compositions of all fractions were monitored by TLC. Fractions 25 -30 was analyzed using TLC on silica gel Toluene: EtOAc: Formic acid (5.5:4:0.5) which had the

same Rf value were combined and yielded 200 mg. The isolation of Lawsone was monitored by its Mp (190-192 °C) and TLC on silica gel. Lawsone (2-hydroxy 1, 2-naphtoquinone) as the major chemical component of henna and it is responsible for coloring orange–red. It was reported that the rain-fed condition induce more of Lawsone content than the irrigated crop (Wagini *et al.*, 2014).

Analysis of the Compound

The ^{1}H and ^{13}C-NMR spectra were recorded on a Bruker Avance Instrument (400 MHz and 100 MHz and TMS is used as an internal standard

(chemical shifts in d or ppm) the isolated compound was dissolved in Dimethylsulfoxide (DMSO - d6).

Methods used for phytochemical screening

1. Test for Alkaloids

Mayer's test

Mayer's reagent: The mercuric chloride (1.36) was dissolved in 60 ml of distilled water and 5 g of potassium iodide in 10 ml of water. The two solutions were mixed and diluted to 100 ml with distilled water. The extract (1.2 ml) was taken in

a test tube to which 0.2 ml of dilute hydrochloric acid and 0.1 ml of Mayer's reagent was added. Formation of yellowish buff colored precipitate confirmed the presence of alkaloids.

2. Test for Flavonoids

Alkaline Reagent Test

To 1.0 ml of the extract, a few drops of dilute sodium hydroxide were added. An intense yellow color was produced in the plant extract,

which become colorless on addition of a few drops of dilute acid, which indicates the presence of flavonoids.

3. Test for Saponins

The extract was diluted with 20 ml of distilled water and it was agitated in a graduated cylinder for 15 minkutes. The formation of 1cm layer of foam shows the presence of saponins. The

extract, 1 ml was treated with 1% lead acetate solution. Formation of white precipitate indicates the presence of saponins.

3. Test for Tannins

Ferric chloride test

To 1-2 ml of the extract and a few drops of 5% aqueous $FeCl_3$ solution was added. A violet color formation indicates the presence of tannins.

Antibacterial activity of the crude extracts

The crude n-hexane, $CHCl_3$/MeOH (1:1) and MeOH extracts of *L. inermis Linn* (Henna)extracts were dried under reduced pressure and antibacterial activity of the extracts were tested against *Staphylococcus aureus, Staphylococcus pyogen, Escherichia coli,* and *S. typhimurium* bacterial strainsusing disk diffusion method (Table 5). Each of the bacterial strains was streaked on the Muller - Hinton agar plates using a sterile swab in such a way as to ensure thorough coverage of the plates and a uniform thick lawn of growth following incubation. The crude extracts were impregnated by 50μL extract on 6 mm diameter sterile disk the test was carried out by dissolving the crude extracts in chloroform. The chloroform which was used as a solvent to dissolve the isolated compounds was used as negative control during the test. Ceftraxone, Ceftazidime were used as a positive control and the diameter of zone of inhibitions reported in all cases include the diameter of the disks. The resulting diameter of the zones of inhibition was measured and the results were recorded in mm.

RESULTS AND DISCUSSIONS

Isolation of Compounds from Henna (*L. inermis*) Leaves

Extraction of the leaves of *L. inermis* with $CHCl_3$/MeOH (1:1) gave a black amorphous extract. Column chromatography of the Chloroform: Methanol (1:1) extract on silica gel eluted with chloroform yielded a pure compound coded as LICM$_1$. The spot of the isolated compound LICM$_1$ on TLC plates acquired a yellow color when visualized using Iodine solid vapor.

Characterization of LICM$_1$

The compound LICM$_1$ was isolated from Chloroform: Methanol (1:1) of *L. inermis* (Henna) leaves by Column Chromatography eluting with Chloroform. LICM$_1$was isolated as amorphous yellow compound. The ^{1}H-NMR spectrum depicts clearly three regions, one in the aliphatic region from d 0.93 to 2.52 the second is in the oxygenated proton signal region from d4.00-4.43 and the other is in the aromatic proton region from d 7.70-7.74.

The ^{1}H-NMR (Table 2) showed signals at d 0.93, 1.33, 2.51 and 2.52 integrated for five methyl groups in the molecule. A multiplet peaks at d 1.28-1.30 integrated for four protons indicated the presence of four methylene protons. A multiplet peak at d 4.00 and 4.48 integrated for two protons indicated the presence of oxygenated methine protons. A triplet peaks at d 7.68 integrated for two protons indicated aromatic methine. A doublet peak at d 7.70 integrated for two protons indicated aromatic methine protons.

Table 2: ^{1}H-NMR spectral data of LICM$_1$

No.	[1]H d (ppm)	No. of hydrogen and multiplicity
3'3''	4.00-4.48	2H, m
4', 4'', 6''	1.96-2.10	5H, m
5',5''	1.28-1.30	4H, m
6'	0.93	3H, t
7'	2.51	3H
7''	1.33	6H, d
9''	2.52	3H
2,5	7.74	2H, d
3,4	7.70	2H, t

The ^{13}C-NMR spectrum of compound LICM$_1$ showed the presence of 16 carbon signals. ^{13}C – NMR spectrum showed the presence of three clearly separated region of aliphatic carbon region with chemical shifts at d11.29, 14.38, 19.36, 22.89, 23.73, 27.69, 30.28 and 38.56, oxygenated carbons at d 67.88, 71.68 and aromatic carbon at d 129.13, 131.70 and 132. 73 and carbonyl carbons at d167.41 and 167.45.

The multiplicity of each carbon atom was determined using DEPT experiment. The DEPT spectrum (Table 3) showed the presence of thirteen peaks corresponding to seventeen carbon atoms. The difference in the number of carbon atoms of the ^{13}C-NMR spectrum and the DEPT spectrum is two and thus LICM$_1$has two quaternary carbon atoms.

The DEPT-135 spectrum displayed downward peaks at d 22.89, 23.73, 27 .69 and 30.28 which indicates the presence of methylene group (-CH$_2$) and the upward peak at d 11.29, 14.38, 19.36 indicating presence of methyl carbons. The upward signal at d38.58 showed the presence of aliphatic methine carbon. Carbon signals at d 71.60, 67.88 are due to presence of methine group attached to oxygenated carbon and signals at d 129.13, 132.70 indicate the aromatic methine carbons.

Table 3: ^{13}C- NMR and DEPT-135 spectral data of compound **LICM$_1$**.

Position	^{13}C – NMR	DEPT-135	Remark	
1, 6	131.7	-		
2, 5	129.13	129.13	=CH	
3, 4	132.70	132.70	=CH	
1'	167.45	-		
1"	167.41	-		
3'	67.88	67.88	CH-O	
4'	30.28	30.28	-CH$_2$	
5'	22.89	22.89	-CH$_2$	
6'	23.73	23.73	-CH$_2$	
7'	11.29	11.29	-CH$_3$	
8', 9"	19.36	19.36	-CH$_3$	
3"	71.62	71.62	CH-O	
4"	27.69	27.69	-CH$_2$	
5"	23.73	23.73	-CH$_2$	
6"	38.56	38.56	-CH-	
7", 8"	14.38	14.38	-CH$_3$	

Based on the above the above spectral data of ^{1}H-NMR, ^{13}C-NMR and DEPT-135 spectral data, the following structure, (3'-methylpentyl-3",6"-dimethylpentyl)phthalate was proposed for LICM$_1$.
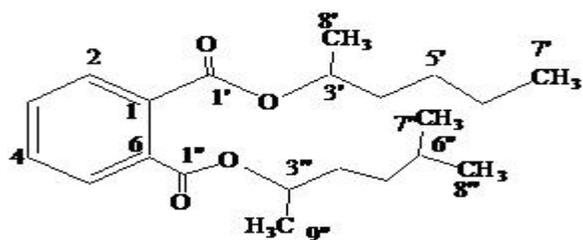
The proposed structure of compound LICM$_1$.

Isolation of Lawsone from the plant leaves

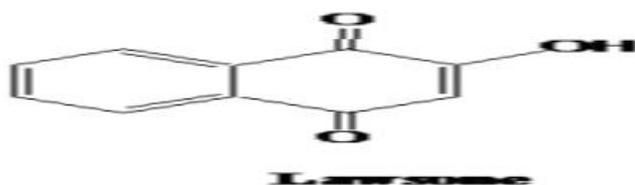Isolation of lawsone was conducted based on the method developed byAshnagar and Shiri, 2011 from the water crude extract. The identity of the compound was confirmed by TLC analysis and comparison of its melting point with those reported in the literature.

Lawsone

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Henna's coloring properties are due to lawsone (Ashnagar and Shiri 2011), a burgundy organic compound that has an affinity for bonding with protein. Lawsone is primarily concentrated in the leaves, especially in the petioles of the leaf. Henna will not stain skin until the lawsone molecules are made available (released) from the henna leaf. Fresh henna leaves will stain the skin if they are smashed with a mildly acidic liquid. The lawsone will gradually migrate from the henna paste into the outer layer of the skin and bind to the proteins in it, creating a fast stain.

Phytochemical Screening

The n-hexane, $CHCl_3$: MeOH (1:1), MeOH and aqueous extracts of the leaf *L. inermis* was subjected to preliminary phytochemical screening of various constituents such as alkaloids, flavanoids, saponins, tannins and the following results were obtained (Table 4).

Phytochemical screening of *L. inermis* extracts showed the presence of most important Phytoconstituents. The medicinal value of the plantcan be correlated due to the presence of various bioactive chemical constituents (Table 4). The chloroform/MeOH (1:1) extract showed the presence of alkaloids, flavonoids and tannins and absence of saponins. The methanol extract showed the presence of alkaloids, flavonoids, saponins and taninins. The water extract showed the presence of alkaloid, saponins and tannins and absence of flavonoids.

Table 4: Phytochemical constituents of n-hexane, $CHCl_3$: MeOH (1:1), Methanol and aqueous extracts of *L. inermis* leaves.

Phytochemicals	CHCl₃:MeOH extract	Methanol extract	Water extract
Alkaloids	+	+	+
Flavanoids	+	+	-
Saponins	-	+	+
Tannins	+	+	+

Key; + = Present,   - = Absent

Evaluation of antibacterial activity of crude extracts of *L. inermis Linn* (Henna)

The antibacterial activates of n-hexane extract, CHCl₃/MeOH (1:1) and MeOH extracts of *L. inermis Linn* (Henna) were determined using disk diffusion method (Table 5).The CHCl₃/MeOH (1:1) and MeOH extracts of *L. inermis Linn* (Henna) did not show any antimicrobial activity against all tested strains.

However, the n-hexane extract showed some antibacterial activities against *S. pyogen.* The n-hexane extract did not show any activity against *Staphylococcus aureus, Escherichia coli* and *S. typhimurium.* In general, we found that the crude extracts of the plant did not show any promising activity against tested strains.

Table 5.*In vitro* antibacterial activity of the crude extracts of *L. inermis Linn* (Henna),

chloroform as solvent

S. N.	Sample	Conc.(mg/ml)	*S. aures*		*S. pyogen*		*E. coli*		*S. typhimurium*	
			Size (mm)	sensitivity	Size (mm)	sensitivity	Size (mm)	sensitivity	Size (mm)	sensitivity
1	n-hexane extract	0.80	6	R	10	S	6	R	6	R
2	CHCl₃/ MeOH (1:1) exract	0.08	6	R	6	R	6	R	6	R
3	MeOH exract	0.28	6	R	6	R	6	R	6	R
4	chloroform	-	6	R	6	R	6	R	6	R
	Ceftraxone	0.03	23	S	20	S	22	S	22	S
	Ceftazidime	0.03	20	S	22	S	19	S	20	S

S=sensitive, R=Resistance, Antibiotics used for QC : Ceftraxone, Ceftazidime

CONCLUSION

Plants play significant uses for the society, research and development should give more attention to traditional health and other practices in order to maximize their proper utilization especially in the health sector and others. Henna (*L. inermis*) is an ancient medicine, dye and generally useful plant. Henna flowers are very fragrant and used for perfume and deodorant.

Phytochemical screening of *L. inermis* extracts showed the presence of most important Phytoconstituents. The medicinal value of the plantcan be correlated due to the presence of various bioactive chemical constituents. The chloroform/MeOH (1:1) extract similar to n-hexane extract. The methanol extract showed the presence of alkaloids, flavonoids, saponins and Tannins.

Henna finds applications in the treatment of a variety of disorders like vulnerary, diuretic, headache, syphilitic, sores scabies and other disorders. The key role behind its therapeutic efficacy is being played by its active compound lawsone (Wagini *et al.*, 2014). Further work remains to isolate the lawsone in large scale and investigate its therapeutic efficacy after its derivatization.

Thus, further tests are needed to evaluate activities of the compounds against other (additional) bacterial species to explore all possibilities, to evaluate potential of the isolated compounds as lead in the development of antibacterial agents. Hence, much more Phytochemical and biological study should be carried out on the plant in future.

ACKNOWLEDGEMENTS

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Green Synthesis and Application of Iron Oxide Nano-particles to Reduce Heavy Metal Chromium (VI) Toxicity

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Abstract

Iron oxide colloidal nanoparticle was synthesized in deionized water by laser ablation. The method is Green or Eco-friendly. Effective dose of iron oxide ($10\mu M$) that can reduce the toxic concentration level of chromium has been identified and applied to reduce its toxicity to wheat plant. Chromium content in the plant after addition of the iron oxide nano particles into the Hog land solution has been analyzed by laser induced breakdown spectroscopy/ LIBS. Distribution patterns of chromium in root, leaf and stem has been analyzed from the LIBS spectra. The result indicated that a 61.26% reduction in the uptake of chromium by the plant had been achieved due to application of $10\mu M$ iron oxide into $100\mu M$ chromium solution. It is also noticed that the plant growing in the $100\mu M$ Chromium showed reduced growth.

Key words: Green synthesis; Chromium; LIBS; Hogland's solution

1. Introduction

Heavy metal pollution is among the major threats our environment is facing every day. Some of the common pollutant elements are Hg, Pb, Cd, and Cr. Chromium is found in all phases of the environment, including air, water and soil [1]. At its stable state it has two different valances. These are Cr (III) and Cr (VI). While Cr (III) is non toxic, Cr (VI) is toxic and carcinogenic to living things, and hence to plants and it usually occurs associated with oxygen as chromate (CrO_4^{-2}) or dichromate ($Cr2O_7^{-2}$) [1, 2]. Both natural processes and human efforts play role in reduction of Cr (VI) to Cr (III). Cr (VI) is a strong oxidant and is reduced in the presence of electron donor.

Electron donors commonly/ naturally found in the soil include aqueous Fe (II), ferrous minerals, reduced sulfur and soil organic matter [2]. The formation of strong binding between Fe (III) and Cr (III) will reduce the chance of re oxidation of Cr (III) to Cr (VI). According to [3], investigations on Cr (VI) reduction on iron bearing minerals and soil surfaces have demonstrated the effectiveness of the Cr (VI) removal reaction based on Cr (VI)/Fe(II) redox process. In addition to this, zero valence iron can also act as an electron donor when it goes to ferrous state due to corrosion. Electrons released due to oxidation of metal, are subsequently consumed by oxidizing species present in the system. In this process, the oxidizing metal attains a higher oxidation state and the oxidizing species is reduced to its lower oxidation state. They added, in the case of the Fe (II)-Cr(VI) system, Fe(II) oxidizes to Fe(III) and Cr(VI) reduces to Cr(III) by consuming three electrons released by three Fe(II) ions as in the following reaction:

$$\longrightarrow Cr~(VI)~(aq) + 3~Fe(II)~(aq) \qquad Cr~(III)~(aq) + 3~Fe(III)~(aq))$$
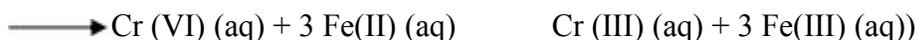
After completion of the redox process, Fe (III) and Cr (III) reaches a stable state by transforming themselves into their oxide or hydroxide depending on the pH of the solution.

Iron oxide also releases free iron in solution as follows:

$$\downarrow$$

$$\longrightarrow Fe_3O_4 + 2H \rightarrow \gamma Fe_2O_3 + Fe_{(II)} + H_2O$$

$$Cr~(VI)~(aq) + 3~Fe(II)~(aq) \qquad Cr(III)~(aq) + 3~Fe(III)~(aq)$$
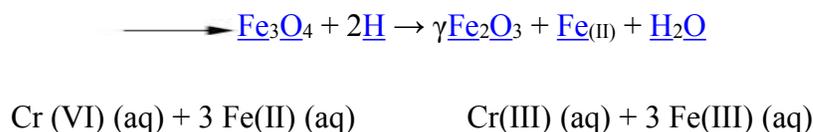
Toxicity of Chromium to plant has been investigated by many researchers. The impact of heavy metals accumulation on the photosynthetic process has been studied [5-8]. Impact of chromium on cellular, plant growth and physiology have been well investigated [9-11]. Different techniques have been employed to reduce the toxicity of Cr (VI) to plants. Addition of scrap iron feelings of different sizes into aqueous solution of chromium under acidic PH was reported to be effective [12]. Chromium removal by combining magnetic property of iron oxide with adsorption property of carbon nanotube has been investigated [12]. The kinetics of chromium reduction by ferrous iron [13] and the spectroscopic investigation of magnetite surface for reduction of hexavalent chromium [14] have verified the reduction of Cr (VI) to Cr (III). Magnetically separable photocatalytic beads containing nanosized iron oxides were applied to reduce Cr (VI) under sun light radiation [15]. However, the effectiveness of such systems depend on the presence of sunlight.

Physio-chemical properties of chromium-iron mixed oxides have been well studied by sol-gel method [16]. Iron- bearing phylosilicate has also been applied for chromium sorption from a solution [17]. Many of these techniques have two limitations. First, the size problem: since the reactivity of a particle/element depends on the surface area, the use of nano sized iron oxide particle would yield a better result than the iron bearings and iron feelings. Second: Echo-friendly synthesis: the nano sized iron or iron oxides produced through wet chemical methods are liable to contaminations and may result in adverse effects if they are directly applied, unchecked for purity, to treat plants. Also they leave reaction by products during their synthesis or preparation.

In the present study an echo-friendly synthesis of iron oxide nanoparticles for chromium toxicity reduction and investigation on the impact of exogenous addition of iron oxide nanoparticles on Cr (VI) tolerance in wheat (*Triticum aestevum*) seedlings by analyzing chromium up take, growth and oxidative stress. Laser induced breakdown spectroscopy (LIBS) analysis is used to analyze the percentage reduction of chromium up take by the plant due to exogenous addition of iron oxide. Wheat was chosen as test sample because it is a staple food crop for about half of the world population.

2. Materials and Method

2.1.Synthesis of Iron oxide Nano Particles in Water

Iron slug (99.95% pure), 9.5mm dia x 9.5mm length and 10g mass was purchased from Alfa Aesar. Ultra pure de-ionized water (HPLC grade) was purchased from Merck, Germany. The laser

ablation of iron oxide nano-particle in pure water was performed by Nd:YAG, pulsed laser(Continuum Surelite III-10, USA). Second harmonic, 532 nm wavelength, at pulse repetition rate of 4Hz is used.The nanoparticle of iron oxide was synthesized at 75mJ. A long focal length lens, 300 mm was use to focus the laser beam on to the material (Iron slug) in 10 ml ultra pure water and the ablation was made for 45 minutes. The schematic experimental set-up for synthesis of the iron oxide nanoparticle is as shown in Fig.1.
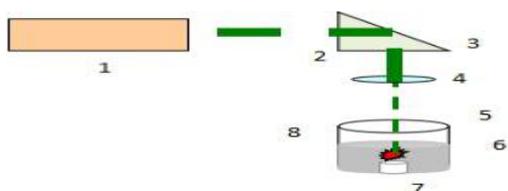

Figure.1 Sketch of experimental set up for laser ablation of iron nanoparticle in water (1-laser source 2- laser light, 3- right angled prism, 4- converging lens, 5- glass, 6-water, 7- iron slug, 8- plasma)

The mass of the iron slug was measured before and after every time of ablation and calculmolation of molar masses of the iron oxide solutions were made: Accordingly we prepared 5 μM, 10 μM, 15 μM, 30 μM, 40 μM and 60 μM solutions of iron oxide solutions. The solutions were used to study the impact of the nanoparticle on the growth of wheat plants and get information about dose response analysis.

2.2 Plant materials and growth conditions

Wheat (*Triticum aestivum*.) seeds were purchased from the market. Before use, uniform sized seeds were surface sterilized with 10% (v/v) sodium hypochlorite solution for 10 min, washed with distilled water and soaked for 4 h. After sterilization and soaking, healthy looking uniform sized seeds were kept in Petri plates (150 mm, Riviera ᵀᴹ) lined with What man No.1 filter papers moistened with half-strength Hoagland's solution (Arditti and Dunn 1969). After this, seeds were germinated for 4 days in dark at 28±2 ℃. Thereafter, seedlings were grown under a photon flux density (PFD) of 150 μ mol photons m^{-2} s^{-1} and relative humidity of 50-60% with a day/night cycle of 12/12 h at 28±2 ℃ for 8 days in a growth chamber. After this, uniform sized seedlings were selected and transferred in half-strength Hoagland's solution to acclimatize them for 7 days. After acclimatization, the seedlings were transferred to the prepared iron oxide 5 μM, 10 μM, 15 μM, 30 μM, 40 μM and 60 μM

and Cr (VI) (K$_2$CrO$_4$; 100 μM) solutions in combination and alone and kept for 7 days. The iron oxide and Chromium concentrations were prepared in half-strength Hoagland's solution.

The effective dose of iron oxide has been identified before the study begun. In the present study, the following combinations of

iron oxide and chromium were made: only half-strength Hoagland's solution (control), 10 μM iron oxide, 100 μM Cr and 10 μM iron oxide +100 μM Cr. After 7 days of iron oxide and Cr treatments, root and shoot samples from control and treated seedlings were harvested and different physical and spectroscopic analysis were made.
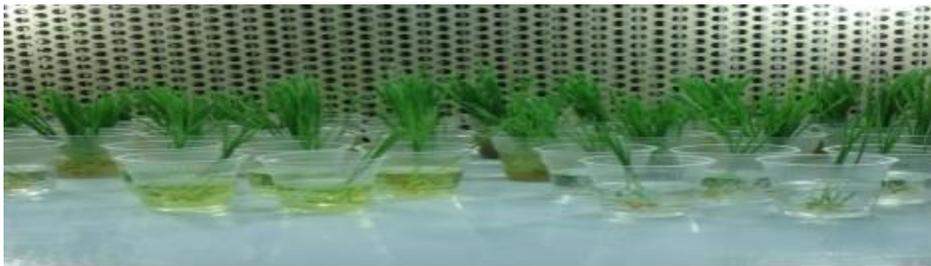
Figure 2.Seedlings in 10μM iron oxide (right) and 100 μM chromium (left) solutions
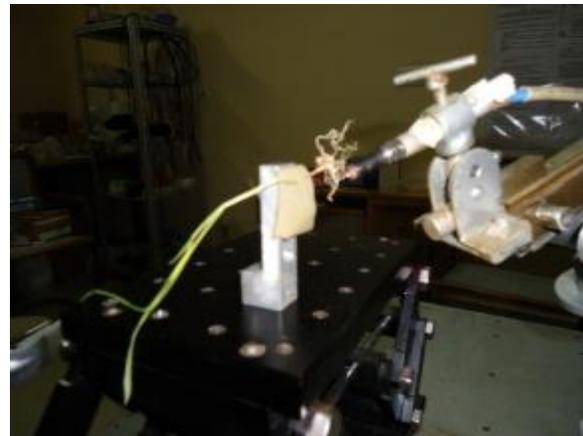
Figure.3 Experimental Set-up for collecting LIBS spectra from root and leaf by fiber optic bundle

3. Results and Discussion

After ablating the Iron slug immersing it in 10 ml pure water for 45 min at 75 mJ energy

and 4Hz pulse repetition rate, iron oxide nanoparticles were synthesized (Fig.5).

Fig. 5 Synthesized iron oxide nanoparticle in water

The formation of iron oxide nanoparticles was also verified by Ultra-Violet (UV)/visible spectroscopic analysis. The UV-Visible absorption spectrum of synthesized nanoparticle was recorded using Perkin Elmer Lambda-35 UV/Vis spectrometer. It is clear from Fig.6 that the position of absorbance peak is around 215 nm.
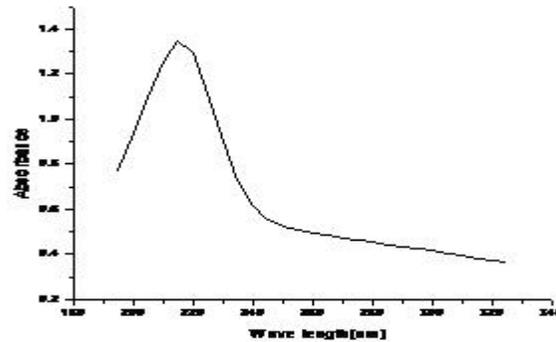
Fig.6 Absorbance of iron oxide in water

3.1 Dose-Response analysis

When the physiological impact of chromium on the seedling could be well observable with a naked eye, LIBS analysis was done to know the right concentration that has impact on root length, as well as fresh and dry weight of the plants (table 1).

Fig. 7 Photograph of seedlings in different solutions

The results gained from the dose response graph for each concentration of iron oxide nanoparticle clearly indicates that concentration of iron oxide at 10 μM is found effective in promoting plant growth, compared to the control group and chromium 100and μM was found most harmful in hindering plant growth. The neutral ph of 7 at the beginning of the experiment has gradually changed. After one week the ph of the chromium solution was found slightly acidic, i.e 6 and that of the mixture of iron oxide and chromium was 8 while the value for the iron oxide was 10. Photosynthetic processes that use water from the solution and the formations of oxides in solution may be the causes for this change in ph values.

3.2 Results from LIBS analysis

In order to check the presence of chromium in the seedlings, we recorded LIBS spectra of the seedlings grown in Hogland solution, Hogland - chromium solution, iron oxide-Hogland solution and iron oxide-chromium-Hogland solution. In the full LIBS spectra of iron oxide – chromium in hogland solution, both the iron and the chromium spectral lines have been detected even though the spectral intensity of iron is small compared to that of chromium.
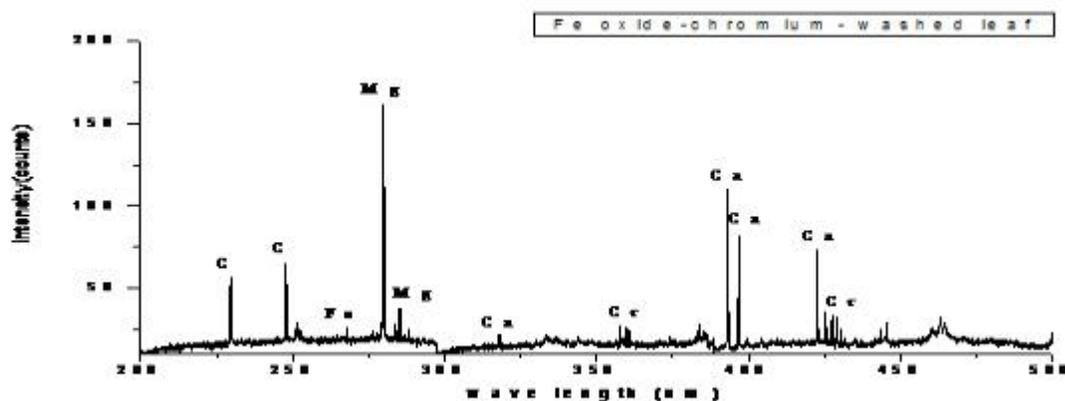
Fig.8 Full spectra of washed wheat leaf in iron oxide-chromium solution

In all parts of the plants: root, stem and leaf chromium lines were detected in those seedlings grown in chromium-Hogland solutions without iron oxide and those with iron oxide in Hogland solution (Fig. 9). But the intensities of the spectral lines were larger in seedlings grown in chromium solution without iron oxide. No

chromium lines were found in the control plant and those grown in iron oxide-hogland solution in all parts of the plant: root, stem and leaf (Fig. 9, 10).
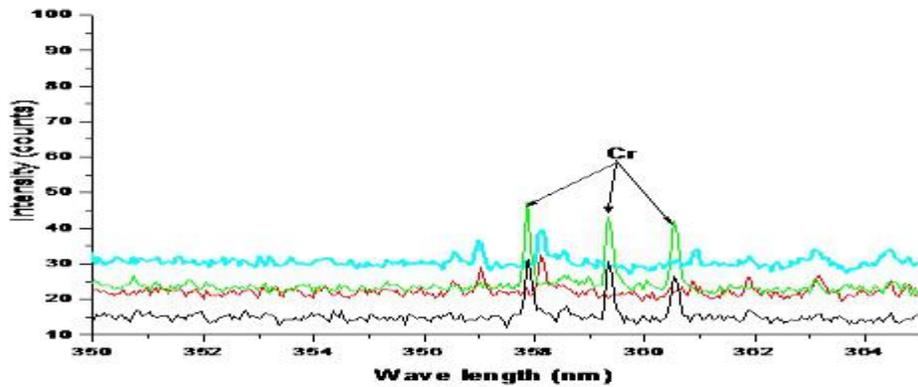
Fig. 9 LIBS spectra of washed seedling root in Hogland solution/control (a), chromium solution (b), iron oxide-hogland solution(c) and in chromium-Hogland solution(d).
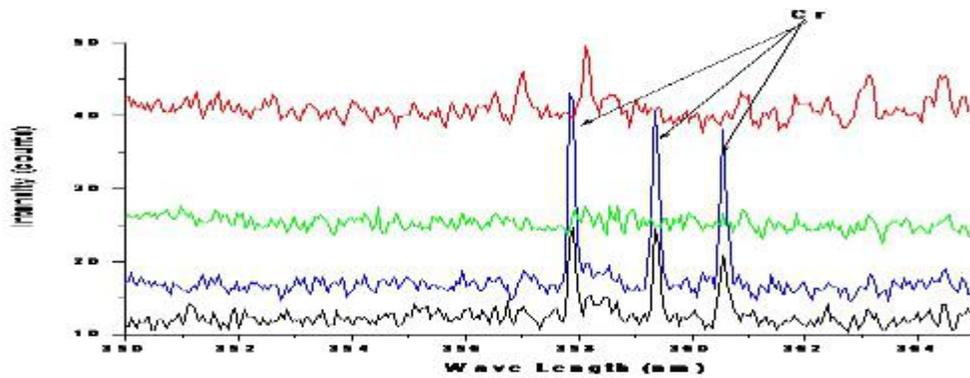
Fig. 10 LIBS spectra of wheat stem in hogland solution/control (a), iron oxide- Hogland solution(b), chromium –hogland solution(c) and iron oxide-chromium-Hogland solution (d)

Since our main objective is to determine the amount of chromium adsorption due to addition of iron oxide to the solution, calculations of integrated intensities for all chromium spectral lines of plants grown in chromium-Hogland solution and those that have grown in chromium- iron oxide-Hogland solution were done (Table 5).

Table 5. Integrated intensities of chromium lines

w. length (nm)	Intensity (counts)	
	Chromium	Chromium plus iron oxide
357.868	132.4	43.3
359.348	117.7	59.2
360.532	125	55.9
425.433	164.9	52.6
427.481	136	53.9
428.973	137.1	50.1
Integrated Intensities(counts)	813.1	315

The integrated intensity clearly indicates that the amount of chromium in a plant treated with iron oxide in chromium solution has about 61.26% reduction in the uptake of chromium by the plant. Similarly, the normalized intensities (intensity to back ground ratios) have been made to to check the validity of the above result.

Accordingly, intensity to background ratios of chromium lines at 425.43 nm was made for both plants grown in chromium-Hogland solution and those that have grown in chromium-iron oxide- Hogland solutions. This result clearly indicates that iron has played a significant role in reducing the uptake of Cr (VI) by plants (Table 6).

Table 6. Normalized intensities of chromium lines

Wave length (nm)	Normalized Intensities	
	In chromium-Hogland soln.	Cr + iron oxide- Hoglan soln.
425.43	3.17	1.72

4. Conclusions

The proper doses of iron oxide nanoparticle that can effectively reduce the toxicity of chromium on wheat was successfully identified. The proportional amount of chromium that is adsorbed due to

application of iron oxide has been quantitatively identified. It is also found that the spectral intensities i.e. the integrated intensity and the normalized intensities found from LIBS spectral analysis of the plants root, shoot and leaves were found

proportional to the amount of chromium absorbed by the plants from the solution. Application of iron oxide colloidal nanoparticle to the chromium containing solution resulted in 61.26 % reduction of chromium up take by the plant.

Acknowledgment

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Root Finding Models With Engineering Applications

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Abstract

This article proposes some iterative methods for solving a nonlinear equation applying construction technique. A new nonlinear equation having the same root r as the original equation to be solved is defined. Then linearization or Newton's method is applied. This gives methods that are competent in comparison with some existing numerical root finding techniques. The basic existing methods such as bisection, secant and Regula-Falsi methods need more than one initial guesses. And others contain higher derivatives, which are sources of algorithm complexities. The present methods need only one initial guess as fixed point methods and may improve convergence of some basic methods. For this, several equations for test of efficiency in C++ and proofs for convergence analysis of the methods are offered. Graphical demonstrations are used in matlab. And some engineering applications of root finding are discussed.

Keywords: –*Iterative methods, simple roots, construction technique, linearization, Newton method*

1. INTRODUCTION

Root finding has several applications in science and engineering. Because, nonlinear models /problems may appear in solving the gas equations (environmental engineering), circuit analysis (electrical engineering), mechanical motions, weather forecasting, solving optimization problems and many other fields [1, 3, 4, 6, 8]. In particular, they are applied for solving nonlinear models to determine local critical points, inflections, zeros and other predictable values, which may be used to indicate extreme local conditions. Nonlinear equations are in general hard to solve, especially when worked out manually. Some may be too intricate to solve [9, 10, 11, 12, 13].

Root finding methods can be constructed applying interpolation methods, perturbation methods, linear estimation, etc. Halley's and Chebyshev's method are methods accelerating convergence rate of the Newton's method (which is not slow convergent) for solving roots of a nonlinear equation $f(x)$ [1, 2, 3, 4, 5, 10].

$$F(x) = \frac{f(x)}{f'(x)^{1/2}}$$

Applying Newton's method on Halley's method was obtained in [5]. And Newton's method was also applied for solving

$$U(x) = \frac{f(x)}{f'(x)^{1/m}},$$

for positive integers m. The result in [5] was based on developing and proving some theorem, and is an interesting. Both Chebyshev's and Halley's method can be derived from second order Taylor's interpolation of $f(x)$ around a root r [2, 3, 4]. Here, based on some ideas in [5], we shall construct a new nonlinear equation $v(x) = 0$ from a nonlinear equation $f(x) = 0$, with the same root as $f(x)$, and apply linear estimation around an approximate root r. This gives new other efficient methods that may also improve convergence of some existing methods.

This study principally focuses on construction of iterative methods for simple root finding of nonlinear equations. The present iterative methods are efficient cubic order convergent.

Organization of the article is as follows: 1) introduction 2) construction method and analysis 3) practical application 4) conclusion and recommendation, and 5) references.

2. CONSTRUCTION OF SOME ITERATIVE ROOT FINDING

In this discussion, we are going to show that there may be different possibilities for construction of a new nonlinear equation $v(x) = 0$ from a nonlinear $f(x) = 0$ and apply linearization method to solve $v(x) = 0$. This also gives third order efficient methods. The method we apply may be referred to as construction technique

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combined with linearization. Taking $F(x) = \dfrac{f(x)}{[f'(x)]^{1/2}}$ with some perturbation h in F, and ignoring the rate of change in the perturbation, we propose some iteration function as below. For this let $v(x) = \dfrac{f(x)}{[f'(x) + h]^{1/2}}$, for some h. It is easy

to show that a simple root of $f(x)$ is also a simple root of $F(x)$ and $v(x)$. The same may hold for some of their fixed point equations. Based on our assumption, applying linear estimation of v(x) or Newton's method, we have the iteration function

$$\phi(x) = x - \frac{2f(x)[f'(x) + h]}{2f'(x)[f'(x) + h] - f(x)f''(x)} \quad (2.1)$$

If the higher derivative is neglected in (2.1), we get Newton's method (2.2)

$$\psi(x_n) = x_n - \frac{f(x_n)}{f'(x_n)} \quad (2.2)$$

If $h = 0$ in (2.1), then one obtains Halley's method (2.3)

$$\psi(x_n) = x_n - \frac{2f(x_n)f'(x_n)}{2[f'(x_n)]^2 - f(x_n)f''(x_n)} \quad (2.3)$$

From convergence criterion of Newton's method, using $\left| \dfrac{f(x_k)f''(x_k)}{2[f'(x_k)]^2} \right| < 1$

and then applying series estimation concept, (2.1) gives Chebyshev's method in (2.4).

$$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)} - 1/2 \frac{[f(x_k)]^2 f''(x_k)}{[f'(x_k)]^3} \quad (2.4)$$

If we let h be a residual $f(x_n)$ at every iterations in (2.1), then we propose an algorithm in (2.5) for a simple root r of $f(x)$.

$$\phi(x_n) = x_n - \frac{2f(x_n)(f'+f)(x_n)}{2f'(x_n)(f'+f)(x_n) - f(x_n)f''(x_n)} \quad (2.5)$$

And in (2.1) if h is the Newton (error) correction, then we offer an algorithm (2.6) or (2.7) for a simple root r.

$$\phi(x_n) = x_n - \frac{2f(x_n)[f'(x_n) - f(x_n)/f'(x_n)]}{2f'(x_n)[f'(x_n) - f(x_n)/f'(x_n)] - f(x_n)f''(x_n)} \quad (2.6)$$

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$$\phi(x_n) = x_n - \frac{2f(x_n)[f'(x_n)^2 - f(x_n)]}{2f'(x_n)[f'(x_n)^2 - f(x_n)] - f(x_n)f'(x_n)f''(x_n)}$$ (2.7)

If we use different signs for h in the numerator and denominator but leave out the higher derivative term in (2.6), we obtain

$$\phi(x_n) = x_n - \frac{f(x_n)[f'(x_n)^2 - f(x_n)]}{f'(x_n)[f'(x_n)^2 + f(x_n)]}$$ (2.8)

The next discussion is convergence of the above methods. Note that an algorithm has to be convergent, stable, consistent and efficient

2.1. CONVERGENCE ANALYSIS

We shall use the following important concepts below to prove convergence [2, 3, 4, 5, 9, 10].

Definition 2.1 A sequence $(x_{n \geq 1})$ generated by an iterative method is said to converge to a root r with order $p \geq 1$ if there exists $c > 0$ such that $e_{n+1} \leq c e_n^p$, $\forall n \geq n_o$, for some integer $n_0 \geq 0$ and the errors $e_n = |r - x_n|$.

Theorem 2.1 (Order of Convergence) Assume that $\phi(x)$ has sufficiently many derivatives at a root r of $f(x) = 0$. The order of any one-point iteration function $\phi(x)$ (fixed point equation $x = \phi(x)$) is a positive integer p, more especially $\phi(x)$ has order p if and only if $\phi(r) = r$ and $\phi^{(j)}(r) = 0$ for $0 < j < p$, but $\phi^{(p)}(r) \neq 0$.

Statement-1: Suppose that $\phi(x)$ is expressible in terms of an iteration function $\varphi(x)$ of order p, $f(x)$ and its derivatives ($\phi = \phi(x, f, f', \varphi, \ldots)$) as in the proofs below. Then the order q of $\phi(x)$ can be determined and $q \geq p$.

1. To prove order of convergence q of an algorithm in (2.5)

$$\phi(x_n) = x_n - \frac{2f(x_n)(f' + f)(x_n)}{2f'(x_n)(f' + f)(x_n) - f(x_n)f''(x_n)}$$ (2.9)

Proof: we can write (2.5) or (2.9) as $\phi(x) = x - (x - \varphi(x))/T$.

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Where $x=\varphi(x)$ is the Newton's iteration function of order p =2 and $T=T(f,f',f'')$.

Clearly $\phi(x)=x$ and $\varphi'(r)=0$ but $\varphi''(r)\neq 0$. Differentiating $\phi(x)=x-(x-\varphi(x))/T$,

we find that $\phi'(r)=\phi''(r)=0$ but $\phi'''(r)\neq 0$. Also if q = 3, then we can check that $\dot{\phi}(r)=\ddot{\phi}(r)=0$,

but $\phi'''(r)\neq 0$. Hence, (2.5) is third order convergent method.

2. Similarly, we can write (2.6) as $\phi(x)=x-(x-\varphi(x))D$. Where $x=\varphi(x)$ is the Newton's iteration

function and $D=D(f,f',f'')$. Hence, (2.6) is third order convergent method. In the same manner,

(2.7) is cubic order $q=3$ and (2.8) is nearly quadratic convergent.

We shall make detail analysis in the future works.

2.2. TEST EQUATIONS AND NUMERICAL RESULTS

The following equations were used, with x_0 to be an initial guess.

$f_1(x)=3x-\cos x-1=0$, with $x_0 = 0, 1, 2$ and root $r\approx 0.607102$ in (0, 1),

$f_2(x)=\log_{10}(x)-2x+2$, $x_0= 0.5, 1.5, 2.2$ and root $r=1.000000$ in [1, 2).

$f_3(x)=2x^3-2x-2=0$, with $x_0= 1, 2, 3$ and root $r\approx 1.324718$ in (1, 2),

$f_4(x)=x^4-x-e^x=0$, with $x_0 = -1.5, -1, 0$ and root $r\approx -0.520651$ in (-1, 0).

$f_5(x)=\cos x+x^3-e^x=0$, with $x_0 = -2.5, -1, -0.5$ and root $r\approx -0.649565$ in (-1, 0).

$f_6(x)=e^{x-1}-\dfrac{1}{x}=0$, with $x_0= 0.5, 2, 3$ and root $r= 1.000000$ in [1, 2).

$f_7(x)=2x^6-2x-2=0$, with $x_0= 1, 2, 3$ and root $r\approx 1.134724$ in (1, 2).

Comparisons (in C++ program) were done relative to Newton method (NM), Halley's method (HM), Chebyshev's (CM) and the algorithms (2.5) and (2.6). The number of iterations required to converge to a root r to six decimal places was recorded in the next table-1under each method.

The stopping criteria were using the error $E_i=\left|x_{i+1}-x_i\right|<\varepsilon, \text{ or the residual } E_i=\left|f(x_i)\right|$ such that

$\left|E_i\right|\le\varepsilon$, for chosen $\varepsilon=10^{-6}$. The average number of iterations (Nar) = (s), as proposed in [3] plays a great role in measuring how faster or slower a method converges also indicated in the table below. The efficiency indices e are calculated as a function e = e(p, f), where p is the order and f is the number of function evaluations [2].

Table-1: numerical results of the test equations

Equations $f_i(x) : x_0$	The number of iterations m required to converge to a root r of $f(x) = 0$ for each algorithms for every given triples of initial guesses.					
	NM	HM	CM	(2.5)	(2.6)	
f_1 : 0, 1, 2	3, 3, 3	2, 2, 3	2, 2, 3	3, 2, 3	2, 2, 3	
f_2 : -5,1,-5,2.2	3, 3, 3	3, 2, 3	3, 2, 3	3, 2, 3	3, 2, 3	
f_3 : 1, 2, 3	4, 5, 6	3, 3, 4	4, 3, 4	3, 3, 4	3, 3, 4	
f_4 : -1.5, -1, 0	5, 4, 3	3, 3, 3	4, 3, 3	4, 3, 3	3, 3, 3	
f_5 : -2.5, -1, -.5	6, 5, 4	4, 3, 3	5, 3, 4	3,2, 3	4, 3, 3	
f_6 : .5, 2, 3	4, 4, 4	3, 3, 3	3, 3, 4	3, 3, 4	3, 3, 3	
f_7 : 1, 2, 3	4, 6, 7	3, 4, 5	4, 5, 6	3, 5, 6	3, 4, 5	
Nar, average of s	≈ 4	≈ 3	≈ 3	≈3	≈ 3	
Order (p)	2	3	3	3	3	
Fun evaluations(f)	2	3	3	3	3	
Efficiency index,e	1.414	1.442	1.442	1.442	1.442	

It is not necessarily true that the higher the order (p) or an efficiency index (e), the faster a method converges. One can check this with some higher order methods in [3, 4]. But in [3] the initial guesses have to be chosen closer to an indicated root r. One can notice that Newton's method needs less number of function evaluations and all methods presented in the table are relatively efficient. For further refer [4].

2. SOME APPLICATIONS IN ENGINEERING

Here, we shall present some application areas of iterative root finding in engineering. For more examples, refer to [1, 3, 9, 11, 13].

A) Water vapor splits into Oxygen and Hydrogen at higher temperature as [1, 3]

$$2H_2O \rightleftharpoons 2H_2 + O_2$$
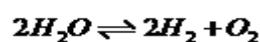
The model for mole fraction f of H_2O is given by

$$k = \frac{f}{1-f}\sqrt{\frac{2p_t}{2+f}}$$

(3.0)

Where $k = 0.04$ is a given reaction equilibrium constant and $p_t = 3.5$ atm is the total pressure at some temperature T. Equation (3.0) is an intricate equation to determine f not easily and hence the importance of root finding.

B) The ideal gas law is given by

$$PV = nRT$$

(3.1)

This formula is accurate only for some gases over a limited range of Pressure p and Temperature T. An alternative equation of state

$$(P + \frac{A}{V^2})(V - B) = RT$$

(3.2)

Where, $v = V/n$ is molal volume of gas, A and B are empirical constants, R is gas constant and n is the number of moles. If p, T, A, B and R are given, we need root finding to solve for v.

for gases (the Van der Waals equation) is the nonlinear model/ equation in v [1, 9]

Direct solution of (3.0) and (3.2) may not be suitable and hence the needs of iterative root finding algorithms. Here, we recall examples in (A) and (B) above.

1. From (A), the equation to be solved for the mole fraction f of water vapor [3] (3.0) becomes

$$F = F(f) = 0.04 - \frac{f}{1-f}\sqrt{\frac{7}{2+f}} = 0.$$
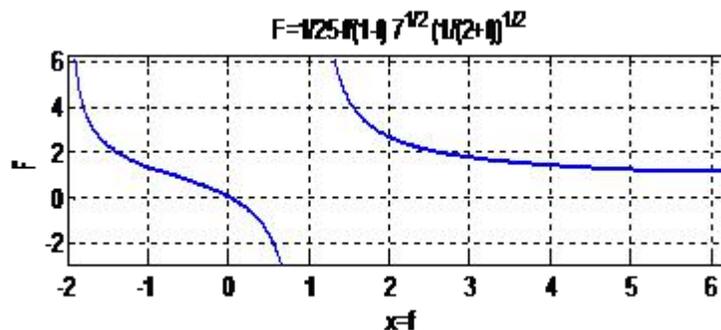
Fig-1: Graph of F indicating a root

One can apply (2.5), Halley's method or Newton's method. The Newton's iterative method is

$$f_{i+1} = f_i - \frac{F(f_i)}{F'(f_i)}, i = 0,1,2,\ldots \tag{3.3}$$

With an initial guess of $f_0 = 0.1$ for (2.5) or Halley's or Newton's method, the approximate mole fraction is $f = 0.0210$ in (0, 1).

2. Considering (B), a chemical engineering design project requires estimating the molal volume v of both Carbon dioxide and Oxygen from equation (3.2). The following data are provided [1, 9].

$R = 0.082054$L atm/(mol K), $A = 3.592$, $B = 0.04267$ for Carbon dioxide, and $A = 1.360$, $B = 0.03183$ for Oxygen. The design pressures are at p = 1atm, 10atm and 100atm.

The designs Temperatures are at T = 300K, 500K and 700K. For n =1, T = 300k, P = 1atm, v = V/n = RT/P = 24.6162L/mol. The computation of v from Van Der Waals equation is to solve

$$F(V) = (P + \frac{A}{V^2})(V - B) - RT = 0 \tag{3.4}$$

One can use (2.5) or Halley's or Newton's method. To apply Newton's fixed point method we need the first derivative of F(v)

$$F'(V) = P - \frac{A}{V^2} + 2\frac{AB}{V^3}$$

Newton's iterative method becomes

$$V_{i+1} = V_i - \frac{F(V_i)}{F'(V_i)}, i = 0,1,2,\ldots \tag{3.5}$$
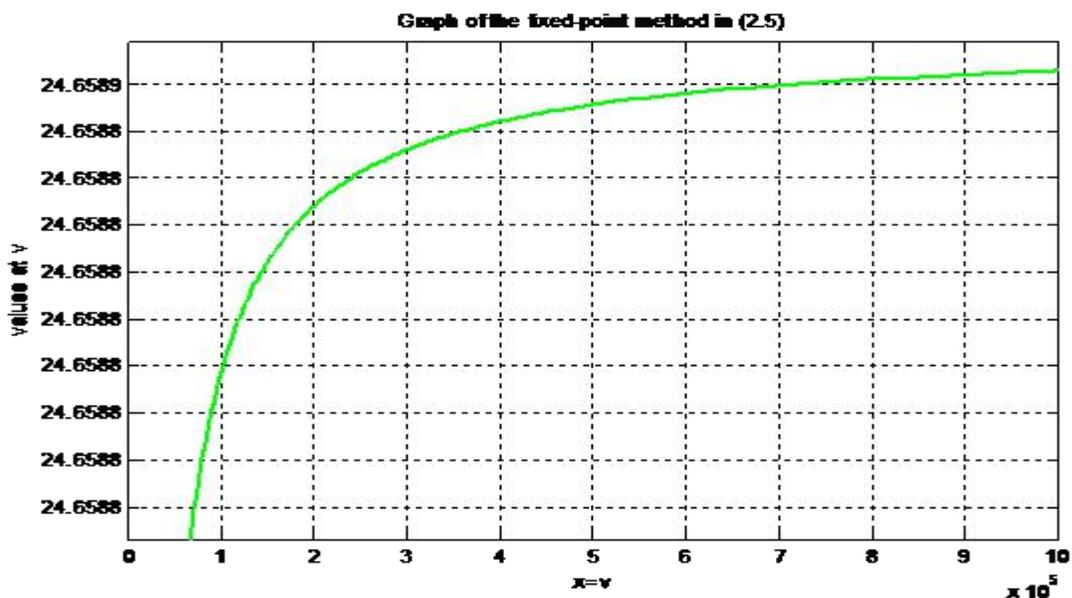
Fig-2: Shows graph of fixed point equation (2.5) for F on some interval for CO_2

Applying (2.5) or Halley's or Newton's method, for carbon dioxide, with initial guess $v_o = 24.6162L/mol$ at P = 1atm and T = 300k, we get an approximate volume $V \cong 24.6589L/mol$ obtained just after few iterations. And for oxygen we get $V1 = 24.5928L/mol$, with the same initial guess v_o.

4. CONCLUSION AND RECOMMENDATION

In this study, we have developed efficient iterative methods for solving simple roots of nonlinear equations. These iterative methods may improve some basic methods. We have shown efficiency tests and convergence analysis. The comparison results are in table-1.

In table 1, we have summarized analysis results of efficiency indices, number of function evaluations in terms of derivatives, order of convergence and conditions of stability and convergence based on initial guesses. We have also discussed some examples of applications of root finding in engineering. Searching for other methods and detail analysis with applications will be our future plan.

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Functional Markers Development from Genomics to Next Generation Sequencing in Crop Plants Improvement

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Abstract

Plant breeding is a continuous process to alter the genetic make-up of crop plants for efficient utilization as food and other purposes. Functional markers are associated with polymorphic sites within genes that determine phenotypic traits. Recent advances of high-throughput marker based technology such as next generation sequencing (NGS), third generation sequencing (TGS) and bioinformatic tools are used for the development and application of functional markers. Numerous plant genomes have now been sequenced at various levels of completion and many more are underway. Improvements in NGS, TGS and genotyping microarrays are promising for understanding the relationships among genes, proteins and phenotypes and being applied to the improvement of crop plants. This article provides the detail review of the discovery, development and applications of functional markers in crop plants improvement.

Keywords: *Affymetrix, candidate gene, DNA markers, Golden Gate, PCR, SSR, SNPs.*

1. Introduction

The world population is continuously growing and thus becoming more demanding, the pressure on resources is increasing, whilst climate change creates further challenges (Lau et al., 2015). There is no balance between the supply and demand of the major food crops. Mankind needs to accelerate plant breeding to increase yield potential and better adaptation to environmental factors include both biotic and abiotic factors that influence crop plants (Deulvot et al., 2010). Since, plant breeding is a continuous process to alter the genetic architecture of crop plants for efficient utilization as food, fiber, fuel or other end uses (Liu et al., 2015). The recent advances in the area of plant genomics has the potential for the introduction of modern farming techniques, which is of vital importance for the development of drastically improved crop plants (Varshney et al., 2014). According to Salgotra et al. (2014), genomics technologies provide the basis for understanding the relationships among genes, proteins and phenotypes and being applied to the improvement of crop plants with encouraging results (Deschamps et al., 2012).

DNA markers have been the most widely used molecular markers in crop improvement in the last 20 years, due to their abundance and polymorphisms (Poczai et al., 2013). They usually grouped in three main categories (1) hybridization (non-PCR) based markers: restriction fragment length polymorphisms (RFLPs) (2) Polymerase chain reaction (PCR) based markers: random amplification of polymorphic DNA (RAPD), amplified fragment length polymorphism (AFLP) and microsatellite or simple sequence repeat (SSR), and (3) DNA sequence-based markers: single nucleotide polymorphism (SNP), diversity array technology (DArTs) and single feature polymorphism (SFP) (Varshney, 2010). These markers vary in their resolution power, genome coverage, experimental designs and application in breeding strategies(Salgotra et al., 2014).

Until recent times, molecular markers developed from the majority of the crop species, which belonged to genomic DNA, and therefore, could belong to either the transcribed or the non-transcribed part of the genome without any information available on their functions (Liu et al., 2012; Salgotra et al., 2014). These genomic markers useful in providing genetic map development and assessing genetic diversity, germplasm

characterization and also used in mapping of quantitative trait loci (QTL) (Sindhu et al., 2014). As a result of the rapid expansion of several public genomic databases, the development of

The advent of next generation sequencing (NGS) in combination with the functional genomics, and expressed sequence tag (EST), led to the acceleration in the identification of variation from the single base pair or coding region (Zhou et al., 2013). As a consequence, large number of genes has

Functional markers (FMs) are developed from polymorphic sites within genes that causally affect a target or phenotypic trait variation (Varshney, 2010; Liu et al., 2012). Hence, development of FMs requires functionally characterized genes, identification of polymorphic or functional site that affect plant phenotype within the corresponding genes and validation of association

functional markers, which are located in or near candidate genes of interest, has become relatively simple (Liu et al., 2015).

been accumulated in public databases (Zhou et al., 2016). The availability of vast amount of sequence data from complete or partial genes has made it possible to develop the molecular markers directly from the parts of genes, which is functional markers (Varshney et al., 2007; Varshney, 2010; Sindhu et al., 2014).

between DNA polymorphisms and trait phenotype (Zhou et al., 2013). Recent advances in the area of genomics like next generation sequencing technologies, high-throughput genotyping platforms and bioinformatics tools have been facilitated the development and application of FMs in several crop species (Lau et al., 2015). Therefore, this paper reviews in detail the development and applications of functional markers in crop plants.

2. Functional markers

The availability of genome, transcriptome sequencing as well as advances in bioinformatics have been generated more sophisticated genetic markers in crops (Lau et al., 2015). Functional markers are associated with polymorphic sites within genes, quantitative trait nucleotides (QTN) or quantitative trait insertion-deletion mutations (QTINDEL), causally affecting phenotypic trait variation (Varshney, 2010). Functional markers FMs

development requires functionally characterized genes, allele sequences from functional genes, identification of polymorphism, functional motifs affecting plant phenotype within these genes, and validation of associations between DNA polymorphisms and trait variation. Therefore, depending on the involvement as well as availability information or feasibility of the FMs it can also be generated (Zhou et al., 2013).

Functional markers can be grouped as direct functional markers (DFMs) and indirect functional markers (IFMs). DFMs are closely associated with phenotypic trait variations and well characterized markers (Lau et al., 2015), while IFMs are less characterized markers and its role for phenotypic trait variation is indirectly known (Table 1) (Andersen and Lubberstedt, 2003). FMs are unaffected by non-functional allelic variation and no recombination between the marker and the gene of interest and thus no loss of information over time (Zhou et al., 2013). Furthermore, FMs are useful for more efficient fixation of alleles in populations, for balancing selection, for screening alleles in natural as well as breeding populations, for the combination of FM alleles affecting identical or different traits in plant breeding and used for the construction of linked FM haplotype (Thomson, 2014).

Table 1. Comparison of marker types

Marker type	Origin of DNA Sequence	Function of polymorphic site	Method for functional sequence motif characterization	Marker development costs	Quality of marker
RDM	Unknown	Not known	-	Low	Low
GTM	Gene	Not known	-	Low	Medium
GS	Unknown	Not known	-	High	Medium
IFM	Gene	Functional motif	Association studies	Medium	High
DFM	Gene	Functional motif	Isogenic line	High	High

Abbreviations: DFM, direct functional marker; GTM, gene-targeted marker; IFM, indirect functional marker; RDM, random DNA marker; GS, genomic selection. **Source: Salgotra et al. (2014)**

3. Comparison of Functional Markers with Genetic Molecular Markers, Random DNA Markers and Genome Selection

Functional markers (FMs), genetic molecular markers (GMMs) and random DNA markers (RDMs) are not essential to predicting the breeding values because these markers are associated with the phenotypic traits (Chen et al., 2013). In contrast, genomic selection is based on a dense set of markers from across the genome. Genomic selection (GS) uses the genome as the selective unit instead of using individual genetic loci that are associated with a trait (Zhou et al., 2013). The significant difference between GS and FM is the greater number of GS markers required for genotyping in a breeding population (Lau et al., 2015). In most GS, the entire set of markers used in the breeding or validating of plant populations (Salgotra et al., 2014). In other words, FMs are essential in trait associated selection, which reduces the amount of linkage drag when used in combination with closely linked markers (Zhou et al., 2016). It also reduces the number of backcross (BC) generations needed (Varshney et al., 2007).

4. Discovery and Development of Functional Markers

Functional genomics discovery in the form of genome sequencing, transcriptome sequencing or gene expression studies have been established since last fifteen years (Andersen and Lübberstedt, 2003). High throughput sequencing techniques in combination with the start of genome and expressed sequence tag (EST) sequencing programs in model plant species, led to the acceleration in the identification of variation at the single base pair resolution (Patel et al., 2013). As a result, a large number of genes have been identified through wet lab as well as *in silico* studies and a rich of sequence data have been accumulated in public databases (e.g. *http://www.ncbi.nlm.nih.gov;*

http://www.ebi.ac.uk;
http://www.ddbj.nig.ac.jp) in the form of BAC (bacterial artificial chromosome) clones, ESTs (expressed sequence tags), full length cDNA clones and genes (Zhou et al., 2016).

FM development methods are (i) indirect linkage disequilibrium (LD) in which mapping based on non-random occurrence of allele haplotypes in the genome(Varshney et al., 2007). (ii) a direct approach such as targeting-induced local lesions in genomes (TILLING) or EcoTILLING and homologous recombination (HR) (Salgotra et al., 2014). EcoTILLING, a variant of TILLING is an efficient method to reveal

polymorphisms between different alleles (Lau et al., 2015).

4.1. Sanger Sequencing-Based Functional Markers Development

The Sanger method is a sequencing-by-synthesis (SBS) method that depends on a combination of deoxy-and dideoxy-labeled chain terminator nucleotides (Varshney, 2010). This technology enabled the first large-scale gene discovery effort via sequencing, i.e. ESTs (Varshney et al., 2007). The development of automated systems was greatly facilitated by technical innovations such as thermal cycle-sequencing and single-tube reactions in combination with fluorescent dye terminators to capture nucleotide incorporation events (Deschamps et al., 2012). Additional improvements in parallelization, quality, read length, and cost-effectiveness were achieved by the development of automatic base calling and capillary electrophoresis (Santos et al., 2016).

In the current version of Sanger sequencing; a mixture of primer, DNA polymerase, deoxynucleotides (dNTPs) and a proportion of dideoxynucleotide terminators (ddNTP), each labeled with a different fluorescent dye, are combined with the DNA template (Deschamps et al., 2012). During the thermal cycling reaction, DNA molecules are extended from templates and randomly terminated by the occasional incorporation of a labeled ddNTP (He et al., 2014). After capillary-based electrophoresis separation, detection is achieved by laser excitation of the fluorescent labels of the extension products. The differences in dye excitation generate a "four color" system that is easily translated by a computer to generate the sequence (Liu et al., 2012).

Sanger method is still the Golden standard, generating high quality sequencing information such as sequencing in recombinant DNA technology (Unamba et al., 2015). It also used to determine specific targets at low throughput, targeted sequencing experiments and used to discover genetic variations within a set of individuals in a population (Deschamps et al., 2012; Liu et al., 2012; Poczai et al., 2013). However, the high costs and labor intensive associated with the Sanger sequencing limit its use in large multi-genome comprehensive studies, both for medical and agricultural applications (Liu et al., 2015).

4.2. Candidate Gene-Based Functional Marker Development

Candidate gene is a gene with known or assumed function that may affect genetic control of a trait, a gene associate with phenotypic character (Lau et al., 2015). These quantitative traits responsible for biomedical, economical, and evolutionary important (Patel et al., 2013).It is very significant for identifying novel genes and alleles that influenced by phenotypic selection during crop domestication and rich in trait diversity available in the germplasm (Liu et al., 2015).

Information on candidate genes based on cloning and the like, which involved in the expression of a particular phenotype, is available in many cases in model or major crop species. The primer pairs designed for the candidate gene (s) can be used to generate the amplicon in several genotypes of a species (Patel et al., 2013). Genetic transformation is required to determine whether the candidate gene is the gene that causes the trait variation (Zhou et al., 2016).

4.3. Expressed Sequence Tags-Based Functional Markers Development

Expressed sequence tags (ESTs) are short cDNA sequences that serve to tag the gene from which the messenger RNA (mRNA) originated and can be used for gene discovery, candidate identification with significant success (Santos et al., 2016). It is also used for obtaining data on gene expression and regulation, sequence determination, and for developing highly valuable molecular markers, such as EST-based RFLPs, SSRs, SNPs, and CAPS (Lau et al., 2015). In addition, it used to designing probes for DNA microarrays that is used to determine gene expression, and also applicable in cloning (Zhou et al., 2016).

The EST approach and subsequent gene-expression profiling (cDNA microarrays) have proven to efficiently identify genes and analyze their expression during different developmental stages, or under various environmental stresses (Poczai et al., 2013). ESTs are also useful for providing markers for genome mapping, since they target specific genes. Specially, EST-derived markers are mainly useful for QTL mapping (Santos et al., 2016). These also allow a computational approach to the development of SSR and SNP markers for which conventional markers development strategies have been expensive (Idrees and Irshad, 2014; Santos et al., 2016).

EST-based markers can be developed either by direct mapping or *in silico* mining. Under direct mapping approaches, the cDNA clones corresponding to the ESTs of interest can be used as RFLP probe or the PCR primers can be designed for the EST or gene and used as sequence taq site (STS) or cleaved amplified polymorphic sequences (CAPS) marker (Idrees and Irshad, 2014). Direct mapping should also be undertaken with the unigene set of ESTs or genes only. *In silico* mining, the SSR or SNP identification software tools are used to screen the sequence data for ESTs/genes (Santos et al., 2016). A large number of bioinformatics tools or pipelines are available in the public databases for identification of markers. Basically, all the tools or pipelines perform clustering on a redundant set of ESTs and the ESTs represents one gene are grouped under one cluster, which can be visualized for the occurrence of markers (Zhou et al., 2016). However, after identification of markers, only non-redundant set of ESTs should be considered for mapping (Varshney, 2010; Salgotra et al., 2014).

4.4. Intron Targeted Functional Markers Development

Introns have been considered as a source of polymorphism due to their moderate sequence evolution. Since, introns are widespread and abundant in eukaryotic genomes and they possess variable amount of polymorphism(Poczai et al., 2013).The basic strategies of introns targeted marker development, introns contain more DNA polymorphisms than exons since introns evolve much faster than exons (Liu et al., 2015). Therefore, intron-targeting strategy of primer design is expected to yield higher polymorphism frequency than other EST–PCR-based conventional strategies (Prabha et al., 2013). The close proximity of introns to exons makes them well suited for the detection of length polymorphism in their structure that can be utilized for various purposes (Santos et al., 2016). In the case of well-characterized species, exon-intron boundaries can be defined using tools like FEGNESH, etc. and subsequently primer pairs can be designed using the flanking exonic sequence of an intron to amplify intronic region (Varshney, 2010).

Development of intron targeted markers has been successful even under resourced crop species (Sindhu et al., 2014). In such cases, the ESTs of the targeted species are BLASTed against the genome sequence of closest model genome sequence data to identify the exon–intron boundaries (Poczai et al., 2013). In this way, intronic sequence can be identified and exonic sequence of the ESTs is used to design the primer pairs to amplify the intronic region (Varshney, 2010).

Several crop genomes have already been sequenced using next generation sequencing (NGS), which is a new generation of sequencing and genotyping technologies (Prabha et al., 2013). These new

At present, three main sequencing methods of NGS technologies are commercially available: Roche 454 sequencing, Solexa/Illumina technology, and AB SOLiD (Sequencing by Oligonucleotide Ligation and Detection) technology (Deschamps et al., 2012). For all these DNA sequencing methods, genomic DNA is randomly sheared, ligated to universal adapters at both end and individual DNA molecules are then immobilized on a solid support, which can be a microscopic bead or a macroscopic support such as a flow cell or slide (Varshney et al., 2014). Subsequently, there is an incorporation of one or more nucleotides, followed by the emission of a signal and its detection by the sequencer (Türktaş et al., 2015). Most NGS platforms are able to generate reliable sequences and display near perfect coverage behavior on GC-rich, neutral and moderately AT-rich genomes (He et al., 2014).

NGS have rapidly advanced next-generation RNA sequencing (RNA-seq) for rapid generation of large expression datasets for gene discovery and expression analysis in non-model species (Prabha et al., 2013). RNA-seq focuses on sequencing of varies

technologies has reduced the cost of whole genome sequencing by many folds allowing discovery, sequencing and genotyping of thousands of markers in a single step (Liu et al., 2015).

mRNA from a particular exon includes variations in the sequences that elucidate functional polymorphisms (Türktaş et al., 2015). Unlike the microarray techniques, RNA-seq can assemble reads *de novo* without mapping to reference genomic sequence. Transcriptome sequencing has, however caused a significant up shot in the expressed sequence tags (ESTs) collections, including the non-model plant species (http://www.ncbi.nlm.nih.gov/dbEST/dbEST) (Unamba et al., 2015).

In addition, there is third-generation sequencing (TGS), received a great deal of attention and has potential to further increase throughput (Türktaş *et al*., 2015). It has two main characteristics; (1) PCR is not needed before sequencing, which shortens DNA preparation time for sequencing (Liu et al., 2012). (2) the signal is captured in real time (single molecule real time) and able to generate longer reads faster (Deschamps et al., 2012), no matter whether it is fluorescent or electric current, is monitored during

the enzymatic reaction of adding nucleotide in the complementary strand (Liu et al., 2012). These new TGS platforms are Helicos BioSciences true single-molecule, Ion Torrent PGM by Life Technologies, Pacific Biosciences real time and Complete Genomics combinatorial, or Oxford Nanopore Grid ION/Mini ION sequencing (Türktaş *et al*., 2015). Consecutively, several bioinformatics community across the world is actively engaged in improving the tools for analyzing the sequencing data with higher accuracy and efficiency (Prabha et al., 2013; He et al., 2014).

Based on the accuracy, lower cost, higher throughput and assay simplicity, NGS technologies have been recently used for whole genome sequencing and for re-sequencing, for detection of mutant genes (Prabha et al., 2013). In such techniques, sequencing data generated using NGS technologies and aligned with the reference genome, transcriptome assembly (Chen et al., 2014). Therefore, the re-sequencing method using a wide range of PCR products for genome-wide marker development, genotyping within populations and the evaluation of genetic diversity (Liu et al., 2015). However, in de *novo* sequencing, there are an alignment of the smaller fragments without the availability of the reference genome (Zhou et al., 2013). Alignment of sequence data can be generating by NGS (such as 454/ Solexa/AB SOLiD technologies) and facilitated by genome or transcriptome sequence data of model or major crop species closely related to the species (Varshney et al., 2014).

5. DNA array-Based Genotyping

Several DNA array-based genotyping platforms have been developed and tested for genetic studies and germplasm characterization (Deulvot et al., 2010). For crops a complete genome sequence, SNP array has been taken as reference because of its high density, assay accuracy, simple data analysis and easy data exchange between research programmes (Figure 1) (Thomson, 2014).

Fig. 1. The patterns of informative SNPs within and between subgroups

Source: Thomson (2014)

The Affymetrix microarrays comprise oligonucleotides fixed to the surface of the chip, GeneChip probe (Thomson, 2014). These microarrys used to identifying

expression level polymorphisms (ELPs), which contain 11 different 25 bp-oligos covering features of the transcribed regions, perfect match (PM) and mismatch (MM) oligonucleotide (Varshney et al., 2007). The PM exactly matches the sequence of a particular standard genotype, the MM differs from this in a single substitution in the central 13th base (Deulvot et al., 2010). Therefore, if the parental genotypes of a mapping population, used for expression study, differ in the amount of mRNA produced by the particular tissue, this should

result in a relatively uniform difference in their hybridizations across the 11 features (He et al., 2014). GoldenGate assay genotyping deals with hybridization of alleles (SNP)-specific primers directed for genomic DNA immobilized on a solid support (Unamba et al., 2015). After performing PCR, the amplified products are captured on beads carrying complementary target sequences for the SNP-specific Tag of the ligation probe (Thomson, 2014). Comparing with NGS, the GoldenGate assay is much easier, since it only needs genomic DNA, avoiding the complexity of library construction. Most importantly, the SNPs that performs well in GoldenGate assays can be directly used as molecular markers for genetic research and breeding (Chen et al., 2014).

The Infinium assay relies on direct hybridization of genomic targets to array-bound sequences (Deulvot et al., 2010). In this assay, single base extension is followed by fluorescent staining, signal amplification, scanning and analysis using the Genome Studio software (Zhou et al., 2013).Infinium chips can be analyzed the high number of SNPs, used for whole genome association studies, population genetic analyses, and copy number variation investigations, and so on (Thomson et al., 2014). Based on Array-CGH (comparative genomic hybridization), Illumina Infinium platform introduced a very high-density SNP genotyping technology to genomic profiling, termed SNPCGH, that allows simultaneous measurement of both signal intensity variations and changes in allelic composition (Varshney, 2010).

6. Challenges in Functional Marker Development

The proper optimization of the FM assay prior to its use is essential that ensures reproducible results; therefore, optimization is required prior to its application in breeding programs (Poczai et al., 2013). Identification or development of optimal QTN or QTINDEL haplotypes might be difficult to achieve the development of functional markers. Another concern for the application of FMs is the pleiotropic, epistatic and genotype-environment interaction effects (Anderson and Lübberstedt, 2003). These creates a challenge to breeders in selecting the traits in breeding programs. Furthermore, linkage disequilibrium (LD) is another challenge in FM development (Sindhu et al., 2014). In mapping populations with substantial intragenetic LD decay, adjacent polymorphic sites might be incomplete LD, ambiguous for the identification of causal quantitative trait nucleotides (QTN) or quantitative trait insertion-deletion mutations (QTINDEL) polymorphisms (Salgotra et al., 2014). LD decay can lead to an overestimation of trait-associated polymorphisms. The costs of development and establishment, and application of FMs in MAB is another challenge (Lau et al., 2015). Therefore, the advancement of sequencing technology is expediting gene discovery and FM development (Thomson et al., 2010).

7. Applications of Functional Markers in Crop Improvement

The development of FMs permits for detection of genes within polymorphic sites in coding sequences, affecting phenotypic trait variation. This is applicable in various areas of crop breeding improvement. Some

application areas in plant breeding are discussed below (He et al., 2014)

7.1. *Marker-Assisted Selection*

Plant breeding has benefited from the advent of marker technology such as marker assisted breeding (MAB), marker-assisted recurrent selection (MARS), marker-assisted backcrossing (MABC), and marker-assisted gene pyramiding (Lau et al., 2015). In these marker technologies, there is a genetic recombination between marker and target locus (Varshney et al., 2007). Such recombination limits the transfer of marker information from experimental mapping population to unrelated breeding materials (Andersen and Lubberstedt 2003). However, this is not the case with functional markers that affecting phenotypic trait variation (Liu et al., 2012). As a result, the FMs, as compared to anonymous markers such as SSRs, are more reliable for identification and selection of favorable alleles, as absence of recombination between marker and target locus increases the diagnostic power of the marker in the marker-based selection of genotypes more accuracy and efficiently (Varshney et al., 2010; Sindhu et al., 2014).

7.2. Genetic Diversity

Molecular Markers are helpful in identifying genes involved in a number of traits, including adaptive traits, and polymorphisms causing functional genetic variation (Varshney et al., 2007). Genetic diversity within and among closely related genotypes is essential for all resource materials that are available for the improvement of a cultivated plant species (Unamba et al., 2015). The concept of germplasm diversity and genetic relationships among breeding materials is very important for crop improvement strategies (Poczai et al., 2013). Neutral molecular markers can be used in genetic and LD-mapping approaches for conservation and adaptation study and breeding (Varshney et al. 2007). However, FMs used to assess germplasm for its genetic diversity (Santos et al., 2016). The advancement of DNA sequencing techniques, genotyping-by-sequencing and others sequencing microarrays have been emerged, allow the rapid and direct study of genetic diversity of large populations (Deschamps et al. 2012).

7.2.   *Germplasm evaluation*

Evaluation of germplasm resources is required for the continuous improvement of crop plants, including the analysis of variation within and among germplasm (Varshney, 2010). Recently, huge genetic resources are available for crop species but

are not well characterized at the molecular level. However, NGS and other biological database tools are rapidly changing this situation for many crops (Unamba et al., 2015). In the availability of techniques, FM can be used effectively to evaluate germplasm, construct heterotic groups, identify rare alleles, identify potential gaps in germplasm collections, monitor evolutionary changes, and find superior alleles (Varshney et al., 2007). If FMs within a gene of interest are identified, they can be used for screening of a vast genetic/ breeding material (Salgotra et al., 2014). In addition, capillary electrophoresis (CE) techniques with FMs used for identification of gene of interests in large number of F_2 and F_3 individuals and other advanced breeding lines (Salgotra et al., 2014).

7. Conclusion

As the world's population continues to grow rapidly and becomes more demanding, the pressure on resources is increasing, whilst climate change poses further challenges. The balance between the supply and demand of the major food crops is fragile. Since, plant breeding is a continuous process to alter the genetic architecture of crop plants for improving crop plants. Functional genomics approaches such as transcriptomics, expressed sequence tags, TILLING, association mapping and allele mining possess the potential to facilitate plant breeding practices. Recent advances in high-throughput marker based technology and bioinformatic tools used for the development functional markers. Numerous plant genomes have now been sequenced at various levels of completion and many more are underway. Advancement in third generation sequencing (TGS) and genotyping microarrays are promising, for further understanding of plant genetics and genomics.

8. Acknowledgements

9. References

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Defendants' Not guilty Plea Monologic Narrative Discourse: a Case of Robe High Criminal Court, Oromia Regional State

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ABSTRACT

Monologic narrative discourse of not guilty plea and its influence on the judges' perception is one of the vital aspects of trial language taken into account in the new emerging discipline of forensic linguistics. The previous trial studies on plea bargaining are focused on investigating a monologic discourse events such as the "leniency plea" or "allocution" that takes place after the sentencing phase of a trial. There is however little or no study that discusses the "not guilty plea" of the defendants from the monologic narrative discursive perspectives. To fill in the gap, this study, drawing on the authentic monologic discourse events of the defendant from Robe Criminal Court trials, Oromia Regional State, Ethiopia, aims to demonstrate some linguistics, autobiographic narrative,identity and persuasion discursive strategies of the defendanst as a calculative persuasion techniques and to understand the implications of the statements and the goals of the defendants' speeches. This study focuses on the analysis of the defedants' not guilty plea monologic discourse events from the perspective of the lexico-grammatical forms of utterances as a resource to construct meaning and its influence on judges' perception.

Key words: *defendant, monologic discourse, not guilty plea, persuasion, judge*

1.   INTRODUCTION

In the analysis of defendants' criminal case, monologic narrative discourse of not guilty plea and their influence on the judges' perception is an important aspect of trial language taken in to consideration. In addition, this study has focused on power and features of powerful and powerless language (Fairclough, 1989). These two aspects of language can have a significant impact on the judges' ongoing perceptions and ultimate decision-making. As Fairclough (1989:31) says, "The way in which orders of discourse are structured … [is] determined by relationships of power in particular social institutions".

In terms of the extended narrative of natural language, the analysis techniques have been primarily applied to the three procedures of denial (not guilty) plea genre properties: the opening, the substance, and the closing (Philips, 1998). According to Philips (1998), these three parts of the procedures also differ in their structuring of participation of the judge, the two lawyers (the prosecutor in the context of this particular genre), and the defendant. The opening and the closing that categorize the procedure regularly and predictably involve interaction between the judge and the two lawyers. The substance of the procedure is conceptualized as two-party interactions between the judge and the defendant (the procedure of not guilty plea that this study focused on, as the case of defendant with the supreme judge). In the process of analyzing defendants' case, the linguistic characteristics that have been employed include investigating a monologic discourse event of "Not guilty Plea", "family problems" and "family responsibility" (Felton, 2008).

The not guilty Plea session provides defendants an opportunity to speak their complaints. During the live trial, the researcher has accessed to the real, naturally occurring, unedited data through direct courtroom observation method.   The linguistic approach to such data involves applications of elements of discourse analysis and a monologic oral narrative discourse (Halliday, 1989; van Dijk, 1997, 1985). Defendants' not guilty plea contains autobiographical information as is awareness of the role of identity (Halliday 1994). The "social- constructionist" approach to defendants monologic narrative discourse was focused on their ability of talk to make sense of their experiences and construct "the self" contends that "selfhood is publicly manifested in various discursive practices such as telling their autobiographical stories" (Felton, 2008).

The forensic linguistic and legal literature contains many references to the "story-

telling" aspect of the courtroom (Heffer, 2005;

Spence, 1995). Some of the elements that constitute the great power argument are the argument in the form of a story. Spence (1995) considers the story as the "strongest structure" to be used in the formulation of legal argument (Spence,1995: 13). Kintsch (1995: 140) describes the role of the listener in discourse comprehension "as constructing a mental representation of the information provided by the text that is integrated with his knowledge, beliefs and goals." Textual coherence is a result of many factors, and plays an important role in autobiography, both from the speaker's and listeners' perspectives. Oliver (1957) emphasizes the particularity of every persuasive event. He asserts that there is a particular type of speaker addressing a particular type of audience, on a specific occasion, to achieve a goal. His element of persuasion is evident that he defines persuasion as any form of discourse that influences thought, feelings or conduct. (van Dijk, 2008) examine the important influence of context in constructing a narrative, and Fairclough, (1989) discusses

the social conditions of production and interpretation.

The previous plea studies certainly contribute to the development of monologic discourse events such as the leniency plea or allocution. They are however limited to the leniency plea that takes place during a sentence, and there is limited or no empirical research on not guilty plea from a lexico-grammatical forms of utterances approach, especially on those in Robe higher Criminal Courts. As Nicholson (2010: 233) comments, the opportunity to make an "allocution," defined by Black's Law Dictionary as "a mitigating statement made by a defendant in response to the court's inquiry" (Garner 2004a: 83)." The past research on plea bargaining has apparently overlooked how the not guilty plea to the next higher court are lodged not only to make the judgments mitigating but also to get free from the alleged crime. This study addresses an issue not previously discussed in the literature and in addition uses examples from Robe High Criminal Court trials, Oromia Regional State, Ethiopia, whose post judgment proceedings/defendants not guilty plea procedures are not well studied. Using the authentic data in Robe High Courts Not Guilty Plea cases, the author presents lexico-grammatical forms of utterances as a resource to construct meaning.

3. AN OVERVIEW OF ETHIOPIAN POST JUDGMENT PROCEEDINGS/DEFENDANTS' NOT GUILTY PLEA

In case the accused may not be happy on the conviction that has been passed on him/her by the lower courts, he/she may appeal for review of judgment to the next high court. The parties feel these things and look for a means with which they could rectify the unfairness thereby look for the review of the judgment (Aderajew and Kedir, 2009).Review of judgment by the court of rendition is a procedure, which is a boutre opening of a case, by the trial court once after it pronounced judgment for various reasons. In Ethiopian legal system, however, there is no lawen force tha ten visage such proceeding. The draft code prepared by the Justice and Legal System Research Institute, however, introduces this idea of_ review of judgment' and it provides under Art 237that —an application to reopen a case after final judgment may be submitted by the defendant (the convicted person)on any of the grounds provided for by the law to the court that renders the judgment that is sought to be reopened.

The convicted person may publicly appeal agains this conviction or the sentence that has been passed on him oragainst both. The party who is not satisfied with the decision of a court, if he wants to lodge his appeal to then ext higher court, he can submit his notice of appeal to the court which renders the judgment in respect of which appeal is sought. Such notice, however, shall be filed to the court with in fifteen days of the delivery of the judgment. The court then prepares the copy of the judgment appealed against and hands to the appellant or his advocate with out delay. Where the appellantis in custody the copy shall be sent to the superintendent of the prison, where he is confinedin, forservice on the appellant. The date on which the copyi shanded to the appellant, his lawyer or the superintendent of the prison shall be fixed on the copy by the registrar of the court.

As per appeal procedure of Ethiopian legal system, this study discusses the not guilty plea of a defendant. It emphasizes how the not guilty plea attempts to convince the judge that the defendant's life is worth sparing or that a free release is warranted. The elements of persuasive discourse that can affect the judge include: telling the truth (Spence 1995); connecting with the listeners through illustrations to which they can relate making a logical, reasoned argument, and using everyday speech. This study focuses on the defendant's not guilty plea that the defendant paints an autobiographical picture of identity and strives to persuade the judge to believe not only her top responsibility of family, but also that she didn't commit the crime and is creditable of getting free.

In fact, the purpose of defendant's denial plea is a complaint to disprove that she is guilty and to request the court to be released freely. If the individual is, in fact, innocent (or maintains that he/she is innocent), it is inconsistent to show guilt for a crime in which the appellant was not involved. Similarly, the defendant argued that the lower court had unreasonably convicted her guilty and imprisoned her. After listening to negative statements about the denial felon (including a 15 minute monologic narrative denial plea from defendant herself), the judge could not reach a decision regarding the guilt and appointed the case for another trial.

The defendant was formally charged in executing felony, found guilty and imprisoned by the lower court. There she did not take the witnesses stand. Here, in the High Court, she overtly appeals against the guiltyconviction made to her by the lower court to lodgeherappeal to then next higher court. So, the plea for discharge was the first opportunity the next high court had to hear her speaking. In a distracted and emotional statement, the defendant denied committing the offense.

4. METHODOLOGY

The fact that this study is located within the inter-disciplinary domains of the social sciences and humanities has made the researcher to make use of qualitative approach. According to Nelson, Treichler and Grossberg (1992), qualitative approach is inter-disciplinary. This is to mean that such an approach holds the humanities and the social sciences. Accordingly, in this study, a qualitative approach has been applied in order to analyze the naturally occurring spoken language of courtroom talk in legal settings. The preference for this approach is further reinforced by the fact that it is also practiced in linguistics, in areas such as pragmatics, discourse and conversation analysis (Wray *et al.*, 1998).

The qualitative approach is used because, within the wider context of linguistics, this approach entails an aspect of discourse analysis, which is used to analyze the naturally occurring spoken language of courtroom talk that has been collected. The emphasis on the use of discourse analysis follows the belief that culture influences the way languages are used in their spoken forms. The data were drawn from the courtroom trial observation made in Robe Higher Court Trial. The transcripts were done for the purpose of making a record of everything said in the courtroom in the efforts of minimizing the challenges of verbatimness and exactness that takes place in stenographic recordings due to the nature of some spoken language.

Data Analysis Note

In order to make the naturally occurring spoken data original, the transcripts and the translations were made in conscious of avoiding making changing to the participants' actual language. So, induced changes which include correction of inaccurate grammar, elimination of false starts, syntactic rearrangements or restoration of dialectal features into standard forms were avoided.

DATA PRESENTATION AND ANALYSIS

From the beginning of modern sociolinguistics in the 1960s, sociolinguists have examined many dimensions of the central tenet that the way in which people speak is related to who they are (Eades, 2008). In the simplest explanation, identity is who and what a person is. Halliday's (1994: 35) functional theory of linguistics states that the "analysis of lexico-grammatical forms of utterances should be fore-grounded as a resource for constructing meaning." It points out how grammatical and lexical choices have particular functions when used by speakers. Listeners gain information about speaker identity through observing language use. Speakers also consciously and unconsciously construct "self" when they speak.

In this regard, defendant's culture in which she lives exerts an influence on her monologic narrative and identity construction. For example, prior to her arrest (according to her autobiographic narratives), she was a woman who looks after her four children and her father and mother by her own. It was to represent the respected and popular culture of the Bale Oromo, (perhaps even adored by some of her cultural congregants). The defendant also exerts much power within her muslin shrine (for example, religious references in dressing styles). Additional examples of defendant's identity-building characteristics include (lines: 48, 50, 54, 56, 64, 68 and 70): her references to good deeds (such as looking after her four children, her father and mother). So, Defendant's identity emerges through a largely compassionate statement illustrated by anecdotes that revolve around family and future fate of her desperate children and parents.

Closely tied to the construction of identity is the resulting persuasive impact of the defendant's pleas. According to Nicholso (2010) a key element of an individual's ability to persuade is personal trust worthiness. A speaker who wishes to convinceo ther sexerts influence based on his/her owner putation anddeeds(Nicholson,2010). Moreover, one who is successful in this domainisa good person trainedin the arts of speech.Given the defendant's commitment to are ligious life and cares for her four children, her father and mother as well, it seemsquite indisputable that

the defendant embodied good performance (as described in the defendant's plea).One can not help but ask if the serema in part of her personality. The defendant emphasizes that she herself is miserable and busy rearing her poor children. This evaluation suggests that the defendant would have minimally persuasive force that she is not in an alleged crime being

she was, "*herself is miserableand busy rearing her poor children*".

In many ways, the content of the defendant's not guilty plea is charitable, as the judge in structs her past as well a sprior influences that contributed to shaping identity. Payne(2007)identifies the"expansion like lihood model of persuasion." This model suggests two ways of persuasion:

(1)The "Central route", an individual conscientiously considers the worth of the argument;

(2)The"Peripheralroute", the presence of a contextualcue (for example, amiserable speaker or a humanelyendorser) result sinanattitude change with out contemplation of the argument'smerits.

In terms of defendant's not guilty plea, it does not appear that side-line indications would be at work. Gitomer (2007) asserts that

persuasiveness is delivering your message in terms of the audience. Accordingly, issues of identity and persuasion continue to be important in the analysis below.

3.1 A Monologic Narrative analysis of Defendant's denial plea that highlights 'Family'

In terms of defendant's not guilty plea monologic narrative structure, she jumps from topic to topic in a disconnected fashion. She does not have a regular theme. Similarly, she was repeating specific lexical items. Below is a discussion of an examination of several themes that occurred in defendant's denial/not guilty pleas with an emphasis on family. She frequently refers to family members during her denial plea. She speaks about her miserable four children and destitute mother and father, and what their future fate might be without her.

Most notably, she spends more than 65% of her statement talking about her miserable four children and destitute mother and father. She describes her family problems in terms of loneliness and destituteness. Defendant says that the elder son of her father (lines: 64, 66) "*died*" in the derg's regime national military service. It is "*me*" who is "*looking after*" them as my children (line, 68). In Excerpt (1), defendant becomes emotional when she tells the judge how much her children, mother and father may suffer without her (lines: 54 (two times), 64, 68 and 70) see Excerpt (1) below. The occurrences

of repetition, grammatical parallelism (my +noun) and direct address (please, observe! watch your own matters!(Line 120,Excerpt4),

"Don't you believe watching at me?" are all characteristics of powerful speech events.

Excerpt(1) Family oriented persuasion

48 I am so suffering in looking after my children, my mother and my father.

49 ijoollee tanaem….Intalli tunyakkakanaanna himattee nahiisfte.Yakka

50 Looking after these children uhh… this woman indicted me an dimprisoned me.

51 dalagaakiyyaamitikun.Aniyakkakanahinraawwanne. Raawwadhe jedhu

52This is not my act.Ididn't do this crime. IfIdid that

53 ilmaantiyyatanaakkamittiilmaanabbaanirraa.…(crying); haadha tiyaa

54   for whom I dare to leave **my children** whose father…..(crying); **my mother**

55 rakkattuuakkasiioggaameeqaittixaareekanjedhu tana….(biterlycrying);

56 who is miserableand I have been looking after her for years…..(bitterly crying);

57 osoo ragoonni mana sirreessaa kana faana… (crying). Ani wantiii hojjadhe hin

58If the witnsses of this prison…(crying).Ididn't do any crime.

59 jiru.Kanaafuu,abbaanmanamurtiiolaanaakabajamaan, ilaalaatiindhimma

60Then, I request the…,Your Honor,supreme court,discern this case

61 kanabilisaannageggeessadhaanjedha;dalagaakiyaa mitii.Ani warra

62 and release me free; that was not my act.

63kiyyaattiijoolleenakkanatti jala jirtii,abbaankiyya ilmi mucaanisaa

64**My family** is suffering looking after the children;the son of**my father**

65 biheeraawwiideemeeachittiirraadu'ee.Hangafniissaanii hinjiran. Ana

66 died in the derg's regimenational military service.Our elder brother is not around.

67 ammoodeebi'eeilmaantiyyaanwaliinwalittiqabee,akka daa'imatti guddisaa

68 It is me who is looking after them as **my children**.

69 waanjiruuf,abbaanmanamurtii olaanaalaaleetiin bilisaanana gadhiisaan

70 Taking in to account that I am caring my parents as **my children**, request

71the supreme court to release me free.

Defendant's insistence on here verlasting compassionate is consistent with what aninnocent person would say. The complete volume of the statement devoted to her children,

father and mother may make the listener think a bout the persuasive impact as well as the credibility of her story. Does she spend so much time revealingher family's destituteness because it is an in direct way of

demonstrating ingenuousness to the judge? In Excerpt(2) below, it can be suggested the extent to which the judge was either leniently following her or affected by defendant's narrative of family destituteness. For example, asking the number of children she has may indicate he is in a patheticmood. Additionally, affirmative statement,"If you have something to add, Defendant!" might also designate the judge'sgracious approach.

Excerpt(2) Judge'sleniency markers

75Ijoolleemeeqaqabda?

76 How many children do you have?

90Waanti itti dabaltu yoo jiraate? Raadiyaa!(pause)

91 If you have something to add? Defendant? (pause)

In the defendant's plea, family playedan important role in her statement. Taken as a whole, there aderhas the impression that, in addition to convincing for not committing the offense, she is also begging the court to claiminnocentandtole ther discharge from the jail.To achieve this, she was purpose fully and repeatedly describingher family's destituteness (about tentimes through her whole statement).See Excerpt(3)below.

Excerpt(3) Describing family destituteness

44 My mother and father are so weak,

46 sold that they cannot survive by their own.

48 I am so suffering in looking after my children, my mother and my father.

51 Looking after these children uhh…

55 for whom I dare to leave my children whose father…..(crying); my mother

57 who is miserable and I have been looking after her for years…..(bitterly crying);

69 It is me who is looking after them as my children.

119 In general, my children,with out mother and father

123 not with them, my mother and my father them is erable ones; noone…

127 My children are demolishing.

3.1.1 Linguistic and rhetorical patterns

Defendantuses simple, ordinaryl exicalitems in her complaint statements. The following are a repeatedly made pleas to get release (For example, sher epeatedly used the clause"***Bilisaannageggeessaa.***" An Afan Oromo phrase when translated to English

language   is"**Get**

mefree"sixtimes).SeeExcerpt(4)below

Excerpt(4)Dischargingpleas

60 Then, I request the Your Honor,Supreme Court,discern this case

61 kanabilisaannageggeessadhaanjedha;dalagaakiyaa mitii.Ani warra

62 and **release me free**; that was not my act.

70Taking in to account that I am caring my parents as my children, I request

71the supreme court to **release me free.**

112reques tthe honorable court **to free me**.I….I didn't do this crime

113osoo hinraawwatinnattimurtaa'ee';nageggeessaa. Aniwanti raawwadhe

114I imprisoned void of doing crime; **get me free**.I did nothing;

119hinjirre,meelaalaa…..Isintessanumalaala,yoo…anis haadha ta'ee bira

120 please, observe…..Watch your own matters, if……I as a mother

121 hin jiru, abbaafi haati tiyya akkasitti dadhabduu sanii; namni tokko…

122no twith them, my mother and my father the miserableones; no one…

123 Abbaanmanamurtii narraakaasaatii bilisaannageggeessaa; cinqameen

124I request the court to **get me free**; I strained.

136 murtii narraa kaasaa;bilisaanna geggeessaanjedha ani.(pause)

137I request the court to **get me free**.

3.1.2 Grammatical parallelism, lexical patterns, tense shifts, repetition and synony my

Defendant's plea includes a variety of rhetorical and linguistic strategies designed to hold the judge's interest. In the Excerpt (3) and (4) above, it demonstrates grammatical parallelism, repetition and tense shift. In Excerpt (5) below, she talks about how she was caring for her family and how their future fate is also relied on her.

Excerpt(5) Defendant as an accountable mother

55for whom I dare to leave my children whose father…..(crying);my mother

56**rakkattuuakkasiioggaameeqaittixaaree**"kanjedhu tana….(biterly crying);

57who is miserable and I *have been looking after* her for years…..(bitterly crying);

68ammoodeebi'eeilmaantiyyaanwaliinwalittiqabee,**akka daa'imattiguddisaa**

69It is me who *is looking after* them as my children.

46………Ilmaan

47soold that they *can not survive* by their own.

48tiyyasanwaliinhaadhaafabbaawalittiqabeeanisiqaayii argee; walitti qabee

The tense shift reverts to her "past perfect continues, present continues and future" (lines: 57, 69 and 47 respectively) actions, although they do not occur in the same order.

Excerpt (6) Defendant's complaints...." *the + noun + made to me", "maqaa + latoo mat-hima agarsiisu + natti kenname kun"*

10 mana murtitti oliyyaadhetiniin**himmannaan nattikenname kun**…,

11Ipresented the Supreme Court that the indictment*madetome*...

12**murtiin nattiikennamekun**;**ragaan nattikennamekun** seeraan,osoo

13The witness *given to me* and the decision *made to me* are illegal,the crime is

14seeraannatii hinargaminiyyannaareebdekanejedhumalee,kan

15not legally *found to me*; the indictment said she quarreled butnothi ther

Excerpt(7)Defendant's family status...." Nama+adjectives" (inAfanOromo), "….so +adjectives"

44jiru.Haadhaafabbaankiyya akkasitti dadhaboota;isaan**nama**

45My mother and father are so weak,

46**nama gurguddaadha**,**nama**dudulloomaadha,**nama**dalagatee nyaatuumiti.Ilmaan

47so elders, sold, so weak that they cannot survive by their own.

The grammatical parallelism in Excerpt (7) above fore ground sher points rejecting all actions made to her. In Excerpt (8) below,she states her family states or socialidentity.With in apersuasion framework, "personal relevance" appears to be significant when individuals believe that the issue will exert an important influence on their own lives (Pettyand Cacioppo1986:144).In Excerpt(8) below, the defendant's intention is that her four children, her father and her mother's life are dependent on her. The implication is if she is not released so on, the life of this destitute family will be in danger.In so doing, defendant tries to persuade the judge that he will feel patheticandinturn release her.

Excerpt(8) Describing person alrelevance

38 Karaa mana sirreessaa deemnaanjedhan. Ana ammoyeroo san ijoolee nama

39They forced me to go to the prison. At thatti me I was a woman who cares for

40afuriigudisaa jira.Ijoollee tana abbbaan irraa gatee biraa deeme; bira hin

41 four children.The father of these children is not around to care them.

42He left the malone.

43jiru.Haadhaafabbaankiyya akkasitti dadhaboota;isaan nama

44 My mother and father are so weak,

45Gurguddaadha,nama dudulloomaadha,nama dalagatee nyaatuu miti.Ilmaan

46soold that they cannot survive by their own.tiyya san waliin haadhaaf abbaa walitti47

qabee ani siqaayii argee;walitti qabee

48I am so suffering in looking after my children, my mother and my father.

49ijoollee tana em….Intalli tun yakka kanaanna himattee na hiisfte.Yakka

From a linguistic point of view, d efendant's repeateduse of the phrase "*get me free*"in excerpt (3)above seemsincompatible. Someone might claim"get me free"based on the witnesses' evidence, or the proved innocence. But, the defendant still didn't support her complaints with witnesses' evidence (Seeexcerpt (9) below). The use of the phrase in her context simply provides unsettled statements. Abruptly after her "*get me free*" statement, she reaffirms "I am innocent" see in Excerpt (9) in bolded phrases.

Excerpt(9) Defendant's reaffirmation of innocence

51dalagaa kiyyaamitikun.**Aniyakkakanahin raawwanne**.Raawwadhe jedhu

52 This is not my act. **I didn't do this crime**.If I did that

61kanabilisaannageggeessadhaanjedha;**dalagaa kiyaamitii**.Ani warra

62 and release me free; **that was not my act**.

111kabajamaa narraa kaasaa?Anillee...,anillee **yakka kanahinraawwanne**;

112 request the honorable court to free me.I….**I didn't do this crime**

113 osoohinraawwatinnatti murtaa'ee';nageggeessaa. **Aniwantiraawwadhe**

114I imprisoned void of doing crime; get me free.**I did nothing**;

115 **takkaahinjirtu**; animmooofiifuurakkatuudhaa; waanagartaniif hin.

3.2 Power Relations

According to vanDijk(2001), the central notion in most critical work on discourse is that of power (the *social power* of groups or institutions).Thus, an individual has less power if she or he is able to less control the acts and minds of other groups (For example, the defendants). Similarly, an individual has more power if she or he is able more control the acts and minds of other groups (For example, the judges and lawyers). This ability presupposes a power base of privileged access to scarce socialre sources, such as status,fame, knowledge, information,"culture,"and other forms of public

discourse. In the context of this study, the judges and lawyers are in aprivileged access to status while the defendant is not. In this case,the defendant is more or less passive targets of text

Excerpt (10) judge's control

5**Judge**:Oljedhi!, (Pause about1:14 minutes

6Rise your head!.

In this legal discourse, the judget old the defendant the way she must get up in front of him. Here, the judge has more power of status that enabled him to control the act sand mind of the defendant. The mind of the defendantal ready inculcated that she must lower her head for the sake of court esteem. She putintopractice what had already been inculcated in her mind as an action for worship through lowering her head. So, she is more or less passive target of the court setting and judge's talk.

If discourse is defined in terms of complex communicative events, access and control may be defined both for the context and for the

Excerpt (11) Judge's context control

138**Judge:**Guyyaaa beellamaa ebla kana 24sa'aatii 4 irraati. (pause)

139Appointment date: this month,Nov.24at4:00

In the above excerpt,the judge decided the time and place of the communicative event that will betake place in then ext trail. Here the judge didn't decideamere setting that then ext trail has to be taken place but also the on going discourse for then extsession (for example, to come up with hertestimonies).

or talk. For instance, of the judge whom aysimply tell the defendant what not to or what to do.

structures of text and talk them selves(Djik,2001, Schiffrin, TannenandHmilton,2001). Context is defined as the mentally represented structure of those properties of the social situation that are relevant for the production or comprehension of discourse(vanDijk1998).It consists of such categories as the over all definition of the situation, setting(time, place), ongoing actions, participantsin various communicative, social, orinstitutional roles, as well as their mental representations: goals, knowledge, opinions, attitudes, and ideologies. Controlling context involves control over one or more of the secategories, e.g.deciding on time and place of the communicative event.

Theenactment of the judge's power is control not only over content, but over the structures of text and talk. As it has been in dicated in the former analysis, the judge decided on the possible discoursegenre(s) orspeech act sofnext cour troomoccasion. In the structure of text and talk, the judge coerceda certains pecific answer from the suspect, and not a personal story or

anargument(Wodak,

1985).Seeexcerpt(12)below

Excerpt (12) Judge's influences for a certain specific answer

104**Judge**:Have you heard what the prosecutor said?

105**Defendant**: Eeyyee;dhaga'ee jira . (however unmatchedresponse).

106 Yes! I heard.

107**Judge**:Sani irraatti deebii,deebii yooqabaatee?

108If you have ananswers for that?

In the above excerpt, the judge didn't allow the defendant to autonomously proceed her story. Instead he obligated to give a response on the comments the prosecutor had given her. In this way, the enactment of the judge's power is control not only over content, but over the structures of text and talk under investigation. Similarly, action and interaction dimensions of discourse may be controlled by prescribing or proscribing specific speech acts, and by selectively distributing orinterruptingturns(vanDjik, 2001: 352-365).

Excerpt (13) Judge's interruption

99**Judge:**(AAinterfered,"Yaada abbaanalangaa jedhe

100 the witnesses wereher husband's brothers

101dhageettee?" she continued…)dhirsa isiiti.Kuunis niitimaisaati. (After a while

102it seems that she heardsome sound fromAA (AA is an abbreviated form of Afan Oromo Language   of 'Abbaa Alangaa' which is to mean 'Prosecutor' in English)side and said, "Yee!",thenAA

103responded,"Yaada abbaanalanggaa kennatandhageetta jirtaamii?

104**Judge**;Have youheard what the prosecutor said?

 In the above extract, the judge in terrupted the defendant. In so doing,he disallowed her to maintain her speech acts she was carrying out.

3. CONCLUSIONS

This study has analyzed defendant's monologic narrative denialpleas for release. In sodoing, I made use of techniques taken from the linguistics, narrative, autobiography, identity, and persuasion literature. I thas been identified that all defendant's not guilty plea statements were a calculating persuasion. In this particular setting and type of discourse, it is possible to underst and the implication softhe statement and the goals of her speeches.Here the question is

whether the judge is in a position for forgiveness.From Excerpt(2), we can suggest that the judge shows sympathy and, in turn,

Regarding courtroom power, it can be said that, by providing an opportunity for the defendant to speak uninterruptedly, the court grants power to her. The defendant has been convicted guilty and face incarceration. So, she is essentially powerless in many ways (Fairclough, 1989). The pressure is on her to impound that power and to assert some influence over her fate. Defendant's description of her families'

In terms of power relation, the findings of the case study propose that the judge has more power of status that enabled him to control the acts and mind of the defendant. In other way, the defendant exercised to put into practice what had already inculcated in her mind as an action for worship through lowering her head. So, she is more or less passive target of the judge's talk.

experience positive feelings for being her family might be in danger.

destituteness is powerful because of the vividness of her impression. On the other hand, the outcome of the study suggest that it is simultaneously powerless as it further fortifies the idea in the minds of the judge that she repeatedly uses the phrase "get me free" in Excerpt (3) above that seems incompatible. In reality, the judge could not reach on a common decision for the release.

In so doing, the enactment of the judge's power is control over both the content and the structures of text and talk. In the content of the text, the judge decided on the possible discourse genre(s) or speech acts of next courtroom occasion. In the structure of text and talk, the judge coerced a certain specific answers from the defendant.

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Economy Wide Impact Of Efficient Public Spending Allocation In Ethiopia: A Recursive Dynamic *Computable General Equilibrium* Analysis

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ABSTRCT

The government of Ethiopia has set ambitious development vision of becoming middle income in 2020-25 by accelerating the pace of social and economic development. But the overall effort to achieve this development objective is challenging. This is so partly due to lack of financial resources, problems of resource allocation and inefficient utilization of the resources in the public sector and lack of multi-sector coordination.

The main motive behind this study is to examine how efficiency of public spending allocation is analytically done and utilization of meager resource is improved in Ethiopia as to promote rapid economic growth. The study employed a recursive dynamic computable general equilibrium model to investigate economy wide effects efficient public spending across Agriculture, Human capital and Transport sectors based on their productivity enhancing effects using 2005/06 SAM updated, 2009/10 of EDRI as data source.

The results of the simulation experiments demonstrates that efficient public spending allocation does indeed has modest effect on economic growth indicators and improve welfare of the people. Moreover, it will lead to the structural transformation of the economy through improvement of productivity in each sector, as industry come to front followed by services and agriculture under efficient public spending as study indicates as compared to baseline.

However, to get maximum of efficiency gains, complementary of economic sectors has to been taken into account. For instance, the enabling labor market functioning and good investment climate is necessary to get better output of human capital and infrastructure investment. A major contribution of this paper is that using efficient public spending linked with other complementary enabling economic environment will lead to higher economic growth rates and also accelerates the rate of poverty reduction.

Keyword: *Public spending, Efficiency, Economic Growth, Poverty Reduction, Computable General Equilibrium*

Introduction

Background and justification of study

Governments in developing countries are more often than not faced with expenditure need that outstrip the resource envelopes, and usually have limited options to raise resources domestically. For instance, most developing countries have a large informal sector which in addition to inefficiencies in tax administration imply lower than average tax-to-GDP ratios. Further, given the narrow tax base, raising additional tax revenues would often lead to significant distortions and create disincentives for the private sector to save and invest (ODI, 2006).

To the extent that the debt carrying capacity of most developing countries is low, external financing even when contracted at concessional terms should always be a last resort. An alternative here would comprise creating fiscal space by re-allocating spending from the less efficient to the more efficient uses. In addition, the effective use of public resources to improve human and physical capital will lead to increased productivity and income and consequently expand the scope for private and public consumption opportunities in the future (WB, 2007). This in turn engenders more GDP growth and enhances the revenue raising capacity.

Several studies have been undertaken to analyze the relationship between the composition of government expenditures and growth. However, neither theory nor empirics provide clear cut answers on how the composition of government expenditures affects economic growth. While the theory develops a rationale for government provision of goods and services based on the failure of markets to provide public goods, the need to internalize externalities, and to cover the costs especially when significant economies of scale exist, such theoretical notions usually do not easily translate into operational rules regarding which component of public expenditure should be reduced or increased (Devarajan, et al., 1996).

On the other hand some scholars argue that government has to compare the relative contribution of different public investment across sectors before making expenditure decisions particularly in developing nations where the budget constraint is natural. Thus,given the budget constraints faced by governments, the critical and actionable research question with regard to public expenditures is often not whether certain types of public investments contribute to welfare improvements, but rather how different types of public investments compare in terms of their relative contributions to welfare (IPPRI , 2008).

Ethiopia has a diverse ethnic and cultural composition with more than 80 ethno-linguistic groups. The political system is made up of a two-tiered parliament, comprising the House of People's Representatives and the House of Federation. For administrative purposes, the country has a federal system of government composed of nine regional states and two city administrations. The administrative hierarchy within a state is composed of a regions, zones, districts and *kebeles*. *Kebele*s are the lowest administrative units. Total population of the country is over 90 million and Ethiopia is predominantly agrarian in which, agriculture sector is the main stay for 84% of population.

Currently, Ethiopia has been implementing Growth and Transformation Plan (GTP I) which has duration of five years (2010/11-2014/15) with vision of extricating itself from poverty to reach the level of a middle-income economy as of 2020-25. This plan envisages an average annual economic growth of 11.2 to 14.9% over the planning horizon of GTP. To achieve growth rate of base scenario 11.2%, growth is expected to be broad based across agriculture, industry and services at average growth rate of 8.6 %, 20 % and 10.6 % per annum, respectively whereas for high growth scenario, the targeted growth rate is 14.9 % while agriculture, industry and services are expected to grow on the average by 14.9 %, 21.3 % and 12.8 % per annum (MoFED, 2010). The GTP has to, within its macro-economic target, increase Ethiopia's per capita

income to 354 dollars by 2015, from 235 dollars in 2010; national saving to GDP to 17.4 % from 9.4%; share of tax to GDP to 15.3 % from 9.7 %; and reduce the size of the population living below the poverty line to 22.2%, from nearly 30%.

However realization of GTP objectives as planned is highly challenging due to domestic financing gaps as compared to policy targets. According to World Bank (WB, 2012) development plans of Government of Ethiopia (GoE) is dominated by public investment which does not careful take into account the financing mechanisms and its impact on macroeconomic variables.

The scope for policy to influence economic growth depends on the underlying model of growth. According to (WB, 2012) development model adopted by GoE since 19904 including the current GTP I relies heavily on high levels of largely government-led investments like the Asian model of development, but faces low saving rates and limited availability of domestic resources unlike the Asian model. The necessity of high investment requirements of the GTP, public investments, which in pastyears have been one of the major drivers of economic growth in Ethiopia, will not be sufficient to maintain high growth performance going forward as stated in GTP targets.

The analysis of public resources utilization should be of interest to policy-makers in developing countries who are concerned about prioritizing the use of the meager public resources particularly in the face of the global economic slowdown and with concessionality of external loans (Edward and John, 2010). Admitting the need for more finance, GTP I suggests that the required additional expenditures would be met by running budget deficits and increasing reliance on external financing (MoFED, 2010).

However, given the macroeconomic effects of deficit financing on consumption and private sector development, authorities need to explore the possibility of creating fiscal space through prioritization of sectors and shifting of expenditures to more productive sectors.

Statement of the Problem

In developing countries, it has become increasingly complex to manage public expenditure allocation because the roles of the government have been expanded and financial resources are in scarce supply to meet this ever-increasing social needs and population growth. Due to inadequate financial resources as opposed to an increasing demand for public service, there is a need to improve resource allocation through proper economic policy and expenditure planning.

Proper utilization of existing theories, evidences and methods on the poverty impact of public spending clashes with the reality of policy making process in poor countries, due to limited technical capacity, unavailability of detailed and reliable data ,heavily reliance on the external assistance and political interferences undermines a rational approach to assessing policy alternatives(ODI, 2006).

It is imperative that the budget process is restructured to include an analytic framework that provides appropriate ways of identifying sectoral priorities and explains what they offer in terms of poverty reduction. One way of doing the above is through multi-sector simulation models that yield macroeconomic growth multipliers from income shocks to respective sectors. Sectors that offer the highest indirect benefit and the most pronounced impact on poverty reduction need to be selected as the most progressive choices to lead economic growth. Thorough planning and research at sectoral level is also of paramount importance. However such kind o practices are seems lacking in Ethiopia planning and budgeting process according to studies by scholars (Alemayehu and Dawit, 2010)

Even though, the country has been undertaking different reforms like legal framework and budgeting process to solve the conflict between planning and budget allocation, successful expenditure planning and modern budgeting system remains a continuous problems of the country. The expenditure planning and budget

reform projects are unable to deliver the systems that effectively perform policy review processes, output or performance based budgeting, standardization of activities, proper budget approval and reporting process (Elizabeth , 2005 ; Getachew, 2005).

In Ethiopia the studies done so far were targeted to examine the effects of public spending on growth and poverty without giving due attention to efficiency of allocation side. One can mention studies by (Agenor et al., 2004 ; Lofgren et al., 2005 ; Tewodaj et al., 2006) are among studies done related to the growth and poverty impacts of public spending. Therefore, evidences from the literature implies that rigorous economy-wide studies to address the relative contribution of public spending across sectors are scarce in Ethiopia. The need for such study is to guide policy maker and bureaucrats for decision of public spending allocation across sectors as an analytical tool to optimize efficiency of limited resources.

In an effort to contribute to the existing knowledge gap, the objective of this study is therefore, to develop an analytical tool that guide an allocation efficiency of public spending decision across sectors in Ethiopia in order to maximize growth impact of limited resources.

Further, the study tries to analyze the economy wide impacts of efficiency based public allocations, taking the selected priority sectors using dynamic CGE model as compared to baseline scenario so as to make sound policy recommendations.

Objectives of the Study

The general objective of the study is to investigate how analytical tool is developed and used for efficiency based public spending Specific objectives:

allocation decisions across different economic sectors in Ethiopia using recursive dynamic CGE model.

- ❖ To develop analytical framework on how public spending allocation will be made among growth enhancing priority sectors efficiently.
- ❖ To examine the effects of efficiency based public spending on economic growth as compared to the baseline scenarios and test whether the latter is suboptimal.
- ❖ To inform Ethiopian Fiscal Policy implications in terms of prioritizing public spending to stimulate growth.

Conceptual frameworks and efficiency of public spending allocation

Roles of parliament and institutions in efficiency of public spending

The authority to exercise power of state is conditional on the sustained trust of the people and that trust can only be maintained through open, accountable and transparent government and informed choices. Systems are therefore supposed to be open, transparent and accountable.

The parliamentarian is the authentic representative of constituents, of which the majority is poor in practical reality of developing countries like that of Ethiopia. So the parliaments have double responsibility of ensuring that the executive performs to the standard of policies and strategies for which they were elected, as the poor are paying taxes out of mouth and bear debts to finance those policies in the expectation better tomorrow, not too boost the pocket of the authorities in the form of corruption or rent seeking as it is true in some developing countries.

This will demand the parliaments to play more roles from formulation and approval of pro-poor policy target to implementation, monitoring and evaluations of these strategies as per standards, resource and time frames with effective legal remedies for deviations. However, studies(Krafchik and Wehner, 1998) found out that, in many developing countries, the participation level of parliament in this process seems weak as they are invited at different stages of PRSP not from very beginning of the process like for the purpose of approval or as ceremonial. For example Out of the 300 delegates from 31 countries that attended the 2001 Dakar Conference on PRSPs in Africa only 5 were members of Parliament.

The general fact is, they should be encouraged to participate in informed debate on the budget and on economic issue from both efficiency and equity perspectives of budget allocation. These scholars found out that the time allowed parliament to review and debate on the budget proposal by executives varies from country to country (South Africa 3-4 month, India 2.5 month, UK 3 month, and Germany 4 months) (Krafchik and Wehner, 1998).

In Ethiopia, draft annual budget is the budget that MoFED prepare and submits to the council of Ministers, who in turn review it and recommends it to the Federal parliament (House of people's representative). According to Constitution 94, article 55 the parliament have the right to perform to draft budget document. The main issue of review is to check for consistency with policy (GTP), which includes classification of capital and recurrent, a review of the subsidies to the regional governments and

the reviews of the estimates of resources available to finance the budget. However, although parliament members are allowed to review the budget documents, in practice review is extremely limited in Ethiopia. In addition the legislative debate is short; only within a month (Elzabet, 2005; EC, 2010) and budget is not a subject of media analysis and debate as it is a case in developed courtiers.

In Ethiopia parliament participation in the process of budgeting is at the infant stage, and mainly confined to the approval of the general economic policies and strategies of the country as detail question of poverty reduction programs, sector development programs, the total resource envelopes and the level budget deficits have

been taken as secondary issues during budget debate and approval (Getachew, 2006).

But according to the scholars (Elazabet, 2005 ; Tassew and Daniel, 2004) one of the constraint is technical skill gab in the case of Ethiopia parliament even when they are motivated to do so including budget and finance standing committee to undertake deep policy and budget analysis. The implication of limited technical capacity associated with shorter budget review time by parliament in Ethiopia affects efficiency of public spending negatively from political point of view provided that parliament members have responsibility of ensuring that the executive performs to the standard of policies and strategies for which they were elected representing their constituency.

Transmission mechanism impact of efficient public spending

Public spending decision is determined by the interaction between bureaucrats and policymakers. Policymakers are agents with a demand for public goods, derived from their interest in maximizing votes, and public goods are produced and delivered by bureaus, departments, or ministries run by bureaucrats who seek to maximize budgets for their own organizations (Tewodaj ,2012)

To reconcile these two repelling objective functions, the ideal method is to compare the efficiency of public spending as measured by outcomes in the form of poverty reduction or

welfare changes, particularly for non recurrent obligator expenditures.

The ability to discern the outcomes of alternative public investments and other policies may be used not only by an interest group to inform itself, but also to provide knowledge to policymakers themselves, who often operate in an environment of imperfect information about the welfare and distributional outcomes of their policies, as well as about the citizens' preferences and views regarding these policies. So using analytical tool like CGE model for public spending allocation will helpful in

creating of knowledge for both policy makers and bureaucrats for rationalization of the decisions as it will helps to undertake counterfactual analysis..

CGE models are potentially, extremely important to assess how to finance public investment policies, and to analyze which fiscal policy induces less economic distortions (Edward al et., 2006). That is to say proper costing of policy targets to optimize the uses of limited resources. As already explained such analytical too fro public spending is not practiced in Ethiopia, and the purpose of this study is also to contribute to this objective.

Data and methodology of the study

Data sources: MoFED annual reports, EDRI SAM, EEA Data bases and WB and IMF publication on Ethiopia Economy (1992-2013).

Discretion of the Model: Updated version of 2005/06 of SAM in 2009/10 by IFPRI in order to adjust the data so as to match it with the economic performance used for calibration.

Agriculture, Human capital and transport sector is selected as representative sectors for this study.(all are pro-poor and consistent with Ethiopia budget allocation system)

Rationale of using CGE model

Nowadays, availability of specifically designed software packages makes CGE a standard tool to be used by professional and policy makers.

The micro-macro interrelationships can be relatively better performed through CGE modeling frameworks. In addition, CGE model solution generates an extensive and economy wide effects (Iqbal and Siddiqui, 2004). Further,

To appropriately capture the economy-wide effects efficient public spending allocation in Ethiopia, the study employed a recursive dynamic CGE framework.

The model belongs to the recursive dynamic CGE literature, which implies that the behavior of its agents is based on adaptive expectations. Variables: Exogenous and Endogenous

The CGE model consists of four different blocks and four Groups of households: Rural Poor, Rural non-poor, Urban poor and Urban Non-poor

it will helps to make informed choices among alternative sectoral spending as it is one of powerful tools of counterfactual analysis.

However, most of studies that used CGE Models frameworks in Ethiopia are mainly focused on poverty, trade and sector specific impacts, not for budget allocation and multi-sectoral analysis.

Description of Simulations

- **Impacts on other macroeconomic Variables**
- **Welfare Effects**
- **Impacts on sectoral Output, and employment**

Simulation Scenarios

According to MoFED (2010), Poverty oriented government expenditures as a percentage of GDP planned to grow from 12.5% in 2009/2010 to 17.3 % in 2014/15 with goal to achieve poverty reduction targets of head count poverty from 29.2 to 22.2 percents.

However the practical implementation of such policy requires the government to carefully indentify pro poor sectors as priority to increase efficiency of government spending since it is a crucial step in pro-poor growth strategies. Particularly, this step is very critical for developing countries like Ethiopia with limited financial resources and hence it requires social planner to allocate the tax payers money to more productive areas.

According to (Lofgren and Robson, 2004) pro-poor public expenditures and land tenure reform can play a role in skewing the growth benefits in favour of the poor and suggested the importance of Simulations of alternative government spending strategies to guide allocation of spending to more productive areas, in order to increase efficiency of government spending

measured by growth and poverty reductions. Such capacity of government will serve as a key element in pro-poor growth strategies.

For the purpose of policy simulation analysis of the study, total government spending is divided into three pro-poor sectors following the function classification of Ethiopia budget allocation system. To this end, social sector is represented by human capital, economic spending is proxied by agricultural spending and infrastructure spending is represented by transport sector.

Theoretical justification behind the selection of these sectors is their productivity impacts i.e. channeling more resources to productivity-enhancing public spending which includes agriculture, human development (education and health) and physical infrastructure (especially transportation and communications) will facilitate rapid growth and poverty reduction (Lofgren and Robinson, 2004**)**

The reliance on the total factor productivity is due to the fact that it can serve as better proxy to explain economic growth.

Following growth accounting to disaggregate GDP growth into factor accumulation and TFP growth, studies by scholars (Lofgren and Robinson, 2004) shows that, across all developing countries, the TFP share in GDP growth varies but typically 33-50%. The study concluded that through improvements inTFP, the economy will grow faster and faster which s i g n i f i c a n t l y leads decline of income poverty.

So informed government decision to allocate more public spending on those sectors to maximize TFP is rational decision as an improvements in TFP will in turn affect thewhole economy, in general, and poverty level, in particular.

Hence allocating limited public spending to productivity enhancing sectors based on proportion of their TFP will help economy to grow fast and that in turn helps eradication of poverty particularly for poor countries as far as data is available for the estimation of TFP elasiticities for each sector.

According to the (WB, 2000) estimation of TFP grow this very sensitive to the data used. Usually, estimation of TFP growth requires data on real GDP growth rate, physical capital and human-capital adjusted labor input. While real GDP growth rates are available from many sources, measuring growth rates of capital stock and human capital adjusted for labor input is

more difficult. Measuring growth rates of capital stock is very sensitive to assumptions regarding initial stocks and depreciation rates. In addition, estimating human-capital-adjusted labor input is, in itself, problematic.

An effort was made to compute the elasticities for the selected sectors under the study. But due to limitation of the data estimation of TFP elasticities is not done.

On the other hand, to the best of knowledge of the researcher and literature, there are no studies that estimated the elasticity of public pending with respect to these sectors in Ethiopia. For the sereasons, it is justifiable to use results on growth elasticities of publics pending obtained fromother studies, on condition of similarity both countries with respect to economy structures. Based on the above grounds the study used elasticity of total factor productivity estimated for Sub-Saharan countries by (Fan and Roa, 2004).

To examine the impact of efficiency based public spending allocation on Ethiopian economy as an alternative to the current practices and thus to achieve the objectives of the study, the following scenarios were considered.

The base case scenario is established to serve as a reference in an absence of any policy shock and serves as a benchmark for policy evaluation

(assumes the status qua continues). Thus, the result of the base line simulation is used as the benchmark value so as to compare the values of **Alternative Scenarios;**

different variables after the policy shocks. The simulation results are explained as compared to base outputs.

Scenario 1(Agriculture):   **A 5.2% increase Agricultural sector TFP**

Scenario 2(Human capital): **A 11.5% increase Human capital sector TFP**

Scenario 3(Transport):   **A 2.1% increase Transport sector TFP**

Then, simulating the effects of all combined scenarios is undertaken to see the effects, since spending allocation is simultaneous in nature to conduct counterfactual analysis.

These elasticities can interpreted as the increase of TFP due to 1% increase in public spending on respective sectors in our case the sub-Saharan African average government spending. So allocation of the government spending on different sector has to be estimated in the same fashion taking into account that more productive sector has to be backed with more resources to promote growth.

Allocating public spending to these sectors based on their TFP is done without accompanying with cuts in the spending on other sectors. These sectors are proxied for priority areas of government and representative of the functional budget classification of the country as mentioned in the other part of the study.

Technically, it implies that, elasticities are calibrated to Ethiopian SAM for the model to undertake simulation of increasing public spending on these sectors to compare the results with baseline scenarios to meet the objective of the study.

Analysis of simulation results and discussions

Effects on macroeconomic indicators

Table 5.1: Average annual percentage changes of macroeconomic indicators from baseline growth rates

| Real Variables | Simulation scenarios | | |
	Agriculture (%)	Human capital (%)	Transport (%)
Absorption	2.22	0.29	0.09
Fixed investment	-0.12	0.35	0
Export	1.09	1.2	0.61
Import	0.42	0.46	0.23
GDP	2.65	0.44	0.14

As indicated in table 5.1, the alternative efficiency based allocation of public spending leads to improvement to macroeconomic performances. The reasons for improvement is due to optimization applied to the resource usage that leads to higher output with same inputs and multiplier growth effects of the productivity of the agricultural, human capital and transport sectors since they are specified as growth enhancing sectors. Consequently, all macroeconomic variables have shown improvement except fixed government investment under agriculture.

The probable reason for negative government fixed investment is related with lack of complementary investment in other sectors, like rural finance. For instance improved harvest by farmers due to efficiency based public spending, may not saved by farmers as there is little awareness or less accessible to financial services and hence, farmers spent on less productive activities or other unplanned expenditures such as over consumptions during harvesting seasons.

This could be a reason for huge resource gap in Ethiopia to finance investment. The other possible reason could be marketing related problems, like low price during harvesting seasons to pay for some obligator expenditures such as fertilizers or low international prices for some cash crops.

It could also be related to rainfall situation for rain fall depend parts of agricultural activities as efficiency based agricultural spending can consider irrigation expansion.

In all cases the percentage changes of export and imports are increased as compared to the base line scenario. However the positive responses of the exports are more than imports as a result of alternative allocation of government spending. The possible explanation of the external sector improvement will be, alternative spending approach take into account efficiency of resource utilization that will contribute to competitiveness of the exports in the international market.

Effects on Factor incomes

Table 5.2: Average annual percentage changes of factors income from their baseline growth rate

| Variables | Simulation scenarios | | |
	Agriculture (%)	Human capital (%)	Transport (%)
labor	5.18	-0.91	0.17
Capital	5.56	0.51	0.15
land	4.28	0.16	0.01
Livestock	2.72	120.73	0.13

Source: Own computation of DCGE Simulation result

As indicated in table 5.2 alternative efficient resource allocation has improved the returns of the factors compared to their base line growth rates under all scenarios except labor income from human capital investment in which case its return reduced by 0 .91%. The reduction of the labor return under human capital investment may be related with irresponsiveness of labor market to efficiency parameters for employment decision as labor market is characterized high unemployment rate. When it comes to the sources of the factors' income in the case of efficiency based agricultural budget allocation, the returns of labor, capital and land is increased by 5.18%, 5.56% and 4.28% respectively. However, Livestock's return is dramatically increased by 120.73% under human capital case as compared to baseline growth rate scenarios.

The justification for labor income improvement is due to the fact that, agriculture is the dominant source of employment and livelihood for over 80% of country's population. But as compared to capital, the return to labor under agriculture is low, which indicates the existence of economy's structural transformation under efficient public spending. In the case of land, its value will increase since all agricultural investments requires land as input and hence leads to increases in the demands of land.

On the other hand, the huge increase of Livestock factor income under efficiency based budget allocation may be explained by modernization of the sector as result of knowledge gain of the holders from investment in the human capital. It will enable the holders to overcome the traditional ways of harvesting Livestock. Similarly, improvement in livestock factor income may be due to higher productivity of self employed livestock holders due to better education and health services. The dramatic

improvement in this sector will further enhance the growth of the country since the nation has large stock of Livestock population.

On the other hand, the probable reason for the better performance of the export sector as presented under macroeconomic variable section is related to increases of the Livestock sector productivity as its products like hides and skins, leather and leather products are among main export items of the country with even more future prospects.

By the same token, the incomes of all the factors are improved with efficiency based public spending on transport sectors with slight magnitude differences. The explanation of higher return to labor income could be due to increases in mobility of labor across better paying activities. For livestock, it will be explained by reduced transaction cost of access to the market while the case of the land will be rises in the values of the land following increases in its demand as it becomes more accessible by many users. On the other hand, the return to capital could explained by complementary nature of inputs as increases in demand of other factors will leads to high demand for capital and hence higher capital returns.

Further, improvements in factors incomes will lead to better government spending as the revenue of the government increases following better earning of factors in the form of income taxes and other forms of contributions.

Effects on household income and consumption expenditure

Table 5.3: Average annual percentage changes of household consumption expenditures from baseline growth rate

| Households | Simulation scenarios | | |
	Agriculture (%)	Human capital (%)	Transport (%)
Rural poor	4.24	0.01	0.08
Rural non poor	5	-0.02	0.14
Urban poor	5.32	-0.29	0.15
Urban non poor	5.58	-0.89	0.18

Source: Own computation of DCGE Simulation result

As shown on table 5.3 efficient allocation of the national resource will improved all categories households' return both under agricultural and transport scenarios while incomes' of the households reduced in the case of human

capital regardless of their magnitude as compared to baseline growth scenarios.

The positive responses of agricultural and transport sector can be justified by increase in the returns to the respective factors' income following improvement in agricultural productivity due to better resource utilization as discussed under factor income section. Again improved infrastructure will positively contributes to all households as it will increase the mobility of factors and reduces transaction costs.

But, in the case of human capital, the probable reason for reduction of households' income may be decomposed into several factors. For instance, better investments in education system may not improve the households return due to distortion of labor market as the trends of educated unemployment is keep growing fast regardless of government efforts i.e. unemployment is about 17.5% in Ethiopia according to (IMF, 2013).. The other probable reason could be less self employment creation by graduates which could be further related to low culture of work or unfavorable business climate.

On the other hand, the contribution of health sector for household income generation is explained through improvement in productivity as healthier worker perform better. As explained, if labor market and other cultural factors contribute to unemployment of the healthier households, it will harms the income generation capacity of households.

Effects on household welfare

Figure 5.1: Percentage changes in equivalent variation (EV) from the baseline
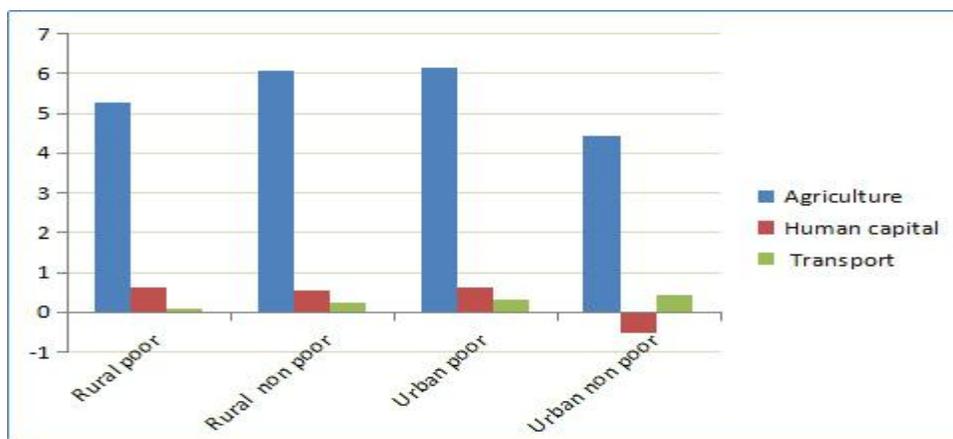
Source: Own computation DCGE simulation result

As clearly indicated in figure 5.1 , efficient resource allocation leads to improvement to households' welfare except for urban non poor under human capital considering changes if, welfare is measured in equivalent variations (EV) from the baseline in the three simulation scenarios.

When it comes to the level of the improvement, efficient agricultural spending will lead to higher welfare improvement compared to the base line scenarios growth rate. The possible explanation for such improvement under efficient agricultural budging is due dominance of the sector as a source of livelihood of the nation and hence increase in the productivity of the agricultural sector following efficient agricultural budgeting on average will lead to 5.46% improvement in welfare of the all households.

In the case of human capital, there is welfare gain for other households except urban non poor. The explanation for the improvement of welfare for these households under efficient human capital allocation may be due to better social services and fair agricultural output prices for stable food items following increased agricultural productivity.

However, the reason for the loss of welfare in the case of urban non poor under efficient human capital allocation may be related to adaptive expectation of the households as they assume the qualities of public social services is continue to be lower. Instead they prefer to pay high price for these services in private sectors.

On the other hand, efficient transportation expenditure planning will leads to welfare gain to all household groups with almost same magnitude. This can be justified by easing the mobility of households across sectors in searching for employment service centers and reduction of transaction costs in addition to improvement in the income of households.

Sectoral Effects

Table 5.4: Effect on Sectoral Average annual growth rates

Simulation scenarios		
Agriculture	Human capital	Transport
Sectors		
Agriculture	8.93	8.97	8.92
Industry	12.82	12.83	12.82
Service	11.58	11.59	11.59

Source: Own computation DCGE Simulation result

As shown in table 5.4 growth performances of all sectors are impressive under alternative efficiency based allocation of government spending .When we come to sector wise comparison, Industry sector takes the lead followed by service sectors. However the growth rate of agriculture sector is lower as compared to the other two sectors. This would be natural trend as efficiency based government spending as it induces economic growth which

will lead to structural transformation of the economy.

On the hand, the growth rate composition of the three sectors indicates the fact that the country is in the process of early stages of economic transformation since dominance of any sectors is not indicated. This is in line with economic theory's predictions as industry has to lead the economy to speed up the growth rate which will finally taken up by service sector for economic development to happen.

Figure 5.2   Average percentage changes of sectors from base growth rate
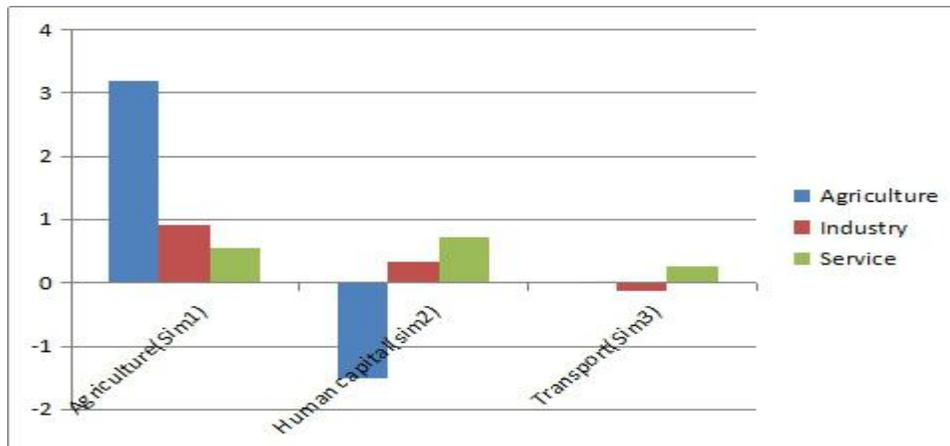
As indicated on the figure 5.5 the impact of efficient allocation of public spending improves sectroal growth rates as compared to the baseline scenarios with exception to the human capital and transport.

As indicated by figure efficient agricultural spending stimulates all sectors. This could be explained as agriculture sectors will serve as an input and market for other sectors. On the other hand, efficient public spending under all scenarios positively affected the service sector growths compared to baseline scenarios. The expansion of service sector following efficient allocation may be due to increases in service demands and provisions as efficiency leads rapid economic growth.

Figure 5.2, also indicates that the growth effect of efficient human capital spending allocation on agriculture sector is negative. The probable reason for low agricultural sector growth rate may be due to unwillingness of educated youths to back to the sector in applying their knowledge gain from school.

This could be related to unwillingness towards the sectors as rural educated prefers to search for jobs in other sectors. So efficient human capital investment is not translated to agriculture sector growth.   This may be the reason for

negative fixed investment under efficient agricultural spending as indicated under macroeconomic indicator since most agricultural labors are uneducated to apply modern inputs and use market signals as well as low saving behavior.

Unexpectedly, as shown on the figure 5.2, the government spending on transport negatively affected the industry sector growth. The possible justification may be low responses of

The results are, therefore, found to be similar in terms of sign. As a result, it can be concluded

private investment following expensive infrastructure spending of government.

This will be better explained with the low performance of investment climate of the country, as discussed under private investment climate, which was declined over time according to WB easy business doing index. The other justification could be infrastructure provision decision may not purely guided by economic efficiency of resource allocation like it may depend on equity and political variables. that the CGE results discussed thus far are robust despite the baseline assumptions.

Conclusions and policy implications

Conclusions

The study analyzed economy wide impacts of efficient public spending using a recursive dynamic computable general equilibrium approach. The study used updated version of the
 The study employs CGE as analytical tool for purpose efficient public spending allocation decision which could be considered as
 From simulation results of alternative efficiency based allocation of public spending,
 Under all scenarios, the growth rate of in real GDP is positive, higher under agriculture 2.26% followed by human capital with 0.44% and under transport 0.14%. Further the performance of external sector is also improved, as export is more than imports under all scenarios of Households welfare is also improved for all households except, urban non poor as explained. The other impressive result is the economic

2005/06 EDRI Social Accounting Matrix. It used simulations analysis to examine the economy wide impact of alternative efficiency based allocation of public spending allocations. contribution of the study and it may help the policy makers to allocate public spending across sectors efficiently. improvement of macroeconomic performances and household welfares is indicated. efficient based public spending. The returns of factors and income are increased except for labor under human capital which may be related with labor market functioning, which further lead to decreases in household income.

structural transformation indicated under alternative efficient allocation scenarios as industry takes the lead followed by services and

agriculture respectively. However, lower performance of industry under transport Therefore, based on all these findings, the study implies that the baseline Publics pending allocation decisions across sectors are sub The study concludes that, efficient public spending allocation guided by CGE model will help Ethiopia fiscal authority to optimize the use So the rapid growth rate due to efficacy will reduce the current high poverty and unemployment level which 30% and 25% of indicate the need to assess the performance of investment climate.

optimal as compared to efficiency based alternative public spending allocation

of limited public recourses to sustain modest the growth rate.

total population respectively as indicated in the study.

Implications

This study has some useful implications for policy makers, and professionals in relation to how to use analytical tools in public spending allocations efficiently. It has also suggestion for future researchable potential areas to deepen macroeconomic policy analysis in Ethiopia.

Policy Implications:

➢ The policy makers and professionals in charge of allocating public spending need to be considere d alternative spending scenarios before making the decision of resource allocation to optimizing efficiency of resource utilization, using CGE model as an analytical tool.

➢ Policy makers have to consider multi-sector linkages of different sectors as investment on one se ctor needs complementarily of the other sector or economic environment. Increase more investm ent of human capital and complementary business environment for livestock as it has more comp arative advantag, i.e, 120% improvement in income.

➢ Improvement is needed in business and investment climate, governance and   to maximize efficie ncy of resource allocation.

Since the study is undertaken under constraint environment, the following issues are suggested for further study to deepening empirical applicability of CGE as policy analysis tool in Ethiopia.

➢ Estimation of TFP from Ethiopian data and structural modification of CGE modeling framework to make it fit Ethiopian Economic structure for more robustness of the results and hence to use C GE as analytical tool of policy analysis, particularly for public spending allocation across multi-s ectors.

- Financing part of public spending allocation is not covered by the study and the study has to be undertaken on the financing means for comprehensive policy implication.
- Reallocation of public spending from less productive to more productive sectors are also appealing as it is recommended by growth theorists in the literature to promote rapid economic growth, particularly in the environment of limited resources.

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Utilization of Available Technologies in Teaching English at Preparatory Schools

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Abstract

This study investigated the availability, familiarity and utilization of technologies in teaching and learning English. Three preparatory schools in East Shawa Zone were taken as samples for the study. Data were gathered from 15 English teachers, and 124 grade 11 students using questionnaires, interviews and group discussions. The data obtained from the informants were analyzed using both quantitative and qualitative methods. The findings of the study indicate that radio, TV, Plasma TV, audio tape, video, mobile and desktop computer are available at the schools, and or homes of the students. Teachers and students of the schools are familiar with most of the common technologies: radio, audiotape, TV, Plasma TV, Internet, mobile phone, email, video, desktop and laptop computers. The study also shows that both teachers and students have positive attitude towards using technologies. However, most of the subjects rarely utilize the available technologies in teaching and learning English. Their positive attitude towards utilizing technology has not influenced their actual use. Lack of awareness, solely relying on textbook to cover portions, and shortage of some technologies were found to be among the factors for the under utilization of the available technologies. The study suggests that education bureau should revise curriculum; schools or education offices should organize awareness raising training; teacher training institutions should incorporate technology utilization courses in their curricula; and teachers should encourage their students to use technologies at their disposal for improving their English language proficiency.

Keywords: *Availability, utilization, technology, teaching, learning, English*

Background and Justification

At present, English is the language of socio-cultural and political context, science and technology, business, media, communication across borders, as well as a key subject in curriculum and language of instruction.

The aim of teaching and learning English is to enable students communicate with the language in different contexts. Nevertheless, there are a number of factors that determine the achievement of this goal. Background, attitude and motivation of learners and teachers, methods of instruction and technologies used are among the factors that influence the practice of language teaching and learning. Learners of English as a second or foreign language should get the necessary aid which facilitates learning the language at ease and with motivation. They

The emergence of new technological tools in foreign language teaching has built up teachers' hopes to fulfill the requirements of communicative settings (Yaratan and Kural

Shyamlee (2012) argues that the use of English language has increased rapidly. Technological innovations have gone hand–in hand with the growth of English and are changing the way in which we communicate.

need to practice listening reading, speaking, and writing in the language to develop their skills. For this, they need various technologies which can help them learn the language easily and effectively (Ybarra & Green, 2003 cited in Nomass, 2013). Radio, tape-recorder, TV, plasma TV, computers, the Internet, electronic dictionary, videos, email, blog, LCD (Liquid Crystal Display), OHP (overhead projector), and language laboratory are among technologies used for teaching and learning language (Koksal, 2004, Patil, 2014).

2010). With regard to the importance of technology in today's era of globalization, Nomass (2013: 111) underlines:

> It is well known that our new life is highly affected by the era of information technology, and technology plays an important role in today's human society development. Based on this fact, it is indispensable to take advantage of the modern technological facilities in aiding the task of English language education

.

According to Shyamlee (2012), utilizing technology in language teaching and learning has several benefits. It raises the interest of

students, promotes their communication capacity and widens students' knowledge, improves teaching environment, improves

interaction between teacher and student, provides flexibility to course content, and creates a context for language teaching.

In Ethiopia, some technologies like radio and television have been in use for long to aid English language teaching. However, to what extent teachers and students exploit available technologies for the purpose has not been investigated. According to constructivist theory,

Some researches indicate that secondary school students lack communication command and proficiency in English language which is usually revealed in slow and poor comprehension (Atkins, et al. 1996). Such inefficiency in using language skills hinders the students' broader studies and inevitably limits their academic performance, especially, at tertiary levels where they are expected to learn a lot independently. This is a serious problem observed by the Therefore, improving the teaching of English language needs a considerable attention. In language teaching and learning, the focus given to the employability of the available technology is very limited. It is well accepted that language learning takes place in the environment where learners are exposed to the real use of language; this is, however, less practical in countries like Ethiopia, as it is not possible to put the learners among the language speaking community. To

Shyamlee underlines that technology is utilized for up-lifting of modern styles and satisfying visual and auditory senses of the students.

teachers are not in class to teach everything, but to show how students can learn by themselves (Sabzian, 2013). Learners should be motivated to use technology at their disposal to construct knowledge/skill.

present researchers with most of the freshman students over the last years. Students' low language command can be attributed to many factors like ineffective method of teaching, inadequate textbooks containing inappropriate tasks meant for developing learners' language abilities, giving little attention to the available technologies, teachers` qualification and teachers and students' attitudes, among others.

narrow this gap we can use technology. The present researchers believe that the little attention given to exploiting the technologies available at one's disposal may contribute for the low performance of the students in using English. Thus, the researchers embarked on investigating the available technologies and the extent to which they have been exploited by teachers and students in teaching and learning English.

Theoretical Framework

This study dealt with the familiarity, availability and utilization of technologies in English language teaching and learning. The theoretical framework employed to guide the study is Technology Acceptance Model (TAM) developed by Davis (1989) to find out the factors which lead people to accept or reject information technology. As Andrew (2014) states Technology Acceptance Model is an information system theory that models how user comes to accept and use a technology.
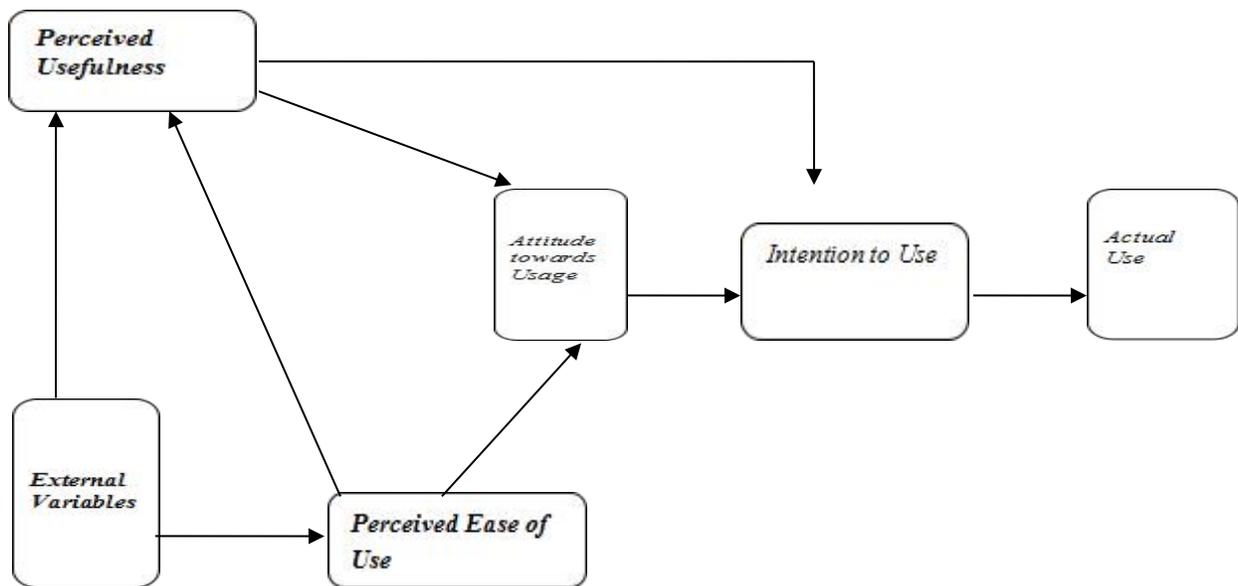

Figure 1. Technology Acceptance Model (Davis, 1989)

This model suggests that when users are presented with new technology, there are factors that influence their decision about how and when they use it. These are Perceived Usefulness and Perceived Ease of Use. Andrew (2014) quoting Davis (1989) explains Perceived Usefulness as the degree to which a person believes that using a particular system would enhance his or her job performance. Perceived Ease of Use is the degree to which a person believes that using a particular system would free him/her from effort. The model is used to specify linkages between perceived usefulness, perceived ease of use and users' attitude, intentions and actual use (Sharma, Chandel, 2013).

The technology acceptance model is based on principles adopted from Fishbein and Ajzen's

(1975) attitude paradigm from psychology. They developed Theory of Reasoned Action which is based on the assumption that individuals are rational decision makers who constantly calculate and evaluate the relevant behavior beliefs in the process of forming their attitude toward the behavior. Fishbein and Ajzen (1975: 216) define attitude as "an individual's positive or negative feelings (evaluative affect) about performing the target behavior". Individuals form attitudes toward a behavior by evaluating their beliefs through an expectancy-value model. Based on the Theory of Reasoned Action, Davis (1989) developed the Technology Acceptance Model to find out what factors cause people to accept or reject an information technology. Davis found out that perceived usefulness is the strongest predictor of an individual's intention to use an information technology. The present study employed this model to see into the factors that affect using or rejecting of technology in language teaching and learning. It helps to find out the factors that lead the teachers and students' perception of the usefulness and ease of using technology along with the factors that contribute to either of these.

Objectives

The general objective of the study was to investigate the available technologies and the practice of utilizing them in teaching and learning English at preparatory schools. The study specifically set out to:

1. find out possible technologies for teaching/learning English at preparatory schools or homes of students and teachers;

2. identify to what extent teachers and students are familiar with and use them formally or informally in language teaching and learning;

3. find out the attitudes of teachers and students towards using technologies in teaching and learning English;

4. identify the factors that hinder the use of available technologies in teaching and learning English at preparatory schools;

Methods

The subjects of this study were grade 11 students and their English teachers from three government preparatory schools in three towns, namely, Assela, Bishoftu and Adama. Grade 11 was targeted as it is a critical time for preparing students for Higher Education Entrance Exam. The students are more stable than grade 12 students during the data gathering time. The researchers used random and purposive sampling techniques to select subjects of the study. From 2,000 grade 11 students in the schools, 200 students were randomly selected to participate in the study. However, only 124 students completed filling in the questionnaires. Besides, 25 English language teachers teaching at grade 11 in the schools were purposefully

involved in the study. From these 15 teachers returned the questionnaire.

To gather data the researchers used questionnaires, focus group discussions, and interviews. Questionnaires were used to gather information with regard to the available technologies and the practice of utilizing them for language teaching and learning. Items on examining teachers' and students' attitudes towards using these technologies were incorporated in the questionnaires. In order to gather information on justification of what was reported in responses to items in the questionnaires, a semi-structured interview was also conducted with six teachers, and 12 students randomly selected from those who filled out the questionnaires. Group discussions consisting of leading items were also conducted both with teachers and students to substantiate the data gathered through questionnaires.

The data were analyzed both quantitatively and qualitatively. The items in the questionnaires were analyzed by working out the frequencies and percentages for each item. Responses to the open ended items in the questionnaires, focus group discussion and the interview items were analyzed qualitatively to support the quantitative analysis.

Results and Discussion

This study set out to investigate the familiarity, availability and utilization of technologies in English language teaching and learning. Partly driven by the low performance of students in English language, the study lays on the premise that technology aids effective teaching/learning of language. The central focus of the study was to find out whether the teachers and the students are familiar with and practically use technologies available at their disposal in teaching and learning English language.

Table 1. Teachers' response to technology familiarity, availability and utilization

No	Technology	Familiar				Available				Utilized				Total	%
		Yes		No		Yes		No		Yes		No			
		F	%	F	%	F	%	F	%	F	%	F	%		
1	Radio	15	100	-	-	12	80	3	20	2	13.3	13	86.7	15	100
2	Audiotape	14	93.3	1	6.7	10	66.7	5	33.3	2	13.3	13	86.7	15	100
3	TV	15	100	-	-	12	80	3	20	2	13.3	13	86.7	15	100
4	PTV	11	73.3	4	26.7	10	66.7	5	33.3	2	13.3	13	86.7	15	100
5	Internet	11	73.3	4	26.7	4	26.7	11	73.3	1	-	15	100	15	100
6	Mobile phone	15	100	-	-	8	53.3	7	46.7	2	13.3	13	86.7	15	100
7	LCD	3	20	12	80	3	20	12	80	-	-	15	100	15	100
8	OHP	8	53.3	7	46.7	2	13.3	13	86.7	-	-	15	100	15	100
9	Email	12	80	3	20	4	26.7	11	73.3	2	13.3	13	86.7	15	100
10	Video	11	73.3	4	26.7	5	33.3	10	66.7	2	13.3	13	86.7	15	100
11	Desktop	15	100	-	-	9	60	6	40	2	13.3	13	86.7	15	100
12	Laptop	15	100	-	-	4	26.7	11	73.3	2	13.3	13	86.7	15	100
13	Lang. lab	7	46.7	8	53.3	-	-	15	100	-	-	15	100	15	100
14	Interactive WB	3	20	12	80	_	-	15	100	-	-	15	100	15	100

As indicated in Table 1, more than 70% of the teachers are familiar with technologies like radio, audio tape, television, plasma TV, Internet, cell phone, email, video, desktop and laptop computers. On the other hand, 53% and 46% are familiar with overhead projector and LCD respectively. Very few of them (20%) are familiar with interactive whiteboard. From this, we can see that the teachers are familiar with the majority of the technologies that can be used for language teaching or learning. With regard to

When it comes to the actual utilization, more than 80% of the teachers said that they rarely use the available technologies for language

availability, more than 60% of the teachers said that technologies like radio, audio tape, TV, plasma TV, desktop computer are available at their schools, homes or both. Technologies which are not available in both are LCD (80%), OHP (86.7%), laptop (73.3%), and Internet (73.3%), email (73%). Language labs and interactive whiteboard are missing from the schools. Here, we can realize that some common technologies are available at their schools, homes or both.

teaching/learning. Thus, there is a gap among familiarity, availability and utilization of technologies for language teaching/learning.
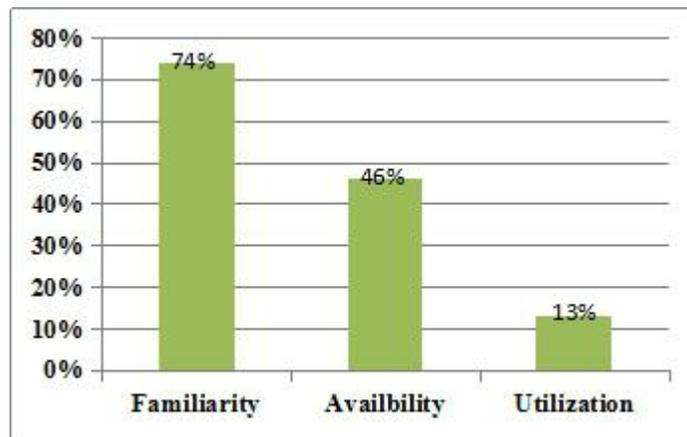

Figure 2: Summary of overall teachers' familiarity, availability and utilization of technologies

Regarding the frequency of using technologies, 80% of the teachers do not use the technologies in the class. Similarly, over 70% of the teachers witnessed that they do not use technology outside class for language learning/teaching. Thus, technologies are not used in the class or

outside for English language teaching/learning English.

With respect to teachers' attitude towards using technology, almost all teachers seem to be positive. They believe that technology enhances language teaching and learning, motivates

students enhances confidence, improves language skills, increases interactive skills, adds authenticity and variety to language teaching, etc. From this, we can see that teachers have strong belief about the use of technology but when it comes to the actual practice there is a gap. The respondents justified that this could partly be due to lack of awareness on how to use technology. In relation to this, 80% of the teachers reported that they have not taken training on how to use technology for language teaching /learning. Their positive attitude has not also influenced the actual use of technology. Similarly, students' data were analyzed by taking the familiarity, availability and utilization of technologies as indicated below.

Table 2. Students' response to technology familiarity, availability and utilization

N o	Technology	Familiar				Available				Utilized				Total	
		Yes		No		Yes		No		Yes		No			
		F	%	F	%	F	%	F	%	F	%	F	%	F	%
1	Radio	122	98.4	2	1.6	90	72.6	34	27.4	10	8.1	114	91.9	124	100
2	Audiotape	106	85.5	18	14.5	61	49.2	63	50.8	4	3.2	120	96.8	124	100
3	TV	119	96	5	4	90	72.6	34	27.4	5	4	119	96	124	100
4	PTV	118	95.2	6	4.8	68	54.8	56	45.2	13	10.5	111	89.5	124	100
5	Internet	117	94.4	7	5.6	62	50	62	50	9	7.3	115	92.7	124	100
6	Mobile phone	122	98.4	2	1.6	87	70.2	37	29.8	11	8.9	113	91.1	124	100
7	OHP	50	40.3	74	59.7	11	8.9	113	91.1	3	2.4	121	97.6	124	100
8	Email	96	77.4	28	22.6	46	37.1	78	62.9	5	4	119	96	124	100
9	Video	111	89.5	13	10.5	65	52.4	59	47.6	6	4.8	118	95.2	124	100
10	Desktop Computer	116	93.5	8	6.5	90	72.6	34	27.4	14	11.3	110	88.7	124	100
11	Laptop computer	113	91.1	11	8.9	44	35.5	80	64.5	3	2.4	121	97.6	124	100
12	Language lab	61	49.2	63	50.8	12	9.7	112	90.3	3	2.4	121	97.6	124	100
13	LCD	-	-	-	-	-	-	-	-	-	-	-	-	-	-

The data obtained from students also show that most of them (more than 70%) are familiar with radio, audio tape, TV, plasma TV, Internet, mobile phone, email, video desktop and laptop computers. Only 40% and 49.2 % of the students said that they are familiar with OHP

With regard to utilization, almost all the students do not use the technologies for English language learning. For instance, 91-96.8% of the students said that they do not use radio, and language lab. This indicates that the students are familiar with most of the technologies. The technologies that are available are radio, audio tape, TV, Plasma TV, mobile phone, and desktop computer. The technologies which are not available include language lab, OHP, laptop computer, and Internet.

audio tape, and TV, and plasma TV. From this, we can deduce that the available technologies are not being used to support English language learning.

Figure 3. Summary of overall students' familiarity, availability and utilization of technologies

From the data on frequency of utilization of technologies in the classroom or outside, more than 70% of the students said they never used

Regarding the attitude of the students towards using technology, almost all have positive attitude towards the importance of technology in English language teaching/learning. They agreed with the statements that technology enhances language teaching/learning, motivates students, provides alternative learning strategy,

these technologies in the classroom or outside. This is another indication that the available technologies are not utilized in language teaching/learning.

improves language skills, interactive skills, increases confidence, adds authenticity and variety to language teaching and learning. Even though 58% of the students asserted that their teachers encourage them to use technology, more than 90% of the students' indicated that they have never used technology for language learning.

Conclusions and Recommendations

Some common technologies which teachers and students are familiar with are available at their schools or homes. Teachers and students have also positive attitude and intention to use technology, but they almost do not actually use

Hence, the study suggests that education bureau should recheck the English curriculum if it gives some space for the incorporation of technologies; schools or education offices should organize awareness raising training to teachers and students on significance of technology and its

the available technologies. Lack of awareness, rushing to cover textbook portions, and shortage of some technologies were found to be among the factors for the underutilization of the available technologies.

utilization in language teaching; teacher training institutions should incorporate technology utilization courses in their curricula; and teachers should encourage their students to use technologies at their disposal for improving their English language proficiency.

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Discourse Analysis of The Portrayal of Women In TV Advertisement

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Abstract

Television advertisements produce different messages that may have bearings on the attitude of the target audience. As one of the prominent genres of television, advertising, both informs the society about products and thereby imparts an underlying message about power relationship in the society. The current study aimed to discern the underlying implications of the portrayal of gender in TV ads. For this study, three TV commercials broadcast in Ethiopia by EBC and Kana were selected and analyzed. Thus, in order to propound women's image in such commercials, Critical Discourse Analysis (CDA) was employed. The results revealed that the selected TV advertisements perpetrate gender stereotypes and traditional gender division of labor.

Key word: advertisement, gender, CDA, representation, discourse

Introduction

In advertising, companies try to persuade people to buy their products using visuals and language. However, advertisements are not limited to serving the purpose of popularizing products only, as they "also amuse, inform, misinform, worry, warn, though it may be argued that these functions are all in the service of the main function" (Cook 1992: 5). In this era, advertising has got a considerable level of involvement with people's everyday activities-through portraying sectors of the society and thereby transmitting various types of messages. As such it is considered a discourse type. In connection with this, Cook (1992: 199) noted that, "advertising is not a remote and specialized discourse, but a prominent discourse type in contemporary society."

Gee (2005: 1) defined discourse as "language (oral or written) in use with more socio-politically oriented meaning." In the same vein, Fairclough (1989) went a little further and described discourse as one specific form of social practice in which power and ideology influence and interact with one another.

Nowadays, media are the main resources of knowledge and information for understanding the world. Thus, television is one of the most popular medium in representing groups of society and thereby shaping attitudes. In connection with this, Cook (2005) has pointed out that advertising is one of the genres of

television and a prominent discourse type in modern society. The role of television is not limited to conveying information regarding products. It also constructs discourse about roles that different members of the society play along with power relation.

Furthermore, television advertisements construct discourses about gender relations. In media, particularly in television, the images of women and men are essential for the understanding of social practices, social interactions and ideology. This means that television advertisements have underlying implications regarding the roles that men and women are supposed to shoulder. Therefore, advertising has an important role in the representation of gender in a society.

The portrayal of different groups of society is directly related with collective meanings, power relations, status hierarchies, resistance, alliances or conflicts that may exist in the public sphere Dines & Humez, (1994); Gauntlett, (2002). Thus, it is believed that the representation of gender relations actually reflects the social, cultural, political and economic values of the society.

Advertising companies use some specific tools in their advertisements to persuade their recipients and change the attitudes and choices of the target audience. To this end, these

companies focus on the cultural values, the ideologies and the beliefs of their audience. Television advertisements use language and visuals to attract viewers.

Van Dijk (1993) asserted that television programs present dominant gender relations and patriarchal values that still remain in post-modern societies. This implies that television advertising has become a site for reinforcing traditional beliefs of gender stereotyping among others. Given the immense role of television in modern society, the way women are portrayed in television has some implications on the cultural roles that they are supposed to carry out.

However, it should be noted that along with endorsing products, advertising also reflects and enhances social ideologies. Moreover, advertising is a cultural environment challenged by ideological discourses in the society and is constantly evolving in response to the shifting power relations between social groups. According to Gledhill, (1988), advertising can be considered as a cultural form and discourse is a site in which different subjectivities struggle to impose or challenge, to confirm, negotiate or displace definitions and identities.

This study aimed to expound how the mainstream television commercials portray women and gender roles and thereby explore the intersections of gender and ideology that are embedded in television advertising. It examined the characteristics of language used in commercializing products. Thus, the study explored how advertisers present specific identities, visuals, texts and ideologies for the promotion of their products and thereby shaping of attitudes.

Materials and Methods

As this study was meant to unravel the role of television advertising in shaping public actions, it gave due attention to embedded meanings of discourse relating to gender roles. Accordingly, the study raised questions that emphasize qualitative and interdisciplinary modes of investigation. Critical discourse analysis (CDA) has been employed as a linguistic tool for discerning the underlying meanings of advertisements.

Van Dijk (2001:352), defined CDA as "a type of discourse analytical research that primarily studies the way social power abuse, dominance, and inequality are enacted, reproduced, and resisted by text and talk in the social and political context" . This means that CDA is a tool for unraveling the underlying meanings of messages. The scholar has further gone to state that CDA emphasizes "how language produces and reproduces domination and abuse of power, engendering injustice

and inequality" (van Dijk, 2001:96). Accordingly, language used in advertising conveys implications regarding accepted norms and practices in a given society.
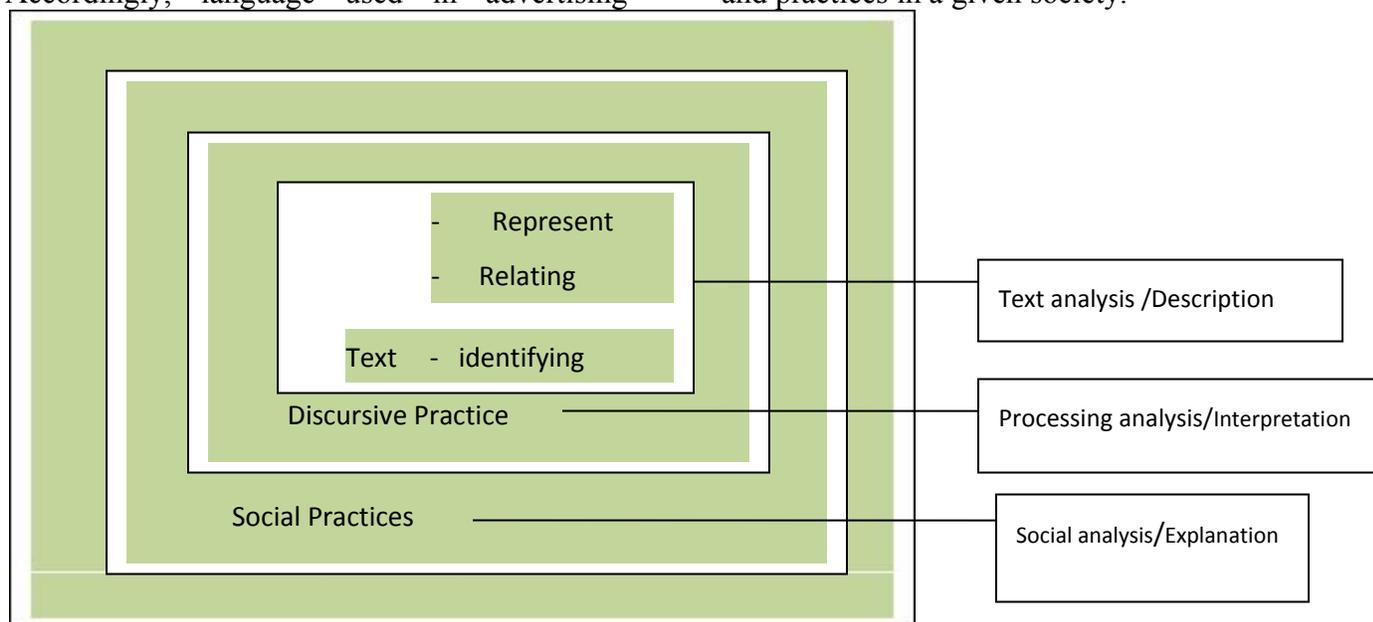

Figure. 1 Fairclough''s dimension of discourse and discourse analysis

Moreover, CDA enables one to provide in-depth reasoning about the social interaction of the overt and the covert ideologies pertaining to a given interaction. In the current study the focus was to investigate the portrayal of females in TV advertisements and examine the ideological impacts created by the portrayal of gender.To analyze the particular slots of language use, Fairclough's three dimensional framework, which explores the discursive relationship of text with society and culture, has been employed. The following research questions were used to guide the study.

1. How do the TV commercials reinforce or contradict the prevailing conceptions of gender in Ethiopia?

2. How does the dominant discourse become naturalized in television commercials?

3. How do television commercials conceptualize women in relation to the dominant male culture and for what reason?

In the current study, textual analysis has been used to uncover the preferred meanings encoded in a text. It helped to depict how ideology and meanings are accepted and conceptualized by television advertisements. In this study, the commonly used advertising strategies that focus on gender roles are scrutinized so as to illuminate how gender roles are encoded in TV advertising texts. Moreover, the study has attempted to examine how woman is defined through consumption ideologies, and how advertising constructs subjective positions.

Consequently, a detailed analysis of the portrayal of women in advertising and the underlying meanings are presented.

Sampling Technique

Purposive sampling has been employed as the method in the current study. As it has been noted by Ritchie & Lewis (2003) this approach is used when samples are chosen because of their specific characteristics which give room for detailed exploration and expounding of The sampled advertisements were selected in terms of their significations in gender roles and their frequency on television. The selected advertisements could help one realize the the key element to be investigated. Accordingly three television commercials from Ethiopian TV Channel 1 and the recently launched Kana television have been selected and analyzed. These advertisements were broadcast in prime time in 2008 E.C

manner in which Ethiopian television portrays women and gender roles in advertising. The selected advertisements are:

 1. Omo detergent ad 2. MAMI lac ad 3 cooking oil add

Analysis of Advertisements

In the process of analyzing the selected advertisements, critical discourse analysis approach was used to account for the manner in which the advertisers constructed the intended messages and whether those meanings The three levels of Fairclough's (1992) discourse analytic framework are textual, discursive and social analyses. In textual analysis, the main focus is on the way the under consideration. Applied to the current study, this means that one has to analyze the The discursive analysis is concerned with level of text's production, distribution and consumptions that give a glance on how power relations are established through text. Fairclough noted that code switching/mixing, celebrity endorsements, using emotive words and scientific evidence are the sub categories of reflect or support the dominant patriarchal ideology, articulation of the portrayal of women and men, and naturalization of dominant discourse. Shots are used as the unit of analysis.

discourse producers describe the things and what type of vocabulary they use when they portray the commodities

choice of vocabulary and how women are depicted through the use of vocabulary. discursive analysis in his model of CDA analysis.

The social analysis deals with ideological conventions, it explains the current situations, trends and background information. Applied to the current study, this means that one has to try

to expound the trajectory posited pertaining to gender.

Advertisement 2

The first analyzed advertisement promoted a detergent named 'OMO'. At the beginning nothing was mentioned about the qualities of the product. Apparently two boys were playing football in a compound. The smaller one hit the ball which was smeared with mud against his elder brother. The big boy got angry and started chasing the small boy who tried to escape. Apparently the small boy tried to take refuge under his father who was dressing up. The father was dressing up in front of a big mirror.

In the process the boys smeared their father's white shirt with their dirty hands whereby the father got irritated and took off the shirt. In the mean time, a girl who was dancing also got drinks sprinkled on her sweater while she was trying to avoid the rushing boys. Both the father and the girl ran to the stairs clutching their dirty clothes. Eventually, they threw their dirty clothes to the woman who was carrying a case full of dirty clothes to the backyard where the servant was washing clothes.

Analysis of Advertisement 2

In textual analysis of this advertisement, positive adjectives have been used to highlight the quality of the product. The adjectives used include, 'OMO for simple wash' which implies that this product simplifies the washing process. In the process these positive adjectives are used to highlight certain qualities and add values to woman so that they get stimulated to buy the product. In this advertisement, the most important action took place in the backyard and In this advertisement, a woman is portrayed to be responsible for washing the clothes of family members which is considered as one of the main housework choirs. The man is portrayed as an entity who is relieved of this house choir. There was no connection between the man and the woman washing clothes. When his shirt got dirty, he had to change it. Although the meaning of the message is presented as

the central character is a woman perhaps a servant who was washing clothes using OMO detergent. As soon as the dirty clothes were brought to her, she immersed them into the white foam and rubbed them for a while. All of a sudden the dirt was removed. The woman took out the clothes and smelled the aroma of the detergent and expressed her satisfaction with its effectiveness as she hung them on a rope.

a norm, indeed the pictures are stereotypical; they appear to be based on older patriarchal models and values. The dominant discourse creates a gender identity for women and they have to use tools and goods accordingly. A device such as the washing pane and goods like OMO detergent have been considered as devices and goods for women.

The portrayal of men in this advertisement implies that the male identity is not involved with this chore. The man was shown in the OMO detergent advertisement relaxing in the bedroom while boys were seen playing football. Rather the use of particular goods and equipment in association with women in the advertisement implies the old traditional belief that a woman's place is in the kitchen. Thus, portraying the woman as a solely responsible body for house chores actually rejects the other meanings, and insists on the projection of the traditional female role imprisoned in the domestic environment.

The ideological analysis of the text indicates that this commercial reflects the traditional beliefs concerning a woman's domestic position in contrast to all the progressive endeavors exerted to bring about gender sensitivity in Ethiopia. The husband was seen rejoicing until two children smeared his shirt with dirt. In contrast, the wife was seen carrying a case full of dirty clothes to the maid servant. In the mean time a teenage girl who got water splashed on her sweater ran to the stairs along with the man to just throw the dirty clothes to an adult woman, perhaps the mother, who took all the dirty clothes to the woman washing clothes.

Figure 2 OMO detergent ad EBC

Advertisement 3

The second commercial considered in this paper promoted a milk product. In this advertisement, a little girl is seen reading a story to a baby loudly. 'Once up on a time….'All of a sudden, the mother appears smiling. She caressed the baby uttering: 'my little baby whom I love will grow up drinking MAMi lac' the mother was

jovial as she fondled the baby as well. Why was the little girl reading the story loud? Perhaps was she doing this because she was amusing the baby to drink the milk? Was she trying taking part in the traditional role and supporting her mother in taking care of her little brother?

Analysis of Advertisement 3 MAMi LAC

Traditionally, actions such as taking care of children in the context of Ethiopian society relate to women and girls. The selection of a girl in this advertisement has its own implications. According to the dominant cultural discourse of the society and the The portrayal of men in this advertisement implies that the male identity is not involved with this chore

In this advertisement gender roles seem to be reduced to the meaning of being concerned about children and being emotional. These meanings suggest that women have such nature. Thus, it leads to

The discourse producers used the discourse strategies of introducing famous celebrities, scientific evidences, and code mixing, in promoting this product (MAMi lac). The woman who played the role of the mother is a

social context of the country, baby sitting is assigned for women and girls. **These acts make naturalization of gender division of labor and allocate the role of taking care of children to the female polarity.**

the formation and continuation of female identity. Such conditions may help to normalize the superiority of male position and the low position of women, and it is based on maintaining the existing gender relations.

famous film actress in Ethiopia. Moreover, the contents of the product have been given in Amharic (Fig 3 last shot). It is indicated that the product is rich in vitamin, protein, minerals…etc.

Figure 3 MAMi lac ad

Advertisement 4 cooking oil ad

The third commercial analyzed in this paper promoted a cooking oil. The advertisement begins when a woman who appears worried about lack of cooking oil recollected that she has got a bottle of cooking oil at her disposal. Apparently as she got the oil, her facial expression changed. She rejoices for being provided with the cooking oil she was craving for. She grabs the bottle of cooking oil and describes it as a solace. All the members of the family look to the mother for food.

The most important activity took place in the kitchen where the woman prepared food. The woman instantly set fire and started cooking. All the households wait for food to be served sitting elatedly until the she brought it. She was also seen purchasing several bottles of the cooking oil from a supermarket.

Analysis of Advertisement 4

In this advertisement, the most important activity took place in the kitchen. The woman took the center stage. She breathed a sigh of relief when she saw the abundant cooking oil in the supermarket. She was seen purchasing several bottles of the cooking oil. Implicit in this advertisement is the stereotypical pattern of role assignment.

The discourse of this advertisement is that women are solely responsible for cooking for the family. No one in the family offered to help the woman in cooking the food. Such actions imply that they are part of the female nature and are therefore unchangeable. In other words, it leads to the formation and continuation of female identity as the sole responsible group for looking after family members. These situations strengthen gender stereotyping as they lead to the stabilization of the superiority of male and inferiority of female.

The portrayal of men in this advertisement implies that the male identity is not involved with this chore. Males are shown in this advertisement playing expecting food and relaxing in the living room. It is not just cooking in the kitchen that left to the woman in this ad, rather the whole process related to preparing food was the sole responsibility of women.

This advertisement implicitly shows the role of women to men (cooking food) by employing traditional beliefs. In terms of division of labor this act is gender based and is in contrast to the presumed endeavors meant to mitigate stereotyping. The discourse of this advertisement limits the role of women to the limited space of kitchen and disregards other role takings of women. Thus, portraying the woman as a solely responsible body for house chores such as cooking actually rejects the other meanings, and insists on the projection of the traditional female role confined to the domestic environment. In this ad techniques such as celebrity endorsement and scientific evidence have been employed in promoting the commodity pertaining to the discursive level.

Figure 4 cooking oil ad

Conclusion

The in-depth analysis of the TV advertisements revealed that the television commercials reinforce the traditional and conventional gender ideologies by constructing female and male identities differently. In particular the commercials not only fail to eliminate the distinction between the genders within the dominant discourse of patriarchal culture in Ethiopia by allocating specific tasks and certain behaviors to feminine or masculine nature; they rather reinforce this distinction. Thus, these commercials indirectly raise values that reinforce the traditional system of gender roles and the patriarchal ideologies in Ethiopia despite endeavors for pursuing gender equality.

In conclusion, gender stereotypes can play a crucial role in guiding and shaping attitude and behavior through an available bias. It is also important to note that biased media content leads many individuals to make inferences, because they are based on widely held stereotypes. Such stereotypical representations will encourage individuals to internalize the socially constructed image of femininity and masculinity presented in media content, thus helping to define femininity and masculinity, as well as acceptable gender roles.

Recently there have been persistent endeavors by both governmental and non-government organizations to shore up gender sensitivity. And it is undeniable that significant level of progress has been made. Despite all of these, gender role transformations endeavors, television commercials represent traditional gender roles of females and males. Apparently, there are contradictions of gender identity between the ads and society. This study suggests that the media, in particular TV advertising, should present the real gender status and roles and should balance the representation of females and males along with an evolution of

gender roles in the society in the future. Social marketers and policy makers should encourage non-gender biased messages in public announcement promoting gender equality. Advertisers should likewise discount the overuse of male-dominance to conform to social reality.

Acknowledgment

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The Oromo Knowledge Of Gender In Light With The *Xunduu* (Coupling) Synopsis In Arsii Gadaa Practices

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Abstract

The paper has aimed to propound the conception of femininity and masculinity in gada system focusing on a traditional expression of xunduu (coupling)synopsis. One of the different ways in the expression of femininity and masculinity in Arsii mainstream culture is the xunduu synopsis. Xunduu is a bipolar means to expressing female and male relationships in the pairing order of corresponding arrangement. Xunduu is a manner of presenting the overall female and male position and the power relationships between wife and husband in replicate to various entities which are highly essential and respected in their worldview. The research was conducted in some selected districts of both Arsi and West Arsi Zones. Data were mainly collected through systematic interviewing of both female and male elders and leaders of the localities, observation of their cultural landscape and ethnographic objects analysis. The finding indicate that, xunduu is a bipolar order with attributing a female and male beings in the cosmos, as a basic pillar and background source to Oromo knowledge of gender in egalitarian gada ethos. The result also shows that beginning with the social status of bipolar beings, things, items and objects, xunduu is a cultural form to expressing and presenting opposite sex partners, in a way everything is assumed and accorded. Hence, Xunduu is a synopsis whereby a wife and husband multidimensional ties expressions are made culturally in pairing terms of corresponding family arrangement. It recommended that as the culture is under strong pressure from internal and external forces, the paper calls for further study to preserve and enhance such thoughtful wisdom towards gender empowerment.

Key Terms: gender, xunduu, Arsii,wife-husband,

Introduction

A feminine-masculine is a biological opposite sex based socio-cultural expression of gender perpetuated, manifested and constructed in various forms and manners of human life (Manji, 2005:4; Stets and Bruke, 1997). Gender is a means of social organization and arrangement which could vary across culture, society, education, production system, and other determining factor (Kuwe Kumsa, 1991; Jeylan Wolye, 2004). Similarly that a different way to the expression of femininity-masculinity and their overall relationships in Oromo of Arsi mainstream culture is *xunduu*. *Xunduu* is a tradition, which dealt with the expressions of female-male relationships in a pairing term of corresponding arrangement. In its underlying

point, female and male beings are permanently interrelated and ever inseparable family life relational builders, as an expression and representation to cohesive social and natural world. *Xunduu*, is hence wife-husband multidimensional ties means of expression including the power relationships, marriage interconnectedness and sharing responsibilities in simulation to biological, non-biological and non-sexual. *Xunduu* is distinct from other gender forms of expressions owning to coupling and pairing one in relation to the other and in replicate to various entities which are highly essential and respected to underlie their importance in their worldview.

In *Xunduu* every major important thing of the universe forms its equivalent opposite partner like that of a female and male who are interrelated in wife-husband synopsis. As wife-husband are linked through marriage and formed a base of society, they are never delinked and appalling to be expressed in a

solitude manner. Solitude is halving as an expression to delinking and disconnectedness, which is an opposite of pairing, that it is being connected and cohesive. As to Dereje Hinew (2005) any unmarried and divorced is incompetent to the most important power holding position, *gadaa* leadership.

Similarly, bipolar means of gender expression is a commonest practices in the tradition of the western world (mostly in Europe) (Manji, 2005; Stets and Burke.1997). The west continuum oppositions for female-male relationships are But, it is argued that hierarchical system is an antithesis to egalitarian (Levin, 2007; Markakis, 1974) which deflates one to the other subordination. Cognizant with this, the positions of female were relatively better in the *gadaa* system than in the hierarchal society. In this regard, the positions of *gadaa* with the feminine have been substantiated to the arduous and physical labor nature of the system (Kuwe

contrastive as follows: subject-object, essence-appearance, culture-nature, passion-reason and passive-active respectively. The arrangement is, however, appeared hierarchical having the man at the top and the wife subordinate.
Kumsa, 1991; Jeylan Wolye, 2004;Alemayehu Haile and Boshi Gonfa, 2006; Daaniyaa, 2008). Specific to Arsii there were feminine led gender imbalances regulating institutions namely: the *siinqee (*feminine stick*), ateetee (mother* of fertility*), saddeetaa (*feminine council*), wayyuu* (notion of sacred*), and qanafaa (*postpartum*) etc. However, discussions made so far on the Arsi have not underlain this background knowledge

and worldview upon which the populace culture and life relied.

2. Methodology and Methods

Like most social science research it dealt with culture that involves claims of values and rights, in qualitative method of data collection. The study conducted on combining both historical and anthropological methodologies. Both methods of data collection from secondary and primary sources through literature review, interview, personal observation and analysis of cultural landscapes were employed. The data were systematically organized, examined and interpreted to produce the material. The research was mainly conducted in Kokosa, Munessa, Kofale and Dodola districts with both male and female elders, particularly custodian commoners (*Gada* leaders, the *Qaalluu/tti*, head of the *Saddeetaa* assembly,) civil servants and administrators. However, this is with the limitation to historicize the topic.

3. Result and Discussion
### 3.1. The Waaqeffannaa Religion and *Uumee-uumaa* Synopsis

One of the first fundamental views with gender ideology in the study area is rooted in Oromo indigenous belief system and creationist theory (Jeylan Wolye, 2004; Daaniyaa, 2008). The Oromo indigenous religion, *Waaqeffannaa* attributes the non-sexual identity of the divine God, *Waaqaa* explained as "*Waaqni hindhalu; hindhalchu*" (*Waaqaa* nevergive a birth nor got progeny) (Alemayehu Haile and Boshi Gonfa, 2006; Dereje Hinew, 2005). This creation theory which served as knowledge background and basis to worldview never perpetuates neither masculine nor feminine same identity of God (Bartles, 1983; Dani'el Deresa. 2002).

The religion again utters the earliest creatures of female and male were assigned into a twin productive realm: the *uumee (*the She*)* and *uumaa (*the He*)*.The *Uumee* and *Uumaa* synopsis *(*Jeylan Wolye, 2004*)* haspropounded female and male based independent stems of genesis i.e. the *uumaa* to the whole male, the *uumee* to the cluster of feminine as indicate below
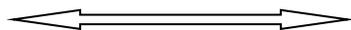
The She Realm (*Uumee*) ⟺ The He Realm (*Uumaa*)
      (Left)   (Right)

This gendered synopsis communicates the origin of everyone following its respective biological opposite realm, in a right-left side manner of arrangement. This indicates neither derivate nor subordinate of the one to the next.

Besides, the *uumee* is the realm of fertility and fecundity associate to female opposite the male. For instance, *Uumee* is ascribed as a supreme Females' Divinity for fertility and generation tree seeds. In the Oromo a dominant says that *Uumeen Walaabuu Baate* meaning all creatures
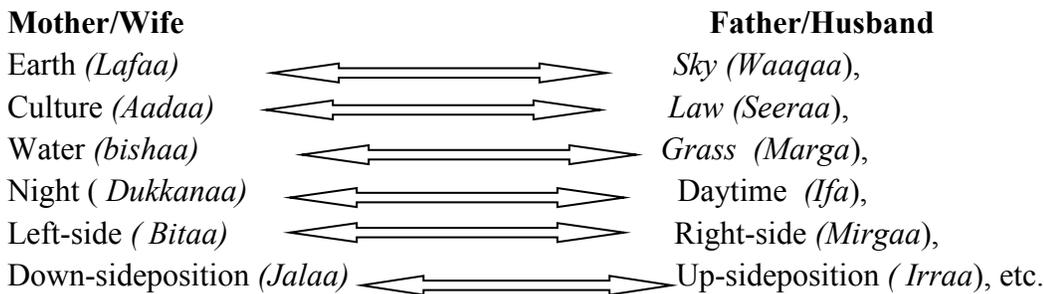
came out of Walaabuu implies the same thing (Alemayehu Haile, 2006).There were also other lesser Deities prayed for reproductive such as *Ateetee, Maaramaa (ibid: 110;* Negaso Gidada: 2001), *Aayyoo Baar,* etc (Ibsa, 2002).

3.2. The Synopsis of Non-biological Non-sexual Gendered Entities

The elevated concept of gender ideology raises femininity-masculinity is again raised in association with and given the identity to simulated objects and things of the non-biological non-sexual world. The synopsis defines and constructs non-biological nonsexual things and objects in gendered form copulating to a female and a male being and amid of their affiliations. To this view, relationships are expressed in a wife (mother) and a husband (father) synopsis as indicated below:

Mother/Wife   **Father/Husband**

Earth *(Lafaa)* ⟺ *Sky (Waaqaa)*,

Culture *(Aadaa)* ⟺ *Law (Seeraa)*,

Water *(bishaa)* ⟺ *Grass (Marga)*,

Night (*Dukkanaa)* ⟺ Daytime *(Ifa)*,

Left-side *(Bitaa)* ⟺ Right-side *(Mirgaa)*,

Down-sideposition *(Jalaa)* ⟺ Up-sideposition *(Irraa)*, etc.

In Oromo of Arsii culture, when women presents any complains on the assembly, it is usual to recall the utterances in front of the assembly saying, for *Waaqaa fi lafaa* (heaven and earth), *Margaa fi bishan* (grass and water), *ifaa fi dukkana* (for light and darkness), *aadaafi seera* (for custom and Law). Women are said to have made complain and the utterances to restore *Wayyuu* in the face of elders represented truth, laws and equality when it is being violated.

The duality of *Waaqaa* and *Lafaa* is explicated in husband-wife relationships and constitute the central avenue in Oromo indigenous belief system. Bartles (1983) explains, the sky is like a father who goes away while Earth is like a mother she is always with us. As the sky by causing and dropping rain does not raise life alone without the earth, which grows grass and food to living creatures so does the latter. For instances, the following sayings that: *waan Waaqni roobse dachiin biqilcha*, which implies what God causes to rain and the earth, grows it well. As the sky and earth relationships determined the universe so does father and mother to their children. Here, a bipolar of feminine and masculine implies the necessity of earth and sky both to be coinciding to sustain and ensure the whole living and non-living. When only both communicated creatures can live peacefully so does the replica female and male relationships (*ibid*).

In the Oromo customary law, there are two distinct social terms *aadaa* (custom) and *seera* (law). The former is known to individuals who belong to the same culture, while the latter is only known to who specialize in it.*Aadaa* refers to custom, habit, tradition, way of life etc and

was a symbol of identity, unity and oneness. *Seera* and *aadaa* are highly integrated to maintain the society in unity and the former protects the latter. It indicates females are more appropriate for maintenance of culture while the

males are for the laws (Dereje Hinew, 2005). This implies that as able bodied male provides protection for the family including his wife from an enemy, male sought his wife ritual and spiritual remedy.
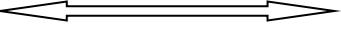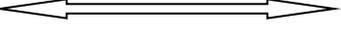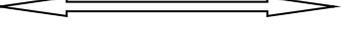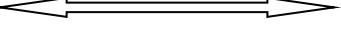
In Arsii cultural expression, a hope of change is vastly submitted to the power of nature and God at nighttime. It is usual to hear among the Oromo express their hopes for change "*waan halkan/dukkanni fidu maaltu beeka*" 'we do not know what thing/change night bring to us?. The night is a reproduction picks time as *dukkanni/halkan rimessaa (*fecund) that causes things to reproduce and replicate. The day (*guyyaa*) light-time is relatively considered to be 'infertile' *goga* as a male dried-womb. At the day-time many tasks are driven through the

power of light, compared to the nature of masculinity. In terms of changes prevalence, the night is organic than the day with that perfection and tranquility are most implied. In brief, femaleness association to night through maternity, the power over fertility and reproduction primarily eventuated. The Oromo listens to various happenings at night and forecasts the coming life. However, it is still when only both combining that only completeness eventuate, and one see full/complete cohesive day.

3.3. Non-sexual Organs of Human Bodies Gendered Synopsis and the Left-Right Dichotomy

Another means to gender relationships expressions are given with the replicas of human body parts. In the culture biological but non-sexual parts of human body are also given

with gendered forms of expressions. This dominant tradition among the Arsii constructs femininity and masculinity with following human body parts:

Female/Wife		**Male/Husband**
The two legs,	left-side ⟷	right-side
The two hands,	left-side ⟷	,,
Eyes,	left-side ⟷	,,
Nostrils,	left-side ⟷	,,
Ears,	left-side ⟷	,,
Lips,	upper-side part ⟷	lower-side part
Tooth jaws,	upper-side jaw ⟷	lower-side jaw

This pairing constructs that female and male are beings having identical roles and performing the same tasks free from exclusion

and partialness except the difference in social position.

3.3.1. The Right-Left Dichotomy Arrangement

In the anthropological work of like Dani'el Deresa (2002) the right-left dichotomy is presented to prevailing prejudices on female. But, the background knowledge in their tradition presents contrary to bear arrangements flowing the one entailed in *uumee-uumaa* synopsis. Assigning female to the left hand side

The left-right dichotomy majorly winds around the key view of life-saving and life-taking realm to which the opposite sexes are attributable with their lesser muscular and physical realm. Culturally, it is uttered that, the left side is associated to non-fighting, non-violent (evade holding and throwing spear) and defending /

Still, the customs are common in the family structure of the Oromo of Arsii, represented with three forks of feminine ritual stick named *siinqee Makkallaa.* *Siinqee Makkallaa* stick holds three limbs on its head representing: the father, mother and children at the same time. In accordance, while the middle limb represents a husband, the left side stands for a wife and the

Another indication is customariness Oromo build house to his/her sons based on their seniority. Accordingly, when the elder son constructs on the right sides of his family's

and male to the right is to entice the major social roles to which each is accounted for in life. As mentioned under the creationist mythology the earliest and first female creature stood to the left side of her opposite partner, male. According to my informants, this is why male customarily clinches his female lover in his left hands.

shielding a spear thrown from the opposite party roles left hand side. Similarly, both feminine and left hand side assumed overlapping roles of peace-loving, life-saving, non-fighting, and non-stubbing, while the right hand side symbolized life taking and violent tasks of males with iron materials.

right side limb bears children (Ginbar Negera, 2010). This is commonest in the southern parts of Arsii around Kokossaa, Dodolaa, Muneessa, Arsii Roobee and Kofalee. Indeed, such values of the society have deep rooted practices which need profound understanding of their past socio-political and religious life.

house, the younger's is to be on the left side (Mohammed Hassan, 1990; Alemayehu Haile and Boshi Gonfa, 2006).

3.4. Gendered Insignias and Title *Xunduu* synopsis

This is a pairing system of non-biological non-sexual entity particularly insignias to female & male relationships. Insignias are emblems of the socio-cultural life which perpetuate the highest author and sources of power which determining on the positions and status of a holder person. High socio-political and ritual emblems are

bearable sources of power, prerogatives, rules for social order and a means to executing temporal and religious functions both by male and female holder. A person's elevated status was determined on the respective matching emblem and title.

According to the knowledge, for every major important power and positions a male holds, his wife stood on besides correspondingly. The manifestations of their corresponding roles are prevailed through elevated insignias and title represents both beings. The pairing is submitted to the power of arrangement through the insignias. Affiliations amid of a wife and a husband could be elaborated subjected to the following insignias:

Female (Wife)	Male (Husband)
The priestess *(Qaallittii)*	The priests *(Qaalluu)*
The mother of Cacu (Haadha Caaccuu)	The father of *Kalacha (Abbaa kallachaa)*
Hnafala Gadaa (made from leather)	The father of *Bokkuu*
*Siinqee (*wooden stick*)*	*Horooroo/waddeessaa*
Saddetaa (female council in *gadaa* assembly)	*sadeetaa*(male council)

For every important positions of a male husband assumes there is a feminine equivalent ones. *Bokkuu* (scepter), *Kallachaa*, *Caaccuu* and *hanfalaa* were possessed by the members of the first born clans in a single family and lineage. *Bokkuu* is a respected emblem for male *abbaa bokkuu*, his female intimates and equates *haadha hanfalaa* hold *hanfala gadaa.*

Kallachaa is holding by the first born male spiritual leaders among the clans, a highlyrespected ritual symbols, an object for cursing and life-taking. While it's matching opposite sex partner is *caacuu*, hold by the wife for blessing and life-raising symbolisms. *Haadha Caaccuu* was women symbolic leader responsible for praying to abundance of well prospered fertility and invokes the *uumee* (the she creature) and *uumaa* (the he creature). As **B**esides male holder of *Waddeessaa/Horooroo* is the feminine insignia, *siinqee. Siinqee* is also an insignias for peace pacifier, counter against an iron object like spear, knife, and etc holder *Kallachaa* represented the *Waaqaa,Caaccuu* is the earth. As a male is essential for the fertility of a woman, *Waaqaa* that drops water is also crucial for the fertility of earth. *Abbaa Kallachaa* and *Haadha Caaccuu* are identified by possessing the ritual insignias and roles in the socio-political and religious life (Alemayehu Haile and Boshi Gonfa, 2006; Daaniyaa, 2008).

male. In this regard women and men of similar *gadaa* class have assumed symmetrical responsibilities.

3.5. Roles Based Gendered *Xunduu* synopsis

As to their culture, the background knowledge of gender is also lined up around parallel centric powers and contrastive social security: fertility and defense. The two are major issues of security from within and outside female and male accounted for are:

Female/wife	male/husband
Life-giving	life-taking

Fertility   dried womb

Spiritual   muscular

Domestic   wilder (hunter)

In accordance to the knowledge, feminine is represented with fertility and fecundity qualifying task. Fertility and defense are the two most determinant factors for society. Fertility is a means to ensuring the continuation of generation tree seeds from within and defense is protecting the land and country from conquest. Unless the balance of power in between both is maintained, the question of survival and continuance is threatened. Once female is life-giving class, tightened in birth and nurturing progeny, it is habitually impious to involve in an opposite realm activity. The more muscular is a higher life-taker engaged in outdoor activity and sinful for progeny, the more spiritual is a greater life-giver pursues fertility at indoor. Defending the land is an outdoor muscular physical activity, indentified to male's prime role to sustain society through their life-taking task and longtime services. Outdoor activities mainly military, hunting and laborious activities qualifying to the *gadaa* power transfer and assuming most important positions are fallen into masculine traits.

This is what Jeylan Wolye (2004) has stated as *Waaqaa* listens to women's desire and instantly responds to it. Women are believed to have natured to meditate and invoke God than men and they are closer to nature in their nurturing and life-sustaining features. While the able bodied male pursue physical realm and the female could do in non-physical through their pure nature. It is a manner of assigning dissimilar into contrastive positions; filling in the absence of the other which is not competing and contending.

3.6. Gendered Behaviors and Manners of *Xunduu* Synopsis

There are behaviors and manners based distinctions between a female and male being. Female and male features are characterized with certain defined behaviors and manners made to represent feminine and masculine. Feminine behaviors and manners are opposite of the male and the two formed bipolar session to form completeness in contrastive and from opposite extremes. According to my informants, the following are some of those the bipolar opposite characters trait represent feminine and masculine.

Feminine   **Masculine**

Softhearted   hardhearted,

Soften   muscular,

Non-violent   violent,

Sociable   non-surrendering,

Shrewder /discerning   forceful,

Pious   impious,

Sacred   sinful,

Innocent   vindictive,

Polite   impolite, etc

As indicated above, female and male have assumed contrastive continuum domains of life. However, the arrangement presents as a mutual opposite extremes than competing and subordination.

Irrespective of the past socio-economic, geo-military, political, etc conditions which will be determining on both behavior and manner, feminine were more modest than the male. The male aggressive nature was dictated by the type of activity and responsibilities accounted for mainly in relationships to defense from attack. In contrast to this, feminine is represented with more of civic, modest and signaled courtesy. The feminine manner was the most required one than the opposite.

It is mentioned that, anytime the ultimate goal of Oromo mottos was to be a *leemmoo (*Salviac, 2008). *Leemmoo* was the most humble, plain and modest behavioral and well mannered person. Characteristically, it is meant a descent, more of silent, affectionate, tolerance, patience and etc of a civil character traits that any humble Oromo individual own to attain in life. The male *lemmoos'* are those of the higher social class who had dropped the masculine realm and imitate feminine in all of their aspects: dressing, urinating, eating, roles, and etc. The*leemmoo* was a person whose characters, personality and actions testified the utmost criteria of purity, truth and greatness and could only visit the religious center and the land of anointment, *Abbaa Muudaa (*Salviac, 2008*;* Ginbar Negara, 2010*)*. Modest behaviors are the absolute features of feminine which is favored and imitated by males of the higher top class of *gadaa* (the pilgrims/ *jilaas*) who reached at the stage of tranquility finishing their masculine duty. Their roles were fostering life through blessing, spiritual services and etc. Thus, modesties were seminal traits commendable as the utmost qualifying behaviors as requirements for an individual of higher social, ritual and spiritual status.**T**his, on the other hand, implies the customariness of gender reversal before the decline of the tradition with the demolishing of *gadaa* system of governance.

4. Lesson Based on the Nature of Correlated Entities

The tradition of *Xunduu* prevails to a customary expression of female-male harness relationships. *Xunduu* typically addresses female-male non-separate bipolar arrangement and their inseparable means of expression. The discussion provided various gendered forms of nouns, expressions, perpetuations and presentations in simulating to female-male/wife-husband multidimensional ties. This expression constitutes of both in person and simulating to various entities varying from elevated social roles, beings of human body parts, behaviors and manners, to natural entities.

In*xunduu* every major important element has its own dissimilar and identical matching opposites that both are given gender representation and linked together in a female and male modeled wife-husband relationship. In accordance, the cosmos organization is held with female-male simulated perpetual harnesses and the outcome of the combined two. This is as if that, the relationships between wife and husband matters and determines on the universe. The expression

is a portrayal to what form, organization and arrangement the universe and elements within should hold together in their strict relationships. In general, it elucidates the creation of human,

Those paired entities are almost highly essential to determining on life in general and reputed social objects whose positions, roles and values are respected and their mistreatment feared for causing instability and end of life. As such that,

The discussion imparts that at the background all entities and objects included in the pairing by their nature are never subjected to vilify and denigration. No single paired entity and object prevails a lesser and/ better condition than the next. But, they rather prevailed to the essentiality of continuum. No part of the whole is established on subordinate and lesser/ greater

the nature of marriage relationships and family life, forms of societal organization, social-cultural structure, the arrangement pattern of life and orders of entities in the universe.

the objects are highly essential so does female and male relationships at a family and societal level should hold on to maintain and secure the nation.

importance relationships since the power of each correlated entities and the rules for correlations regulate the whole relationships. This has owning to the fact that, the surviving of one is only determined on its correlated matching party as the either can cause the opposite inhibited.

5. **Lesson from the Correlation Presentation Methods**

The multidimensional relationship expressional to a female and male being directly in person and simulated to various social and natural entities has followed a corresponded pairing order.This manner of various correlated similar and/ dissimilar things and objects organization as inseparable ones bear corresponding arrangement. This has entailed that *Xunduu* pertains to prevailing side by side arrangement

This is a manner of instilling the knowledge of gender into the minds of their child through replicated things and objects from their immediate surrounding environment. In accordance, since some of the objects are highly reputable, sacred and feared, wife is meant corresponding to the object represented her to

Various forms of representations in pairing order of corresponding arrangement and organization are made replicating wife-husband

in between female and male relationships. This paring order established on continuum relationships is a means to portraying one to the other type of correlations in avoidance of exclusion from almost all important areas of life. This perpetuates the normality of gender and its relationships beyond aiming of prejudices. The pairing seemed to be positively influenced by horizontal egalitarian gada system.

the husband and the reverse is also true. In this regard, one is meant exactly what the entity and object represented him/her. It underlies the essentiality of one for the other and the whole in general. In this regard, only in the strong presence of one next to another would compelorganichealthy.

relationships. As such that the representing entities are varying, owning to the type of category, the positions assumed in one to the

other relationships would not be unanimous. In this regard, the discussion is made in wide ranging representation and pertains to the following conclusion. One, they are alike being but only varying in social position and place held next to the other to form something whole. Again in indicates that, they are identical but given separate roles and functions that can never be presumed by the second. Third, they are non-identical and having different function but only in common could provide what are essential for others including the universe. Forth, they form opposites which assumed contrastive but mutually held towards the realization of healthier universe. In all of the expressions, they are not competing contrasts but independents absolutely tied in mutual order of nature.

6. Conclusion and Recommendation

In *Xunduu* bipolar expressions female-male beings are presented both in person and simulated to several entities varying from biological non-sexual to non-biological non-sexual categories, which are highly essential and reputable one. *Xunduu* explains what the female-male relationship would look like in cultural form of correlation to show the underlying inseparable and interrelatedness of one to the next. It seemed to be unique from traditional manner of coupling and binary expressions.

Coupling is a mannerism to expressing the relationships between two things and beings identical and/ opposite in essence and appearance but both are essential independent, simultaneously interdependent. For someone who sees into the background knowledge of gender, the separation into female-male is nothing than sharing activities along the labor division principles. Assigning female and male into varying positions and roles by itself does not necessarily present prejudice unless the manner of arrangement does not prevail to imbalance and dissect in picking order and subordinate way.Into what unequal positions and tasks both of them assigned simultaneously and differently prevail prejudice. The *xunduu* view of gender seems to be the way the populace had been addressing the problems of inequality and the sensitivity of the subject in their culture.

In order to do so, thus, the paper underlies the need to understand society from the background and with its own cultural points of view. In doing so, such indigenous values can be helpful in gender empowerment areas. However, irrespective of this, the past position of female in the study area was dominated by their male opposite partner and could never be free from their influence. Nonetheless, the condition of female was relatively better during the gada system than worsening prevailed later under the Ethiopian state empire. This happened with the demolishing of *gadaa* system of governance. But, in order to bring the experiences to the lights of today gender empowerment there needs to study the subject. The practice is limited to grass root level and its current positions are facing challenges from factors like globalization, expanding religion, modern education and including non-cultural conformity gender policy, etc. Thus, the paper calls for its inclusion for the purposes in the area.

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