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Volumetric Flow Rate

Yield Components in Fenugreek

Highlights

Moisture Content Effect

Cluster Analyses Based on Yield

Discovering Thoughts, Inventing Future

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Moisture Content Effect on the Volumetric flow Rate of Egusi-Melon (*Colocynthis citrullus*) Seeds through Horizontal Hopper Orifices

By Sabbas Nwabueze Asoegwu, Agboola Sunday Ogunlowo & Leo A. Sunday Agbetoye
Federal University of Technology, Nigeria

Abstract- Seed flow through hopperorifices is found in systems of dosing-filling-packaging; in hopper feeding systems; and in technological processes for control and/or monitoring.This study was aimed at establishing the relationship between moisture content and the volumetric flow rate (Q) of egusi-melon (*Colocynthis citrullus*)seeds as they passed through horizontal hopper orifices. It is observed that Q decreased as the moisture content increased due probably to the increase in internal friction as the moisture content increased as well as the change in bulk density with moisture. When egusi-melon moisture content increased from 6.76 to 18.9% d.b., the Q through circular and square horizontal hopper orifices decreased by about 5.36% from 3.5848 to 3.3926m^3/h (circular) and by about 4.36% from 2.3459 to 2.2436 m^3/h (square), showing higher Q for circular than for square orifice. Also, Q had a negative linear relationship with moisture content with $R^2 = 0.91$. However, for increasing hopper orifice sizes, Q increased with power regression with exponents ranging from 2.54 to 2.95 for both orifices and for equivalent orifice diameter (D_e) and hydraulic orifice diameter (D_h). This study is important for proper design of hoppers and outlet nozzles to facilitate uninterrupted egusi-melon seed flow rate.

Keywords: *egusi-melon, colocynthis citrullus, volumetric, flow rate, hopper, moisture content, orifice.*

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Sabbas Nwabueze Asoegwu [α], Agboola Sunday Ogunlowo [σ] & Leo A. Sunday Agbetoye [ρ]

Abstract- Seed flow through hopperorifices is found in systems of dosing-filling-packaging; in hopper feeding systems; and in technological processes for control and/or monitoring.This study was aimed at establishing the relationship between moisture content and the volumetric flow rate (Q) of egusi-melon (*Colocynthis citrullus*)seeds as they passed through horizontal hopper orifices. It is observed that Q decreased as the moisture content increased due probably to the increase in internal friction as the moisture content increased as well as the change in bulk density with moisture. When egusi-melon moisture content increased from 6.76 to 18.9% d.b., the Q through circular and square horizontal hopper orifices decreased by about 5.36% from 3.5848 to 3.3926m^3/h (circular) and by about 4.36% from 2.3459 to 2.2436 m^3/h (square), showing higher Q for circular than for square orifice. Also, Q had a negative linear relationship with moisture content with $R^2 = 0.91$. However, for increasing hopper orifice sizes, Q increased with power regression with exponents ranging from 2.54 to 2.95 for both orifices and for equivalent orifice diameter (D_e) and hydraulic orifice diameter (D_h). This study is important for proper design of hoppers and outlet nozzles to facilitate uninterrupted egusi-melon seed flow rate.

Keywords: egusi-melon, colocynthiscitrullus, volumetric, flow rate, hopper, moisture content, orifice.

I. Introduction

To ensure steady and reliable flow rate (measured as the mass or volume of the material per unit time) it is crucial to accurately characterize the flow behavior of the bulk materials (***Kamath et al., 1994***) through the orifice of bins, cylinders, funnels, hoppers, and silos. The flow of granular materials through these storage structures constitutes a problem extremely important in the design of hoppers and bins, other handling equipment, grain drills, among others. Information on the flow rate of egusi-melon through orifices of various sizes, shapes and orientations and the functional design of bins, hoppers and other storage equipment is needed to determine its flow and properly size the opening for flow control during transfer of grain from storage (***Gregory and Fedler, 1987; Wilcke et al., 1992; Wang et al., 1995a; Sahay and Singh, 2001).***

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Chang and Converse (***1988)*** found that the flow rates of wheat and sorghum increased as moisture content decreased. Using two grains (wheat and barley) and two oil seeds (flax and rapeseed) through circular, square and rectangular orifices, ***Moysey et al. (1988)*** noticed that the flow rates were affected by moisture content but not by bulk density of grain in the bin. These go to show that moisture is a key parameter when considering flowability of any granular material ***(Bhadra et al., 2008***), because most agricultural materials tend to gain or lose moisture with changing environmental factors, thereby affecting cohesive strength, arching and the frictional properties of bulk grains and seeds (***Marinelli and Carson, 1992). Seifi and Alimardani (2010)***posited that coupled with surface properties, moisture influences adherence properties between particles and materials handling equipment such as storage tanks, bins, hoppers, etc., leading to flowability problems.***Raymus (1984)*** said that moisture content is one of the most common and controllable flow factors. And that most materials can safely absorb moisture up to a certain point; however, the further addition of moisture can cause significant flow problems.

Discharge rates increase with increase in orifice size, more rapidly for smaller orifices, and appear to approach a power law for larger orifices (***Beverloo et al., 1961; Wang et al., 1995b; Sheldon and Durian, 2008; Janda et al., 2009***).The **Beverloo law** (Eqn. 1) is the most accepted law that predicts the flow rate of grains through an orifice with one most important and interesting issue: the dependence of flow rate on a 5/2 power of the diameter of the orifice, if the orifice is large (***ASAE, 2003; Mankoc et al., 2007).***

$$W_m = C_d \rho_b g^{1/2} (D - kd_e)^{2.5} \quad (1)$$

Where,
W_m = mass flow rate, g/min;
C_d = friction or discharge coefficient ($0.55 < C_d < 0.65$);
ρ_b = bulk density, g/cm^3;
g = gravitational constant, cm/s^2;
D = orifice diameter, cm;
d_e = equivalent particle diameter, cm;
k = shape coefficient ($1 < k < 2$);
kd_e = empty annulus, cm.

The Beverloo equation can describe the relationship between discharge rate and orifice size,

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however the constants in the equation may vary with the wall friction coefficient, particle friction and damping/moisture coefficients (***Zhu and Yu, 2004***). Volume flow rate is chosen by many researchers instead of mass flow rate as the parameter to express flow rate as a function of orifice diameter because an orifice has direct effect or control over volume flow rate rather than mass flow rate (***Chang and Converse, 1988***) and eliminates the differences in densities (***Moysey et al., 1988***).

Based on some prediction equations for flow rate through orifices taken from ***Gregory and Fedler (1987), Chang and Converse(1988), Moysey et al.(1988) and Chang et al.(1990; 1991***), the American Society of Agricultural and Biological Engineers (ASABE) developed a Standard for flow of grains and seeds through orifices (***ASAE, 2003).***The Standard gave the equation for predicting volumetric flow rate of grains and seeds as Eqn. (2).

$$Q = C_o A D_h^n \quad (2)$$

Where,

Q = volume flow rate, m^3/h;

A = area of the orifice, cm^2;

D_h= hydraulic diameter of the orifice, cm;

C_o= coefficient, $m^3/cm^{(n+2)}h$, varying for different crops *at* different moisture contents and different orifice hydraulic diameters;

n = exponent with value between 0.5 and 1.0.

Since the constants and exponents of the predicting flow rate equations vary at different seed moisture contents and orifice diameters, this work intends to determine experimentally these constants and exponents foregusi-melon seeds as they flow through horizontal circular and square hopper orifices.

II. Materials and Methods

One hundred (100) kilograms of egusi-melon seeds were purchased from the Eke Onunwa Market, Owerri based on estimation from the experimental design for the actual tests. The sun dried egusi-melon seeds were cleaned manually to remove all foreign materials, empty and broken seeds. The initial moisture content of somerandomly selected 200 g seeds was determined by using the standard oven method at 105 ± 1 °C for 24 h (***Gupta and Das, 1997;Altuntaşet al., 2005***). The initial moisture content of the seeds was 6.76% d.b. The seeds were then divided into six (6) batches of 18 kg each. Five (5) of the batches were conditioned to various moisture contents following the method of ***Balasubramanian (2001),*** Eqn. (3).

$$Q_m = \frac{W_i(M_f - M_i)}{(100 - M_f)} \quad (3)$$

Where,

Q_m = mass of water added, kg;

W_i = initial mass of sample, kg;

M_i = initial moisture content of sample, % d.b.;

M_f = final moisture content of sample, % d.b.

The amount of distilled water used for the seed conditioning and the final moisture contents determined for the five batches are given in Table 1.

After the conditioning of the seeds, they were all put in high density polyethylene (HDPE) bags, tied tightly and labeled, and then put in a functional refrigerator at 5°C.

Table 1 : Amounts of distilled water for seeds conditioning

Egusi-melon seeds			
W_i (kg)	M_i(%)	Q_m (kg)	M_f (%)
18	6.76	1.18	12.5
18	6.76	1.50	13.9
18	6.76	1.91	15.7
18	6.76	2.03	16.2
18	6.76	2.69	18.9

Two hoppers with upper and lower orifices of areas 240 and $60cm^2$ and circular and square shapes respectively, were constructed. Both hoppers have side slope of 70°, with heights of 12.0 and 10.63cm for the circular and square shapes, respectively. These give hopper volumes of about 900 and $800cm^3$ for circular and square respectively. Two slide gates with orifices of areas 16, 20, 30 40 and $50cm^2$ spaced 70cm each of circular and square shapeswere also constructed.

To determine the flow rate of the seeds at specific moisture content, a bag of the seeds was brought out from the refrigerator; left spread out on a cardboard sheet for 24 h to equilibrate to the room temperature of the laboratory, with their moisture content not significantly different from their original values. While this was going on, the hopper stand and the hoppers were brought out and one hopper mounted on the stand (Fig. 1), with the slide gate closed. The seeds were used to fill the mounted hopper, of known volume (V m^3). Three trial runs were made with each hopper to get used to and perfect the procedure for flow rate data collection from the different hopper orifices and also to condition the innerhopper surfaces for the experiment. With a stop watch ready, the slide gate was pulled out to open the orifice as the stop watch is started. At the end of the seeds discharge from the hopper, the stop watch was stopped and the time (t hr) to empty the hopper was read and recorded, and the slide gate was pushed back to close the orifice. Three replications were taken and averaged for each hopper orifice and moisture content. The volumetric flow rate (Q) was calculated from Eqn. (4).

$$Q = \frac{V}{t}(m^3/h) \quad (4)$$

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(a)

(b)

Fig. 1 : Experiment set up with square orifice (a); Actual test going on for egusi-melon (b)

III. Results and Discussion

The results of this work showed that the overall volumetric flow rate, Q decreased as the moisture content increased (Fig. 2) due probably to the increase in internal friction as the moisture content increased as well as the change in bulk density with moisture (***ASAE, 2003).*** For egusi-melon seeds, these decreases were 5.36% and 4.36% for circular and square orifices respectively as moisture increased from 6.76% to 18.90%.Even for vertical orifices ***Chang et al. (1988)*** found flow rate to decrease with increase in moisture content. Similar results were also observed by ***Wang et al. (1995b)*** who posited that for soybean meal, increased moisture increased the binding force at the surfaces of particles, thereby decreasing flowability.

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Bokhoven and Lohnes (1989) are of the opinion that cohesion increased with increasing moisture content decreasing volumetric flow rate.The Q was observed to be higher for circular than for square orifice, because for the same orifice area, the orifice diameter is higher for the circular than for the square. Again, the height and the overall volume of the hoppers were higher for the circular than for the square. Also, the linear regression model of the effect of moisture on the overall volumetric flow rate had the highest $R^2 > 0.91$ and given as Eqns. (5)&(6). It may be argued that the low sphericity of egusi-melon (0.414 – 0.466) made it flow faster through round orifice than through square orifice.

$$Q_{cm} = -0.0171M + 3.7163 \quad (R^2 = 0.9146) \qquad (5)$$

$$Q_{sm} = -0.0091M + 2.4159 \quad (R^2 = 0.9142) \qquad (6)$$

Where,

Q_{cm} = volumetric flow rate of egusi-melon from horizontal circular hopper orifice, m^3/h.

Q_{sm} = volumetric flow rate of egusi-melon from horizontal square hopper orifice, m^3/h.

M = moisture content, % d.b.

The Q increased with power law as the hydraulic orifice diameter (D_h) increased, though it decreased with increase in moisture content as shown in Fig. 3a & b for circular orifice and Fig. 4a & b for square orifice.The curves plotted on log-log scale paper of volume flow rate vs orifice diameter or the length of orifice side were nearly linear for all tests *(Chang et al., 1984).* Thus the flow rate can be expressed as a function of orifice size in the following form (Eqn. 7):

$$Q = \alpha D_h^{\beta} \qquad (7)$$

Where,

Q = volume flow rate, m^3/h

D_h = hydraulic orifice size (diameter or side length), cm

α & β = coefficients to be determined experimentally.

The function coefficients of the power regression models were determined using regression analysis and are given in Table 2 for horizontal circular and square orifices. At lower moisture contents of 6.76 – 13.9% d.b., the exponent on D_h for the volumetric flow rate of egusi-melon through circular orifice ranged between 2.8311 and 2.8705 while for higher moisture contents of 15.7 – 18.9% d.b. it ranged between 2.5405 and 2.5626.

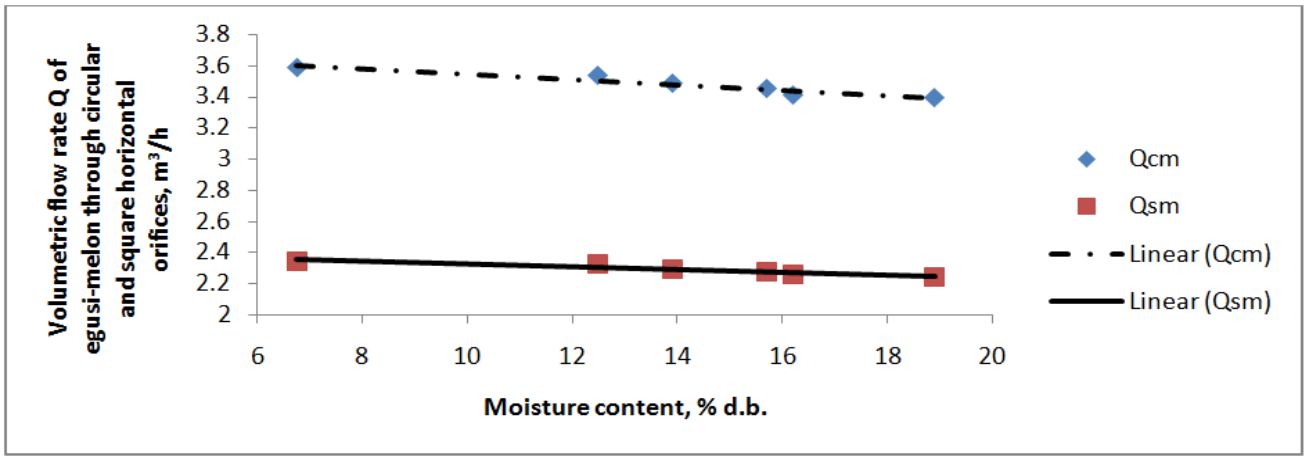
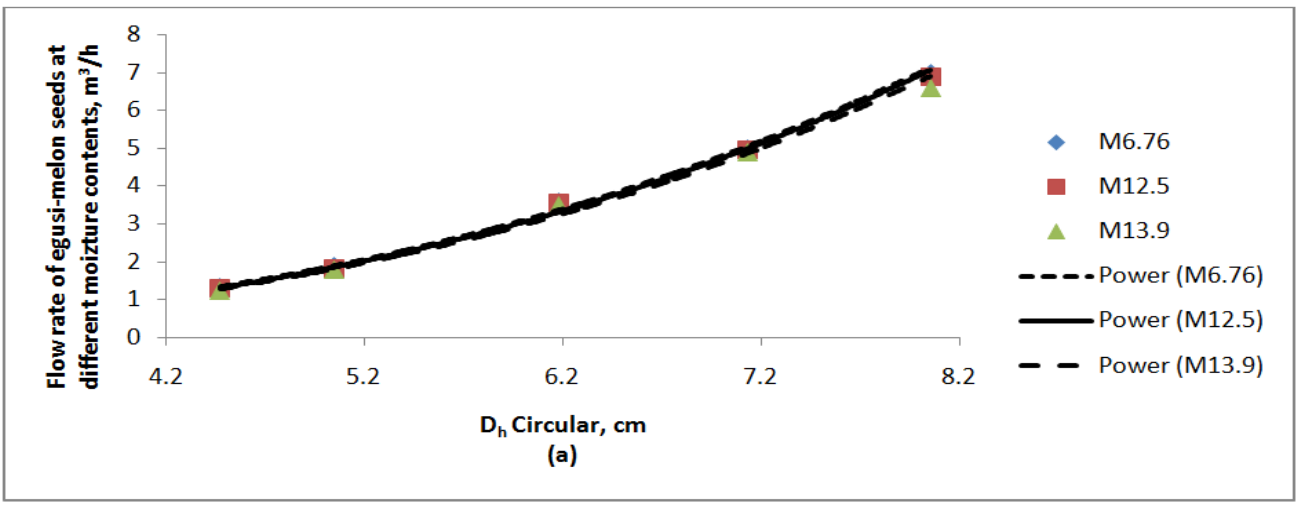


Fig. 2 : Effect of moisture on the volumetric flow rate of egusi-melon horizontal hopper orifices



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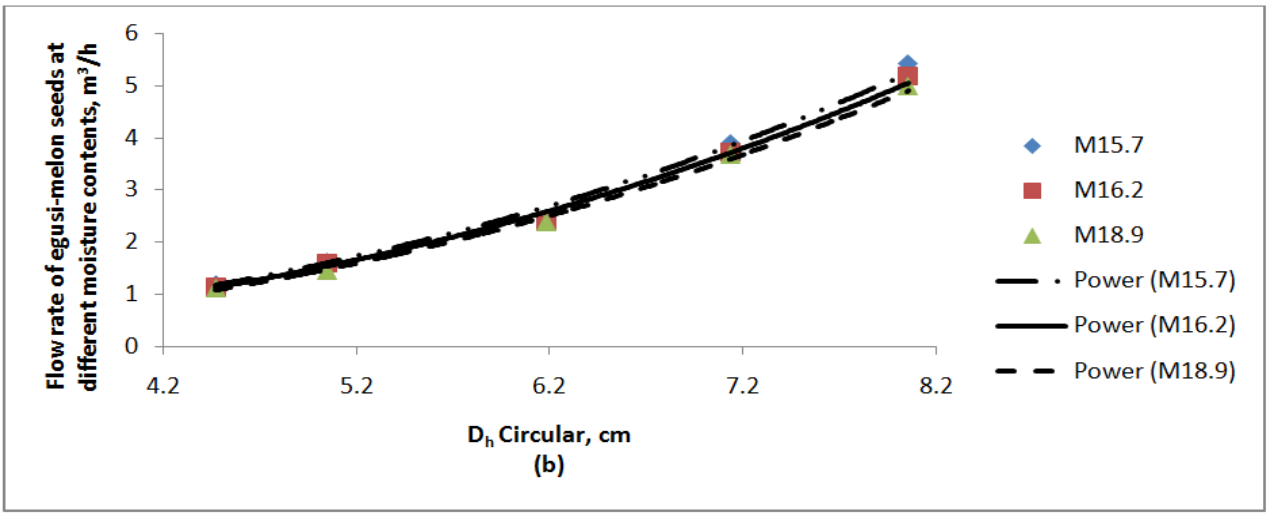

Fig. 3 : Effect of circular hydraulic orifice diameter on Q for different moisture contents

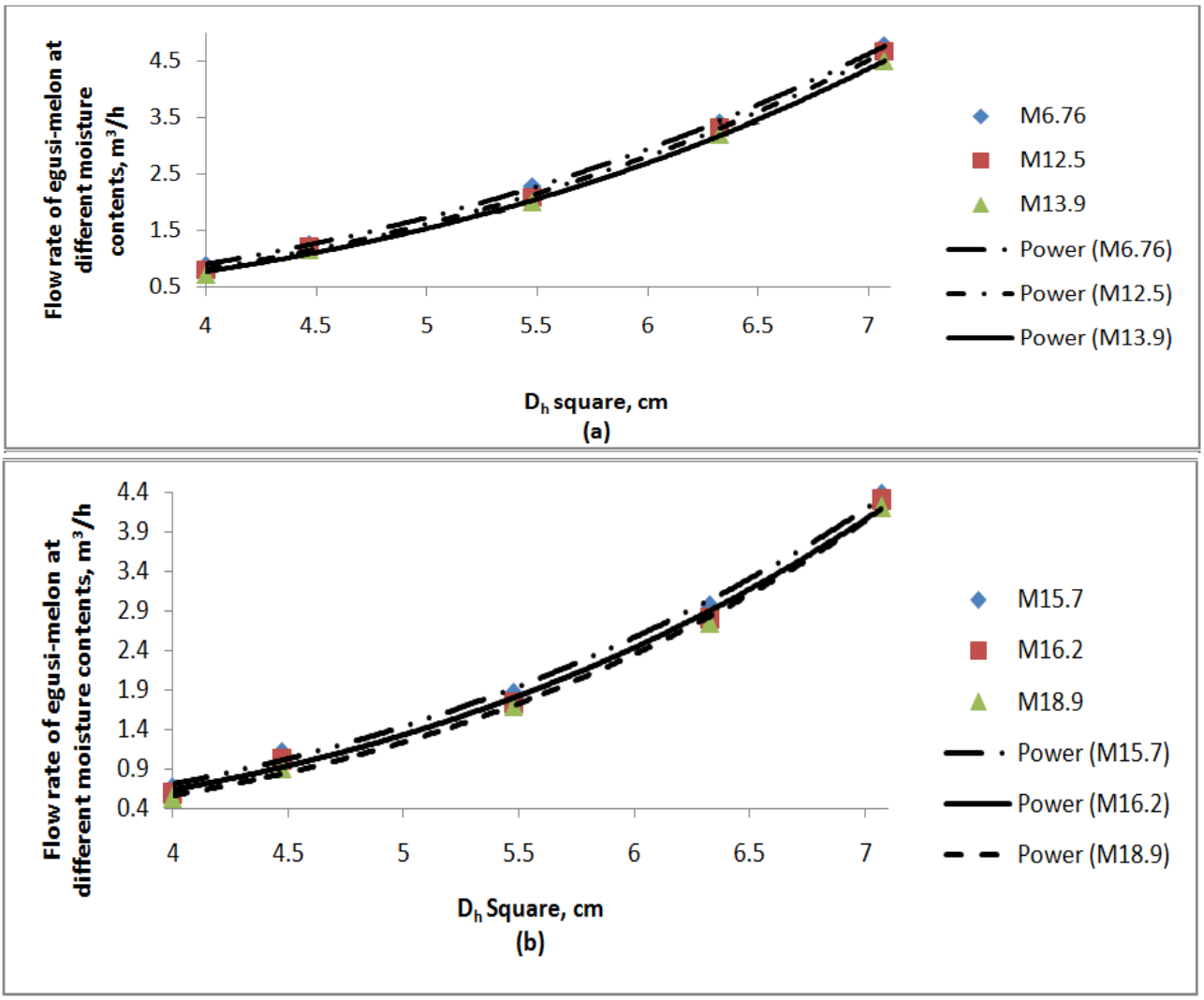

Fig. 4 : Effect of square hydraulic orifice diameter on Q for various moisture contents

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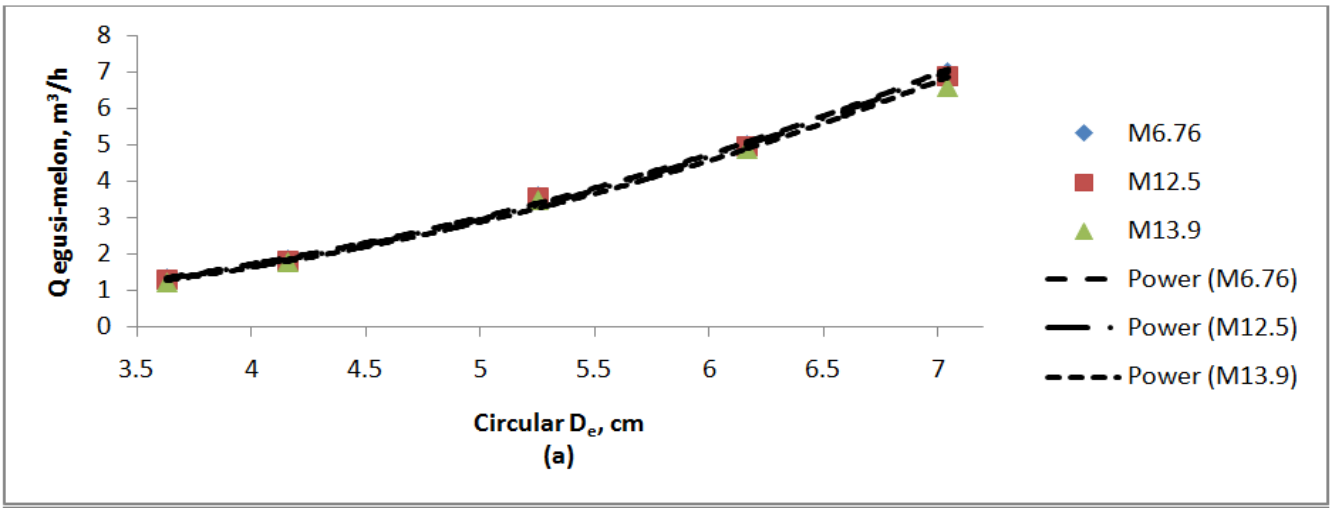
Table 2 : Coefficients of the equation* expressing volume flow rate of egusi-melon as a function of hydraulic orifice diameter

Moisture Content, % d.b.	Coefficients			
	Circular orifice		Square orifice	
	α	β	α	β
6.76	0.0194	2.8311	0.0159	2.9143
12.5	0.0180	2.8628	0.0124	3.0292
13.9	0.0173	2.8705	0.0102	3.1137
15.7	0.0261	2.5405	0.0088	3.1680
16.2	0.0259	2.5267	0.0065	3.3104
18.9	0.0234	2.5626	0.0045	3.4943

$$* \; Q = \alpha D_h^{\beta}$$

This is very informative as ***Chang and Converse (1988)*** working with wheat and sorghum at 12.9 – 15.1% and 11.2 – 17.7% w.b. respectively, got the exponent to range between 2.6394 and 2.6774 for wheat through the circular orifice. For the square orifice, the flow characteristics of egusi-melon seeds were similar to the circular orifice and the exponent on D_h ranged from 2.9142 to 3.4943 and higher than for circular orifice. For moisture content 13.9 – 18.9% d.b. the power exponent for the square orifice was high ranging from 3.1137 – 3.4943, quite above what were found in Literature. It is also higher than for wheat and sorghum for square orifice ***(Chang and Converse, 1988)***. For wheat and sorghum, they found the flow higher for square than for circular orifice of the same diameter/side length at lower moisture contents.***Morsey et al. (1988)*** working with wheat, rape, flax and barley within moisture content range of between 3.8 and 16.4% w.b. also found the flow rate of these crops to decrease with increase in moisture content.***Kusińska (2005)*** reported that the flow intensity of rape seeds through square orifice increased with decrease in moisture content from 8.4 to 17.6% d.b.Working with Olejarczykthey got the overall Q's α as 0.0173 while its β is 2.829 for oat grains through circular orifice ***(Kusińska and Olejarczyk, 2005)***. They found the flow rate to decrease with increase in moisture content between 8.9 and 13.8% d.b.

With the equivalent diameter, $D_e$the power law trend is similar to D_h as shown in Fig. 5a & b for circular and Fig. 6a & b for square orifices respectively. The coefficients are given in Table 3. Also the R^2 ranged from 0.9923 to 0.9981 for circular and from 0.9938 to 1.0 for square orifices. At high moisture contents of 15.7 – 18.9% d.b., the power exponents on D_e for Q of egusi-melon through circular hopper orifice were 2.2369 – 2.2693 which are lower than found in Literature.



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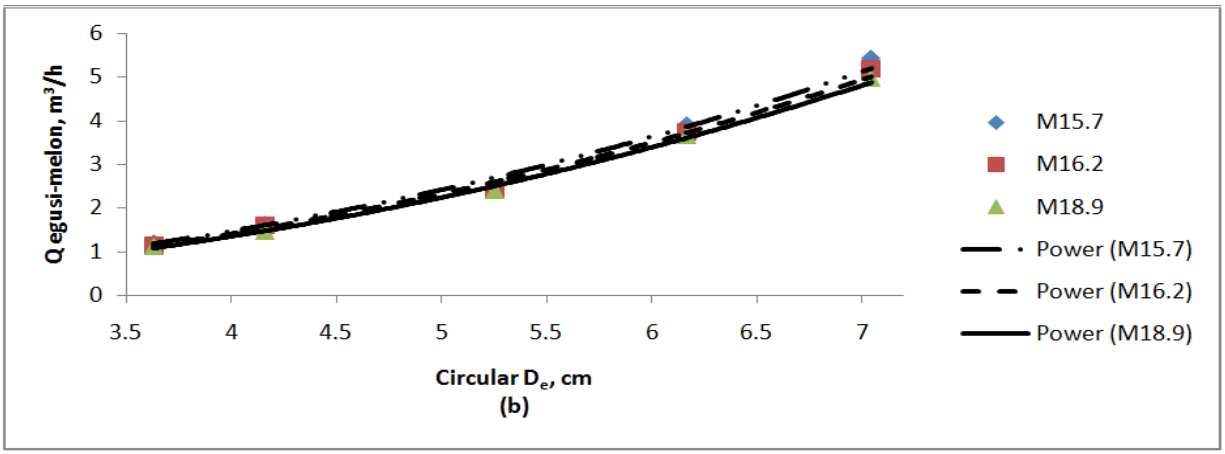

Fig. 5 : Effect of circular equivalent diameter on Q for various moisture contents

Table 3 : Coefficients of the equation* expressing volume flow rate of egusi-melon as a function of equivalent orifice diameter

Moisture Content, % d.b.	Coefficients			
	Circular orifice		Square orifice	
	α	β	α	β
6.76	0.0529	2.5085	0.0625	2.3727
12.5	0.0495	2.5368	0.0514	2.4662
13.9	0.0477	2.5440	0.0440	2.5356
15.7	0.0645	2.2489	0.0388	2.5801
16.2	0.0635	2.2369	0.0305	2.6961
18.9	0.0582	2.2693	0.0231	2.8459

$* \; Q = \alpha D_e^{\beta}$

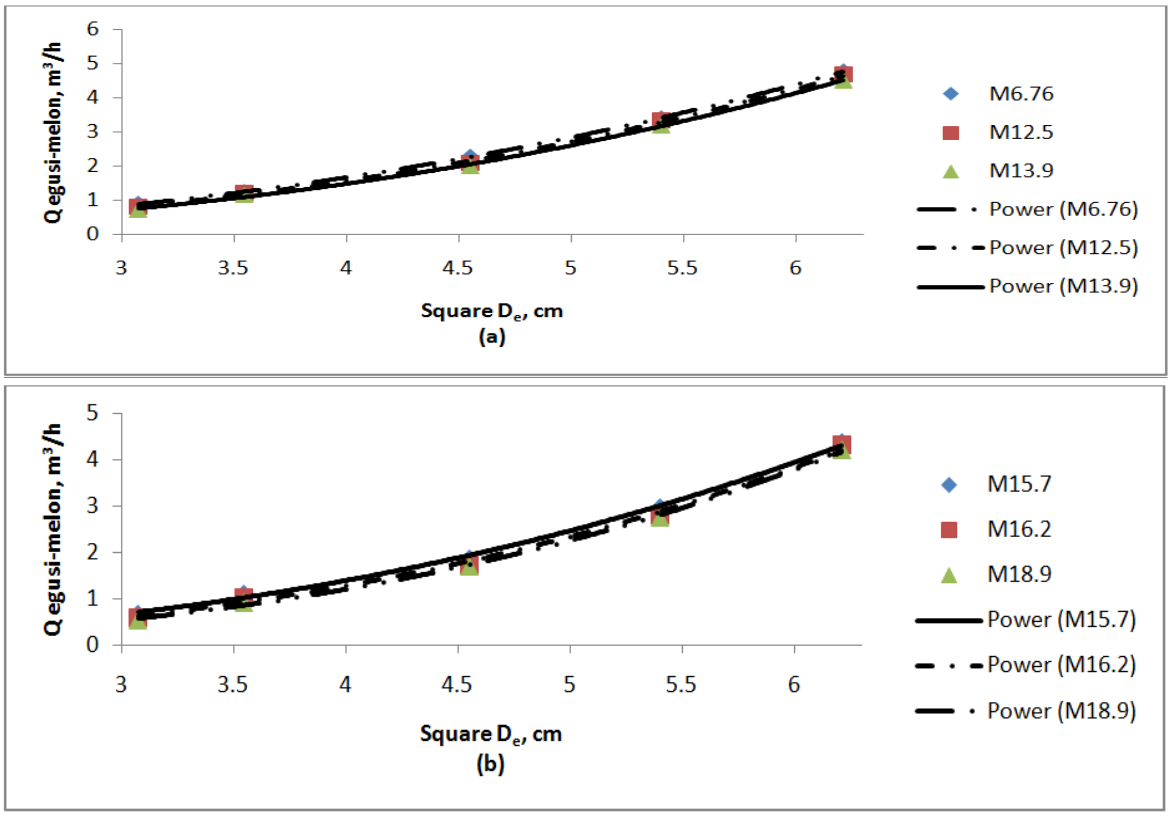

Fig. 6 : Effect of square equivalent diameter on Q for various moisture contents

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For lower moisture contents of 6.76 – 13.9% d.b. they ranged from 2.5085 to 2.5440 which are within the range found in Literature. However, the opposite was observed for the square orifice where for moisture content range of 13.9 – 18.9% d.b., the exponent ranged from 2.5356 to 2.8439 as found in Literature. It may be said, therefore, that for circular orifice and within the range of moisture content under review, use could be made ofD_h since the power exponent of the regression model is within the range found in literature. However, D_e is suitable with circular orifice for lower moisture contents and with square orifice for higher moisture contents.

Using the above Eqns. 5 & 6 for M = 7, 13 and 19% d.b., Table 4 shows the Q through the different orifice shapes. The differences in Q for the three moisture contents between circular and square orifices were 34.6, 34.2 & 33.9% respectively, decreasing as the moisture contents increased.

Table 4 : Volumetric flow rates of egusi-melon through circular and square orifices at M =7, 13 & 19% d.b.

Parameter	Moisture content, % d.b.		
	7	13	19
Q_{cm}	3.5966	3.4940	3.3914
Q_{sm}	2.3522	2.2976	2.2430

For circular and square orifices of the same diameter/side length (D_h = 4.472 cm), it is observed that flow rate was higher through the circular orifice as seen in Eqns. (8)&(9)and Fig. 7. The differences between the orifices increased with increase in moisture content from 5.26 to 18.75% as the moisture increased from 6.76 to 18.9% d.b.

$$Q_{cm} = -0.0011M^2 + 0.0100M + 1.3185 \quad (R^2 = 0.9397) \quad (8)$$

$$Q_{sm} = -0.0031M^2 + 0.0486M + 1.0724 \quad (R^2 = 0.9716) \quad (9)$$

For same hopper orifice diameter/side length (D_h = 4.472 cm), it is observed that Q has a polynomial relationship with moisture content with R^2> 0.93 (Eqns. 8 & 9).

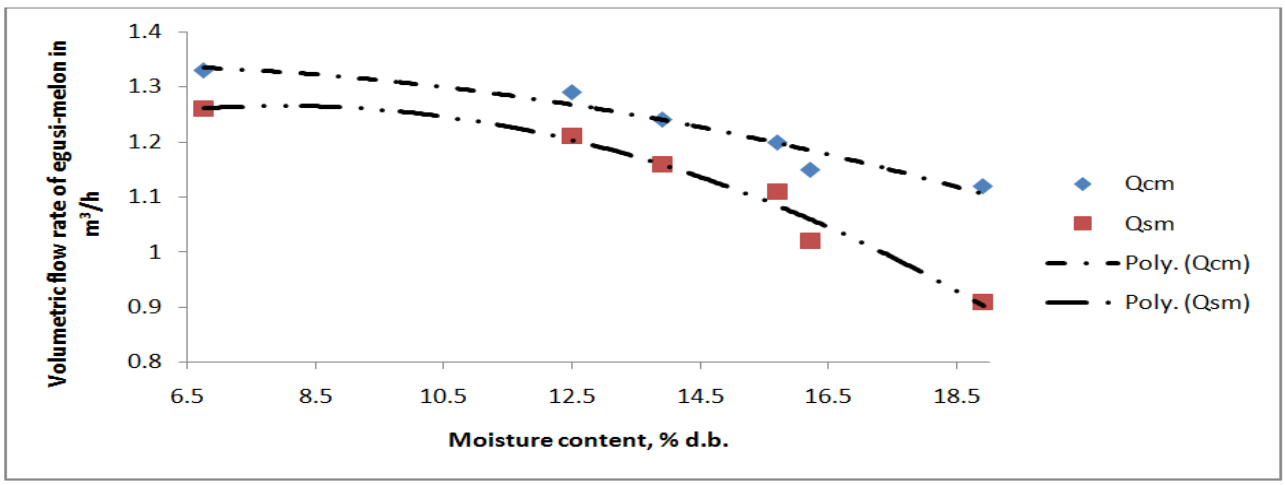

Fig. 7 : Effect of moisture content on the volumetric flow rate of egusi-melon through circular and square orifices of the same diameter/side length (D_h = 4.472 cm)

IV. Conclusions

For egusi-melon seeds, the volumetric flow rate generally decreased with increase in moisture content, linearly with R^2> 0.91. However, for the same hopper orifice diameter/side length, the decrease was polynomial with R^2> 0.93. Also, the flow rate is more through circular hopper orifice than square. As the hopper diameter/side length increased, the volumetric flow rate increased with power regression with the exponent ranged between 2.5267 to 2.8705 for D_h for circular orifice; 2.5085 to 2.5440 for D_e for circular at lower moisture content and 2.5356 to 2.8459 for higher moisture content for D_e.

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Studies on Supplementation of Graded Levels of *Millitia Ferruginea* Leaf Meal on Feed Intake, Growth Performance and Carcass Charactfers of Arsi Bale Goats

By Sisay Tadesse, Sandip Banerjee, Ajebu Nurfeta & Bangu Bekele
Hawassa University, Ethiopia

Abstract- The study was carried out to investigate the effect of supplementation of Millitia ferruginea leaf meal on intake, growth performance and carcass characteristics in intact Arsi Bale bucks fed a basal diet of grass hay. Twenty yearling male bucks with an initial body weight of 10.28 ± 0.96 kg (mean ± SE) were assigned to treatments using a completely randomized block design with four treatments i.e.T1 = 0% MLM + wheat bran+ maize and hay adlib,T2=2% MLM + wheat bran+ maize and hay adlib,T3=4% MLM wheat bran+ maize and hay adlib and T4=6% MLM + wheat bran maize and hay adlib One hundred gram concentrate mixture supplement was given twice a day in equal portions. The results indicated that there were no significant differences on feed intake, weight gain and feed conversion efficiency among the bucks receiving different treatments. The results pertaining to the carcass traits indicated differences (in percentage terms) in un eviscerated carcass weight and dressing percentage with values higher among the bucks reared on T3 ration the weight of the empty gastrointestinal tract was also different between treatments with higher values observed in the bucks reared on T4 diet.

Keywords: millitia ferruginea leaf meal, bucks, feed intake, growth performance and carcass characteristics.

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STUDIESONSUPPLEMENTATIONOFGRADEDLEVELSOFMILLITIAFERRUGINEALEAFMEALONFEEDINTAKEGROWTHPERFORMANCEANDCARCASSCHARACTFERSOFARSIBALEGOATS

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Studies on Supplementation of Graded Levels of *Millitia Ferruginea* Leaf Meal on Feed Intake, Growth Performance and Carcass Charactfers of Arsi Bale Goats

Sisay Tadesse [α], Sandip Banerjee [σ], Ajebu Nurfeta [ρ] & Bangu Bekele [ω]

Abstract- The study was carried out to investigate the effect of supplementation of Millitia ferruginea leaf meal on intake, growth performance and carcass characteristics in intact Arsi Bale bucks fed a basal diet of grass hay. Twenty yearling male bucks with an initial body weight of 10.28 ± 0.96 kg (mean ± SE) were assigned to treatments using a completely randomized block design with four treatments i.e.T1 = 0% MLM + wheat bran+ maize and hay adlib,T2=2% MLM + wheat bran+ maize and hay adlib,T3=4% MLM wheat bran+ maize and hay adlib and T4=6% MLM + wheat bran maize and hay adlib One hundred gram concentrate mixture supplement was given twice a day in equal portions. The results indicated that there were no significant differences on feed intake, weight gain and feed conversion efficiency among the bucks receiving different treatments. The results pertaining to the carcass traits indicated differences (in percentage terms) in un eviscerated carcass weight and dressing percentage with values higher among the bucks reared on T3 ration the weight of the empty gastrointestinal tract was also different between treatments with higher values observed in the bucks reared on T4 diet.

Keywords: millitia ferruginea leaf meal, bucks, feed intake, growth performance and carcass characteristics.

I. Introduction

Ethiopia possesses an estimate of 25.5 million sheep and 24.06 million goats (CSA, 2013) which are well adapted to the prevailing climatic and nutritional conditions and contribute significantly to the national economy (Alemayehu and Fletcher, 1995). Livestock also play important roles in the urban and per-urban areas as substantial populations are directly or indirectly dependent for their livelihood on livestock rearing or allied activities (Ayele *et al.,* 2002; Halderman, 2005).

The country's considerable potential of the livestock sector is reported to be untapped, according to the Ethiopian Revenue and Customs Authority report of 2009/2010, livestock and livestock products such as: live animals, skins and hides, meat and meat products, leather and leather products etc were Ethiopia's fifth most important export commodities next to coffee, oil seeds, gold and chat (*Catha edulis*) (Access Capital Research, 2010).

Therefore, it can be inferred that the livestock sector is important in Ethiopia for the economic development and for poverty reduction in general. Because of the potential of livestock, the present government is giving adequate emphasis to a market-led livestock development policy (MORAD, 2004). Despite large livestock population in Ethiopia, it was not possible to bridge the gap between the ever-increasing demands for livestock products (FAO, 2000).

There are various constraints affecting the livestock production in the country among which the major limiting factors include under nutrition and diseases. To mitigate the problems of feed availability and under nutrition the use of leaf meal from the perennial leguminous trees can be a viable option. Multipurpose trees provide a cheap source of protein supplement especially during the dry/lean season, when both the quantity and quality of pasture herbage is low. They are becoming particularly important in highly humid and agriculturally productive areas where the increasing human population has necessitated the cultivation of grazing land. Multipurpose trees can be integrated into the crop-livestock production systems as live fences, feed gardens, fodder banks, alley farms, wind breaks and multi-strata systems as sources of homegrown supplements for low-quality crop residues during dry season (FAO, 2010). The leaves of most of the browse plants have high crude protein content, ranging from 10 to more than 25% on dry matter basis hence they may be considered as a reliable feed resource (Okoli et al., 2003).

As indigenous multipurpose browse species *Millitia ferruiginea* is known to farmers in Ethiopia and is better adapted to the environments than its exotic counterparts. It is also important feed resource in traditional animal agro-forestry systems throughout the tropics but its potential as forage has been a subject of little research. *Millitia ferruiginea* is a nitrogen fixing leguminous tree species used as shade for coffee plantation and also for intercropping with other field

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crops especially in the Southern parts of Ethiopia, Berhanu et al,.(2012).

In addition, the feeding standards as well as the nutritional composition and quality of multipurpose trees especially *Millitia ferruginea* has not been yet studied in goats indicating the need for further study on different ruminants (Banerjee et al, 2013). In Sidama zone farmers use the leaves of *Millitiaferruginea* for feeding livestock especially during the dry season and they do so throughout the year for feeding small ruminants especially, goats. However, there is very little information regarding the effect of long term feeding of *Millitia ferruginea* leaf meal on growth, carcass and serum biochemical traits of bucks. So that, the present study was intended to bridge this gap as well as to evaluate the effect of feeding *Millitia ferruginea* on growth performance, quality measures and chemical composition of goat meat.

Objectives

- To determine effects of different levels of *Millitia ferruginea* leaf meal on the feed intake Aris Bale goats
- To study effects of different levels of *Millitia ferruginea* leaf meal on weight gain Aris Bale goats
- To study effects of different levels of *Millitia ferruginea* leaf meal on carcass characteristics of Aris Bale goats

II. Materials and Methods

a) Description of Experimental Site

The experiment was conducted at a commercial goat farm situated at Hawassa city which is located at $7^0.06$ '032 "west latitude and $38^0.47$' 67"east longitude and at altitude of 1650 m.a.m.s.l and characterized by sandy and loam soil. The annual rain fall of the area is 674-1365 mm. the average annual minimum and maximum temperature is 12^OC and 27^OC, respectively. The main rainy season extends from April to September interrupted by some dry spells in June and sometime in May to July (Adugna, 1998)

b) Feed Preparation

The study included twenty yearling bucks purchased from Tulla local market which is sub city of Hawassa. Fresh leaves of mature *Millitia ferruginea* trees were collected; the leaves were trimmed from the twigs and collected and spread on a plastic sheet. This was followed by shade drying for five days and then air dried leaves was then transported to the experimental site in plastic bags. Grass and wheat bran was purchased from a nearby private farms and markets shops, respectively. The purchased bucks were quarantined for a fortnight and then provided with appropriate antihelmenthic preparations and albendazole. The bucks were ear tagged in before adjusting the animals in to each treatments and blocks and after took weight of bucks in two consecutive days at the beginning of offering experimental feed. Then the animals were blocked according to their body weight and then randomly assigned to each treatment groups. Thus The bucks were provided with 100 g of concentrate comprising of 33 g of maize , 67g of wheat bran and 2 g of salt irrespective of the treatments, the bucks were also provided with 2 grams of common salt per day irrespective of the treatment throughout the experimental period. Hay was provided adlibitum (~15% refusal). The treatments are 0, 2, 4, and 6% MLM for T1, T2, T3 and T4 respectively.

c) Experimental design and treatments

The experiment was designed in a completely Randomized Block design (CRBD).The experimental animals were blocked into five blocks of five animals based on initial live weight, which were determined by two consecutive weightings after overnight fasting. The experimental treatments were then randomly assigned to each animal in a block giving five animals per treatment.

d) Feeding Trial

The growth trial lasted for the 105 days after the animals had adapted themselves to the environment. The feed was offered twice a day and prior to offering the feed the residual feed was collected back if any. The amount of hay was so offered and at the end of the day refusal feed was left back were collected. The amount of leaf meal was adjusted every fortnight to ensure that the required amount is provided in the diet since it is adjusted based on body weight to dry matter basis. Sample of the hay offered and refused were collected daily. The bucks were weighed at two weeks interval. The bucks were weighed in the morning hours after overnight fasting. Daily weight gain (ADG) was calculated as the difference between final live weight and initial live weight divided by the number of feeding days. Feed conversion efficiency (FCE) was calculated by dividing ADG by daily total DM intake.

e) Carcass Analysis

After completion of 105 days feeding trial, in four treatments totally 17 goats were deprived of feed and water for 12 hours. The slaughtering was carried out according to the method suggested by (Banerjee 2005). Pre slaughter weights were recorded and then the animals were slaughtered by severing the jugular vein and the carotid artery with a knife. The blood sample was taken using sterilized test tube for serum biochemistry. After the blood was poured the weight was measured to identify amount of blood and at the time when blood flow ceased, the skin was flayed and weighed with legs below the fetlock joints, and the head was cut and separated from the rest of the carcass and weighed. The alimentary canal consisting of esophagus, small and large intestine were weighed together without

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contents. The weight of offal such as head with tongue, skin and feet and internal organs namely liver, heart, lungs, kidneys, spleen, reproductive organs and, were also recorded. The weight of neck, foreleg, hind leg, and thorax, lumber were measured. The cross sectional area of rib-eye muscle between the 12th and 13th rib were traced on transparency paper from the right and left side and measured by using a planimeter (Portable area meter, model LI 3000A) , then the average the two cross sectional areas was taken for each bucks. Dressing percentage was computed as proportions of hot carcass weight to slaughter weight and empty body weight.

The total fat in meat sample was assessed using Soxhlet apparatus and according to the methods suggested by AOAC, (2000). 1 gram of oven dried meat sample was weighed on a digital balance and then folded in a filter paper. The sample was then being placed in a soxhlet apparatus and was refluxed using petroleum benzene (boiling point 60-80° C). The sample was refluxed for 30-40 times when it is expected that all the fat from the sample was transferred to the petroleum ether. The samples was then transferred to desiccators and allowed to cool overnight.

f) Chemical analysis of the Feed and Meat

The chemical analysis of the experimental feeds, i.e., hay, what bran, maize and *Militia ferruiginea,* and the mixtures of the latter three were done after taking the representative samples. Samples of feed offered, refusals dried in an oven to a constant weight at 60°C for 48 hours to determine the nutrient content. Partially dried samples of feeds were ground using laboratory mill to pass through 1mm screen size and the analysis was done at ACA animal nutrition laboratory. Dry matter was determined after oven drying of sub samples of partially dried samples at 105°Cto a constant weight. The OM, ash, and nitrogen (N) were analyzed according to the procedures of AOAC, (1990). The nitrogen content of feed and meat sample was analyzed by using Kjedahal method. The nitrogen content of feed and meat sample was analyzed by using Kjedahal method. Neutral detergent fiber and ADF were analyzed according to the procedures of Van Soest *et al.* (1991).

The meat moisture content was analysed according to the method suggested by AOAC, (1990) 2gms sample with 3 replication of was placed in Petri dishes and was oven dried at 70°C overnight, The sample was placed in desecrator overnight to obtain a constant reading. The difference of oven dried sample and original sample was indicate the moisture percentage The meat ash analysis was conducted according to the method suggested by AOAC, (2000).Two samples with 2 replication of was wrapped in a What man No 42 filter paper, which was then dried in a hot air oven at 125 °C overnight, till a constant weight was achieved. The sample was weighed to determine the loss in moisture. The crucibles along with the ash were weighed on an electronic balance. The total fat in meat sample was assessed using the methods suggested by AOAC, (2000). One gram of dried in 70°C over night meat sample was weighed on a digital balance and then folded in a filter paper. The sample was then placed in a soxhlet apparatus and was refluxed using petroleum benzene (boiling point 60-80° C). The sample was refluxed for 30-40 times when it is expected that all the fat from the sample was transferred to the petroleum ether. The sample was then transferred to desiccators and allowed to cool overnight. Then the sample was reweighed .The protein content was determined according to the methods suggested by (Kjedahal method).

Statistical Analysis

The data was analyzed statistically using SPSS V19 for Windows. The data was analyzed using descriptive statistics, mean, standard deviation. The means were compared using Duncan's multiple range tests while the growth of the bucks was assessed using repeated measure ANOVA. The sensory evaluation was assessed using non parametric tests (chi square). The values were considered significant $P<0.05$.

Model

$$Y_{ij} = \mu_i + b_j + e_{ij}$$

Y_{ij} =the overall effect

μ= overall means

b_j= effect of treatment

e_{ij}= error

III. Results

a) The Chemical Composition of feed ingredients and nutrients used for Arsi Bale goats fed natural grass hay supplemented with Graded Level of Millettia ferruginea leaf meal.

The results from Table 2 indicate that the average dry matter of content of MLM, maize and hay were more or less similar while the values for wheat bran were lower than the above mentioned ingredients. The results pertaining to the ash% indicated that the value was highest for hay and the lowest for maize with the values of wheat bran and MLM being intermediate of the two. The results pertaining to the crude protein content indicated that the value was highest for MLM while it was lowest for maize; the crude protein value had a wide range between the ingredients. The results also indicated that the ether extract value was highest for maize while it was lowest for the hay. The neutral detergent fiber (NDF) was highest for MLM closely followed by hay and the lowest value was assessed for the wheat bran, while the values for acid detergent fiber (ADF) indicated that the value was lowest in maize while it was highest in MLM.

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Table 2 : Chemical composition of feeds ingredients used in the study

Chemical of feed composition (%)	*Millitiaferruiginea* leaf meal(MLM)	Wheat bran	Maize	Hay
DM	93.23	91.58	93.07	94.53
Ash	3.21	2.83	1.04	8.68
CP	19.25	12.19	5.30	5.33
EE	2.88	3.21	4.02	2.25
NDF	69.53	47.44	57.74	65.99
ADF	32.07	13.45	5.5	17.28

DM (dry matter), OM (organic matter), CP (crude protein), EE (ether extract), NDF (neutral detergent fiber) and ADF (acid detergent fiber); T1= hay adlib + wheat bran +maize, T2=2% MLM+hay adlib + wheat bran +maize, T3=4% MLM+hay adlib + wheat bran +maize, T4=6%MLM+ hay adlib + wheat bran +maize.

b) *Daily Feed Intake of Arsi Bale goats fed natural grass hay supplemented with Graded Level of Millettia ferruginea leaf meal*

The daily feed intake of the experimental animals is presented in Table 3. The result indicated that the DM, OM, CP, NDF and ADF intake was highest for the bucks reared on T4 diet.

The results indicated that while the DMI and OMI was similar in bucks receiving T1 and T2 diets there was variation in crude protein (CP) intake which increased ($P<0.05$) with increasing levels of MLM

Table 3 : Average feed intake (g) of Arsi Bale goats fed natural grass hay supplemented with Graded Level of *Millettia ferruginea* leaf meal

	Treatments				SE	Sig
	T1	T2	T3	T4		
Intake (grams)	527 ^{d}	556 ^{c}	598 ^{b}	638^{a}	1.00	***
DM	513^{c}	524^{c}	560^{b}	601^{a}	1.00	***
OM	471 ^{c}	484^{c}	517^{b}	560^{a}	1.00	**
CP	39.4^{d}	42.2^{c}	50.2^{b}	55.9^{a}	1.00	***
EE	12.1 ^{b}	12.1^{b}	12.6^{a}	12.8^{a}	.98	**
NDF	285^{c}	297^{b}	290^{b}	329^{a}	1.00	***
ADF	84.6 ^{c}	84.6^{c}	101^{b}	123^{a}	1.00	***

$^{a\ b\ c}$ values across the columns differ significantly ($P<0.05$) DM (dry matter in gram),OM (organic matter),CP (crude protein), EE (ether extract),NDF (neutral detergent fiber) and ADF (acid detergent fiber)) T1= hay adlib + wheat bran +maize, T2=2% MLM+hay adlib + wheat bran + maize, T3=4% MLM + hay adlib + wheat bran +maize, T4=6% MLM+hay adlib + wheat bran + maize,

c) *Weight gain of the bucks of Arsi Bale goats fed natural grass hay supplemented with Graded Levels of Millettia ferruginea leaf meal*

The initial and final body weight and daily live weight change of the experimental goats fed on the different treatment feeds are presented in Table 4 and Figure 1.

The results indicated that there was no significant difference between treatments in all the parameters studied.

Table 4 : Growth performance Arsi bale goats fed natural grass hay supplemented with graded level of *Millitia ferruginea* leaf meal

Week	T1	T2	T3	T4	SE
Initial weight (kg)	10.28	10.26	10.24	10.32	Ns
Final weight(kg)	13.53	13.92	14.06	13.50	Ns
ADG(g)	30.95	34.86	38.2	30.28	Ns
Feed conversion efficiency	0.06	0.07	0.07	0.05	Ns

T1= hay adlib + wheat bran +maize, T2=2%MLM+hay adlib + wheat bran +maize, T3=4%MLM +hay adlib+ wheat bran+maize, T4=6%MLM+hay adlib + wheat bran +maize,

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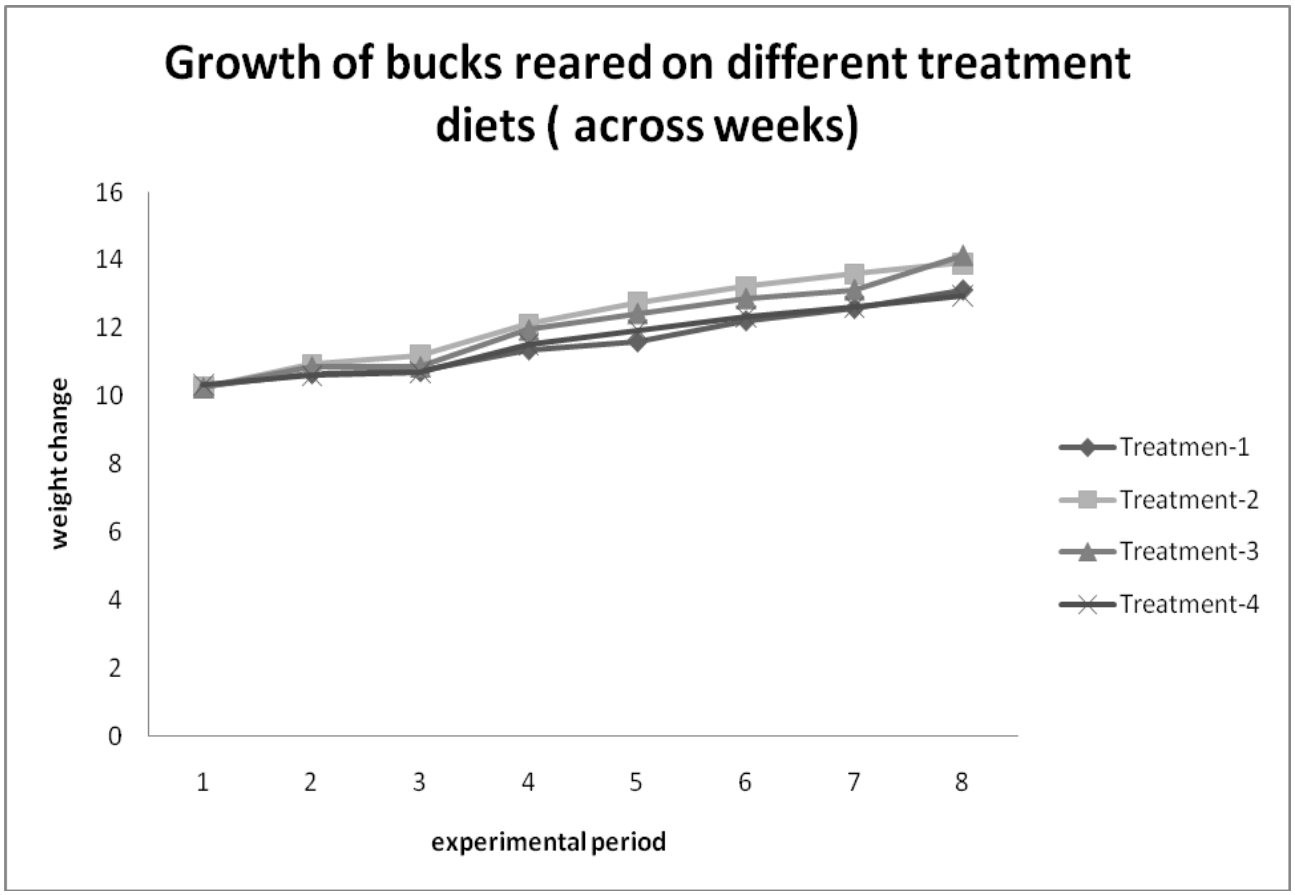

Figure 1 : Growth performance of bucks reared on different treatment diets across (across periods).

IV. Discussion

a) *Chemical Compositions feed ingredients and nutrients used for Arsi Bale goats fed natural grass hay supplemented with graded levels of Millettia ferruginea leaf meal*

The results as presented in Table 3 indicated that the dry matter (DM) content of *Millitia ferruginea* leaf meal (MLM) is higher than the values reported by Gidado *et al*. (2013) for browse species but lower than the values reported by Banerjee *et al*. (2013) for the *Millitia ferruginea* leaf meal. The difference may be attributed to the effect of season in which the leaves were plucked for the different experiments while in former the leaves were harvested in the dry season while in the present study it was harvested during the rainy season. The result also indicates that the values of NDF and ADF as obtained in the present study are higher than those reported by Banerjee *et al*. (2013). However, the percentage of CP and ash in the present study are slightly lower than those reported by Banerjee *et al*. (2013). The differences may be attributed to the age of the leaves plucked from the tree or because of geographical location. The observations are in accordance to the results of Kakengi *et al*. (2007) who also reported that there was variation in the nutrient contents of *Moringa olifera* leaf meal due to maturity and geographical location.

The NDF values for MLM as observed in the present study are higher than the threshold level of 60% beyond which the feed intake of the ruminants may be affected (Meissner et al., 1991) As reported by Jonathan *et al*. (2003) high crude fiber in feed affects the digestibility of polysaccharide. Similar to this finding Alemu *et al* , (2014) fed pasture hay for Washara rams supplemented with *Millitia ferruginea* leaf hay and observed absence of difference in apparent crude protein digestibility among the supplemented groups.

The result also indicates that the average value for ash for wheat bran is in accordance with the values reported by Awet *et al*. (2007). The average values for the ash (%) of maize is similar to those reported by Nurfeta *et al* . (2012). The study also indicates that the values pertaining to the ash (%) for hay are similar to the findings of Tolera (2008).

The low CP content of the MLM as was observed in the study may be attributed to the maturity of the leaves itself. Accordingly when the leaves becomes mature the crude protein declines which is similar to the results reported by Banerjee *et al*. (2013). The CP content of the wheat bran is similar to the observations of Nurfeta *et al*. (2012), however higher

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values were reported by Tolera (2008). The results also indicate that the average CP content of maize as was observed in the study are more or less in consonance with the findings of Tolera (2008), while that of hay was similar to those reported by Getachew (2005) and Sebsebe (2000).

The results pertaining to the NDF content of the wheat bran as was assessed in the study was higher than the result reported by Awet (2007), but similar with the findings of Stanton *et al*. (2010) while the NDF content for the hay are similar to those reported by Sebsebe *et al*. (2007), however, higher values for the NDF have also been reported by Tolera (2008). The NDF content of maize in the present study was lower than the values observed by Nurfeta *et al*. (2012). The NDF value for hay was similar to those reported by Nurfeta *et al*. (2012). The results pertaining to ADF values for wheat bran as were observed in the present study are in accordance with the findings of Abebe (2006) while that of maize is similar with the observations of Nurfeta *et al*. (2012). The results also indicate that the ADF values of hay are more or less similar to those reported by Nurfeta *et al*. (2012) while that of the wheat bran is within the lower range of values as reported by Nurfeta *et al*. (2012).

b) *Daily Feed Intake of Arsi Bale goats fed natural grass hay supplemented with Graded Level of Millettia ferruginea leaf meal*

There was a tendency of increasing DM intake with increasing levels of MLM which is attributed to the increase in the amount of supplementation. The results also indicated that enhancement of the total intake in the treatments enhance the intake of all the nutrients which are in close accordance with the findings of Hirut, (2008) who also reported that the dry matter intake improves linearly with the levels of supplementation provided.

The improvement in feed intake of the bucks reared on MLM supplementation may be attributed to higher crude protein content in the leaf meal thereby improving the palatability of the feed. This enables increased rate of digesta fermentation, hence increase feed intake and digesta passage rate go hand in hand. The findings are in accordance with the findings of Rehrahie*et al. (*2003) and Van Soest, (1994).The result is also in accordance with the observations of Nurfeta *et al*. (2009). In addition, the current findings are also in accordance with the observation of Banerjee *et al*. (2013) who also reported an increase in the intake of DM, OM, CP, NDF and ADF values with increased levels of MLM in the diet. The higher nitrogen content of MLM when compared to the other supplemented diets might be because the tree is leguminous and hence can effectively utilize the atmospheric nitrogen. The high protein content in the leaf meal indicates that it can serve as a cheap protein substitute especially during the dry season when there is fodder scarcity; similar results have also been reported by (Kassa, 2013).

c) *Weight Gain of Arsi Bale goats fed natural grass hay supplemented with Graded Level of Millettia ferruginea leaf meal*

The numerically low weight gain at higher inclusion levels of the leaf meal (T4) is in accordance with the findings of Banerjee *et al*. (2013). It may be attributed to the presence of condensed tannins in the MLM (4.13% as leucocyanidin equivalent) as was reported by of Banerjee *et al*. (2013). However, Alemu *et al.* (2013) reported that the level of condensed tannins in leaves of Millitia ferruginealeaf hay was 3.52%. A study by Cooper and Owen-Smith (1985), indicated that the threshold levels of tannins in small ruminants is 2% while it is 5% for large ruminants. However, the highest growth though not significant were observed in the bucks reared on T3 diet may be attributed to the low tanning content in the diet (when compared to T4 diet) and is similar with the findings of Makkar (2003) Several studies (Barry and Duncan, 1984; ; Barry 1985; Barry *et al*., 1986; Waghor*et al*., 1994); Pritchard *et al.*, 1988, 1992) indicated low feed conversion efficiency of rams receiving higher levels (>5%) of condensed tannins, while at lower levels (<5%) the presence of condensed tannin is beneficial for the animals. Studies (Van Soest 1982, Barry and Duncan, 1984: Waghorn *et al*. 1990) reported that higher levels of tannins impair the rumen function thereby affecting the digestibility. Condensed tannins have negative effect on N utilization by protecting from microbial digestion (Dicko and Sikena., 1992) thereby affecting nutrient availability. However, as reported by Krebs *et al*. (2007) and Majid *et al*. (2011) at a lower level the tannins may have a beneficial role by impairing the growth of the gastrointestinal parasites and thereby improving the feed efficiency. It also helps in protecting the crude protein which is thereafter available for digestion in the lower part of the intestine. The present findings are also in accordance with the reports of Banerjee et al. (2013) who also reported that at higher levels of inclusion of MLM there was depression of growth in rams, however, at lower levels there were improvement in growth as compared to those reared on control diet. Contrary to this study Alemu *et al*.(2014) reported significant difference in growth performance among washara sheep supplemented with *millitia ferruginea* leaf meal .

d) *Carcass Characteristics of Arsi Bale goats fed natural grass hay supplemented with Graded Level of Millettia ferruginea leaf meal*

The difference in the carcass traits can be attributed to the differences in weights of the visceral organs and also the edible and the carcass as a whole. The difference in neck weight may be attributed to the difference in weight of the muscles around the region.

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The differences in dressing percentage between the treatments is not consistent with findings of Banerjee *et al*. (2013) who reported lack of significant differences in dressing percentage of rams reared on different levels of MLM. The dressing percentage of the Arsi Bale bucks (irrespective of the treatments as assessed in the study are in close agreement with the observations of Samuel *et al*. (2013) who had fed cassava leaf meal as a supplement to urea treated teff straw (*Eragorostis te*f). The lack of significant differences in all other carcass trait is in accordance with the findings of Banerjee *et al*. (2013). In contrast to the present finding Banerjee *et al*.(2013) who reported significant difference in feed conversion efficiency of rams read under hay as basal diet supplemented with graded level MLM. Similar to the current finding, Alemu *et al.* (2014), reported that no significant difference in the rib eye area in Washara sheep reared on pasture/natural grass supplemented with *Millitia ferruginea* hay. Studies by Alemu *et al.* (2014), reported significant differences in some edible carcass parts like liver, heart kidney small intestine, kidney fat and abdominal fat of Washara sheep fed on pasture grass supplemented with *Millitia ferruginea* leaf mea, however no differences in the carcass parameters were observed in the present study the findings are similar to those reported by Banerjee *et al* .(2013) .No significant differences among the treatments in rib eye area, the average values are higher than those reported by Tesfay *et al*., (2008) for Arsi Bale goats. The values as assessed in the study are in close accordance with the observations of Schoenian (2009).

The lack of significant difference in non edible parts of the carcass agree with the result of Temeem *et al.,* (2012) who found similarity in the non edible offal's like skin, lung, spleen, head, blood and pancreas in Nubian, Desert and Swiss Nubian goat breeds vis-a-vis the native Sudan ecotype goats when fed with diets with different levels of energy and protein. The findings are also in accordance with the findings of Ukanwoko *et al.* (2012) who reported that the levels of supplementation with cassava leaf meal did not influence (significantly) on the non edible parts like weight of skin, feet, full gut, empty gut, kidney, heart, spleen lungs and testicles. The results are also in accordance with the findings of Banerjee *et al*. (2013) who reported no significant difference in non edible parts of carcass with supplementation of graded level MLM. In same way Alemu *et al*. (2014) reported no significant difference of non edible like head, skin, feet, and testicles in by feeding on pasture hay with supplementation of *millitia ferruginea* leaf hay. However, the same author reported some variation in non edible carcass like spleen and penis.

V. Conclusions and Recommendation

a) Conclusions

It can be concluded from the results that *Millettia ferruginea* leaf meal can be used for feeding the goats, but basically as a filler diet and in spite of difference in crude protein levels across the treatments there was no significant differences across the treatments. There were no significant changes in weight gain across the treatment groups. Significant differences were observed in unevicerated carcass weights, dressing percentages

b) Recommendation

Studies are needed to be carried out to study the effect of feeding the supplements for a longer duration may be 3-5 months growth trail. Studies too need to be conducted for assessing the effect of *Millettia ferruginea* supplementation on growing does and also on spent animals for assessing their response on growth. Studies need to be conducted by incorporating the young tender leaves as a feed supplement. as tender leaves are expected to have higher levels of protein.

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Analysis of the quality of the wool of Shetland Sheep Bred in the Czech Republic

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Abstract- On one selected farm the wool of Shetland sheep was analysed for two years. The wool was collected from animals of different sex and age, and also from different parts of their bodies. Our results indicate that that two-year rams have largest amount of wool (1.48 kg) with average length of 9.5 cm. Three-year rams have 1.78 kg of wool with average length of 9 cm. From one-year old sheep we collected 1.22 kg of wool with average length of 12 cm and from seven-year old sheep we collected 1.36 kg of wool but with shorter average length of 7 cm. The average finenesses of the wool from rams, sheep and castrated rams ranges from 24.81 μm to 26.86 μm. According to the measured values, we can classify selected animals form fine-wooled to semi-fine-wooled sheep. The finest woolis on animal's sides (24.5 μm) and shoulders (25.05 μm) the roughest wool is on the rump (27.59 μm).

Keywords: *shetland sheep, short-tailed sheep, shetland wool, fineness of wool, fleece.*

GJSFR-D Classification : *FOR Code: 300999*

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Analysis of the quality of the wool of Shetland Sheep Bred in the Czech Republic

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Abstract- On one selected farm the wool of Shetland sheep was analysed for two years. The wool was collected from animals of different sex and age, and also from different parts of their bodies. Our results indicate that that two-year rams have largest amount of wool (1.48 kg) with average length of 9.5 cm. Three-year rams have 1.78 kg of wool with average length of 9 cm. From one-year old sheep we collected 1.22 kg of wool with average length of 12 cm and from seven-year old sheep we collected 1.36 kg of wool but with shorter average length of 7 cm. The average finenesses of the wool from rams, sheep and castrated rams ranges from 24.81 μm to 26.86 μm. According to the measured values, we can classify selected animals form fine-wooled to semi-fine-wooled sheep. The finest woolis on animal's sides (24.5 μm) and shoulders (25.05 μm) the roughest wool is on the rump (27.59 μm).

Keywords: shetland sheep, short-tailed sheep, shetland wool, fineness of wool, fleece.

I. Introduction

Sheep were the first animals to be domesticated. This domestic animals are favourite because the universals benefits (wool, meat, milk), easy for breeding, the low dietary requirement and high resistance to weather conditions. Sheep was very important animals for cultural and religious ceremonies in the past. They were used as religious symbols and sacrificial animals (Heanlen, 2007; Kenner, 2007). Shetland sheep, Romanov, Finnsheep, Moorland, Gotland, Icelandic sheep are classified as a primitives breeds that originated territory is from Russia to Island,Greenland and several islands of Scotland. We classified them between the short tailed sheep *(Brachycerae)*, because they have got less than 13 caudal vertebrae (Ryder, 1983; Thomas, 2010).

Shetland sheep are very resistant animals with dual-coated wool. This breed has small body frame with good reproduction and milk quality (Friggen*set al*., 1997; Doane, 2015). They can be all year round outside on pasture with small shelter. It´s benefit for breeder, because they have smaller financial costs. These breeds have important function in keeping and using pastures, and grazing to heavily reach areas. Meat is the main product in breeding of short tailed sheep and their crossbreeding in Europe. Wool and milk are still considered like byproducts (Dýrmundsson *et* Niżnikowski, 2010).

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Shetland sheep belong to the breeds with long wool with a wide range of colour patterns and quality of fleece. Their classification by the fineness of wool isn't clear. The range of wool is dependent on climatic conditions, sex, age, health conditions act. Some authors and breeders indicate the Shetland sheepas semi-coarse wool breed (Horák*et*Treznerová, 2010), other says, that it is fine wool (Fair Isle Shetland Sheep, 2015). Shetland wool has 11 main whole colours and 30 recognised markings(The Shetland Sheep Society, 2015).

Thomas (2010) confirm in his paper that is not many studies about quality of wool of short tailed sheep occurring in North America. A last study was about the growth of the wool of lambs and ewes of Shetland sheep, percentage of inactive follicles in the fleece, length and average of fibres. And the difference colour of fibres behind winter and summer. The results of this study the secondary follicles become inactive in both sexes in September, but their new growing is faster. New grow starts from January to March, maximum growth was observed from April to October. The greatest growth was in lambs in July and in ewes in August. Pigmentation was reducing by decreasing the density of pigment granulesin the fibrein winter (Ryder, 1971).

Shetland sheep are kept in small herds especially in interest and small farms. It is the cause for the deficiency of scientific paper. As noted, the breeding Shetland sheep is popular for their unique look and unique fleece. The interest is constantly growing from consumers in the word.

Shetland wool is suitable for both dry and wet felting technique. It is also desirable for farm processing of final products (Anderson, 2001; Thomas, 2010). Tendency is to renew and strengthen the economy in breeding Shetland sheep in England. For example, the production of quality carpets from 100% Shetland wool (Liddle, 2007). Shetland wool has become popular for the unique features like insulation material in the construction industry. Wool industry was threatened by reduction in the quality of the wool due to crossing of Shetland sheep with meat breeds (Thomas, 2010). However Shetland sheep are good for crossing with Australian Merino. This soft wool breed is the recently often breed in England (Saul *et al*., 1992). In 1927, was founded,, Shetland Flock Book Society´´ to protect to this breed and it was prepared description of the breed

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standards. It was selected native endangered breeds of sheep. Measures were designed for their protection as genetic reserves. Hall (2004) said in his work that the Irish and Shetland sheep are among the highest priority for protection bred in England.

Shetland sheep is very popular breed also in America. Four rams and 28 ewes were brought to Canada in 1980. This native breed was brought to USA in 1986 (Doane, 2015). Shetland sheep are used breed for obtain a unique fleece. And demand for this fleece grows constantly (Thomas 2010). Number of Shetland sheep grows around the world. It is especially in England, North America andNetherlands. Also in Czech Republic increased the number Shetland sheep in recent years. It is especially in hobby and small farms (Bucek *et al*., 2013).

We focused on objective evaluation of fineness, length and the amount of Shetland sheep wool in Czech Republic, due to deficiency of scientific paper. These measured values were evaluated depending on the age of the selected animals and their sex.

II. Materials and Methods

a) Animals

Animals were selected for this experiment from the biggest farm of Shetland sheep in Czech Republic. This farm was founded in Mělník in 2005. Shetland sheep were imported from Netherlands in 2008. Since then, the farm name is Shetland Farm Mělník. They behave here 12 ewes, 2 rams, 4 castrate rams and 15 lambs (9 rams, 6 ewes) in this time. This farm is classified in monitoring performance. Altogether 22 Shetland sheep was included in our experiment (rams from 1-6 years, ewes from 1-9 years, castrate rams 1 and 3 years old).

b) Sample processing

Measurement of body size (height at withers and body length) and quantity indicators wool (length and quantity shorn wool) was performed during staple. Samples of wool were taken from various parts of the body - shoulder, side andrump. Samples were washed in petroleum ether, and then were colored with picric acid. Measurement of wool was photometrical at fourfold magnification microscope with a Nikon camera that is connected to the computer. Samples were evaluated after shooting PC software NIS-Elements AR, version 3.2. Each sample of wool was measured hundreds of times.

c) Statistical evaluation

The results were statistically evaluated by monitoring the program SAS 9.1 (SAS Institute Inc., 2003), multiple analysis of variance with the interaction of gender and year of birth.

$$Yijk = \mu + di + sj + (ds)ij + eijk,$$

Where: yijk = value of the trait; μ = overall mean; di = effect of age; sj = effect of sex; (ds)ij =sex and age interaction; eijk = residual error.

Significance levels $P < 0.05$ and $P < 0.01$ were used to evaluate the differences between groups.

III. Results

From the results shown in table 1 can be compared with the average values of the measured variables and their statistical significance in relation to sex, age and the interaction of these two indicators.

Quantity of wool is highest at the rams in the second year of life. The average value of wool is in annual males 0.78 kg and in two-year 1.48 kg. The average value of wool for four-year, five-and six-year rams is 1.20 kg. In castrate rams is a difference in the amount of wool depending on age, like as in rams. The average value of wool from one year rams is 0.95 kg and from three years rams increased to 1.75 kg. The measurement was performedon wool of females in selected between one and nine-yearpieces. The average value of a quantity of wool ewes range from 0.72 kg to 1.36 kg.

Wool of two years rams is the longest, it is 9.50 cm. Four years rams have the wool length shorter, only 6 cm. Difference was measured in the wool length of one-year and three-year castrated rams. Wool length of annual castrated rams was 7.32 cm and 9 cm at three years. The average wool length in ewes was in ranges from 5 to 12 cm. Withers height and body length increases with age to four year in rams. Ewes were measured at different values. The measured height at the withers ewes ranged from 50.66 - 60 cm. All of these values are statistically highly significant.

Other monitored characteristics of wool were the fineness of wool on selected body parts. The fineness of wool was monitored on shoulder, side and the rump. The average value of the fineness of wool on the shoulder rams are in the range from 22.97 to 31.15 μm, in castrated rams from 21.15 to 25.06 μm and ewes values were from 21.46 to 27 μm. The fineness of wool on the sideof the rams ranged from 20.35 to 27.92 μm, with rams 22 – 24.78 μm and ewes from 21.20 to 27.64 μm. The average value of the fineness of wool measured on the side of rams range from 25.99 to 36.54 μm. The average value of the fineness of wool measured on the side of castrated rams range from 24.13 – 24.78 μm and ewes 24.24 – 31.25 μm.

In our results, the fineness of wool statistically significant on the shoulder and side depending on age, sex and the interaction of these two factors. The fineness of the wool is not statistically significant on the side depending on the sex of the animals. But the age and the interaction of age and sex was demonstrated statistical significance.

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According the results of table 2, the values of the correlation coefficient are below 0.3. It indicates a weak dependence. Correlation coefficient determines the degree of dependence of two variables. The correlation coefficient of fineness of wool is 0.149 in samples collected on the shoulder and side. It is 0.148 on the shoulder and rump, and 0.229 on the shoulder and rump. And on the side and rump it is 0.147.

Consequently, the fineness of the wool measured at theshoulder, side andthe rump of the selected animals are dependent on each other very weakly. This means, that the diversity of the wool is minimal on the body of the Shetland sheep. For a comprehensive assessment of the fineness of wool, it is appropriate to take samplesfrom different parts of the body.

Relationship of the average value of fineness was scored in depending on the sex of the animals, it is in table 3. All age groups were included in the monitoring. According to the results, ewes have the fineness wool 20.81 μm, then rams 20.47 μm and castrated rams 20.86 μm. These results are statistically highly significant(at the surface evidential$<$0.0001).

The average fineness of wool is registered in table 4, regardless of sex or age of the animals. The fineness wool is in side (24.5 μm), shoulder (25.05 μm) and the highest in the rump (27.59 μm). These results are statistically significant.

Theaverage values ofthe fineness of wool taken from the shoulder, side and rump selected animals dependingon their age.The finest wool animals have one year to the side (20.99 μm) and the roughest wool was measured at seven years old animals on the rump(32.35 μm). Furthermore, it is evident from these results that the coarsest wool was measuredatall agesexcepteight year animal on the rump. These resultsare statisticallyhighly significant.

IV. Discusion

There are noscientific papers about quantity and quality indicators Shetland wool in depending on sex and age. Some scientists studied ideal composition of the diet of sheep (Iasone*t al*., 1994, 1995) or a growth and development of their sceletons (Friggens*et al*., 1997) or the occurrence of various diseases such as scrapie (Vilas *et al*., 2006). Ryder (1971) was studied Shetland wool. In his research, he studied cyclical follicular growth in Shetland wool. This research was focused mainly on quantity of inactive hair follicles and their pigmentation. It was measured at rams and ewes for three years, depending on the season. Anderson (2001) in his studies has focused on difficulty of processing method of Shetland sheep fleece.Some authors classify Shetland wool as semi-rough-wooled (Horak *et* Treznerová, 2010). The others authors describe it as a very fine (Fair Isle Shetland Sheep, 2015). The fineness Shetland wool ranges from 18 to 30 microns (The Shetland Sheep Society, 2015). Wool of this breed has a wide range of fiber fineness and fiber colors. According to our results, we can classify Shetland Sheep reared on Shetland farm Mělník in Czech Republic between fine-wolled to semi-fine-wooled sheep. This sheep have an average length of wool 5 to 12 cm. The wool length of Shetland Sheep bred in England is from 8 to 18 cm (The Shetland Sheep Society, 2015).

The demand for wool of Shetland sheep began to show increasing especially in small and hobby farms, despite the worldwide lack of interest. These results are unique benefit and provide important information for Czech breeders of Shetland sheep. According to our results, we can include Shetland sheep reared in the Czech Republic between fine-wolled to semi-fine-wooled sheep with length of wool 12 cm. The wool measured at various body parts of animals have different fineness. Fineness of wool in one animal is not uniform. It is necessary to analyse the wool of three parts (shoulder, side, rump) for the determination.

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Tab. 1 : There is the averagevaluesof the measuredvariables andtheirstatistical significancein relation to sex, age andthe interaction of thesetwoparameters

sex	age	QW (kg)	LW (cm)	HW (cm)	LB (cm)	Shoulder (μm)	Side (μm)	Rump (μm)
male	1	0.78	6.85	56.13	56.28	22.97	20.35	25.99
	2	1.48	9.50	63.00	66.00	27.12	27.92	31.45
	4	1.20	6.00	66.00	67.00	26.07	23.92	25.46
	5	1.20	6.00	66.00	67.00	26.29	21.85	30.88
	6	1.20	6.00	66.00	67.00	31.15	27.54	36.54
female	1	1.22	12.00	50.66	51.00	22.27	21.20	25.46
	2	1.34	9.00	56.50	58.50	23.23	24.88	29.34
	3	0.81	6.00	59.00	62.00	21.46	27.28	25.74
	4	1.14	11.52	57.37	64.00	22.39	21.92	24.31
	5	0.91	7.04	59.00	65.02	22.98	23.50	25.70
	6	0.72	5.00	58.50	67.50	24.67	27.64	24.24
	7	1.36	7.00	56.00	61.00	26.46	24.03	31.25
	8	1.25	9.33	59.00	63.33	27.00	25.88	24.96
	9	1.00	7.50	60.00	66.00	21.80	23.15	26.66
castrated male	1	0.95	7.32	56.70	58.31	21.15	22.00	24.13
	3	1.75	9.00	62.00	64.00	25.06	24.78	24.78

Conclus.

RMSE	0.187	1.678	1.441	1.963	4.968	4.878	6.875
sex	0.001	0.001	0.001	0.001	0.001	0.854	0.001
age	0.001	0.001	0.001	0.001	0.001	0.001	0.001
sex*age	0.001	0.001	0.001	0.001	0.012	0.0154	0.001

Abbreviated: QW – quantities of wool, LW – length of wool, HW – height at withers, LB – length of body, Shoulder – fineness of wool on shoulder, Side – fineness of wool on side, Rump – fineness of wool on rump.

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Tab. 2 : The correlationcoefficientindicating thedegree ofdependence of twovariables (fineness of Shoulder x Side, Shoulder x Rump, Side x Rump)

	Shoulder	Side	Rump
Shoulder		0.148	0.229
		0.0005	< 0.0001
Side	0.148		0.147
	0.0005		0.0005
Rump	0.229	0.147	
	< 0.0001	0.0005	

Abbreviated: Shoulder – fineness of wool on shoulder, Side – fineness of wool on side, Rump – fineness of wool on rump.

Tab. 3 : Average values offinenessof wool, depending on the sex of the animals

sex	the average value ofthe fineness ofwool (μm)	SEM	P-value
1	26.86	0.349	< 0.0001
2	24.81	0.198	< 0.0001
3	25.47	0.522	< 0.0001

Abbreviated: sex – 1 = ram, 2 = ewe, 3 = castrated ram

Tab. 4 : The average value of the fineness of wool taken from the shoulder, side and rump selected animals depending on their age

age	Body parts	Finenessofwool (μm)	SME	P-value
1	Shoulders	21.89	0.433	< 0.0001
	Side	20.99	0.433	< 0.0001
	Rump	24.83	0.433	< 0.0001
2	Shoulders	24.88	0.683	< 0.0001
	Side	26.14	0.683	< 0.0001
	Rump	30.11	0.683	< 0.0001
3	Shoulders	24.08	1.067	< 0.0001
	Side	25.94	1.067	< 0.0001
	Rump	26.26	1.067	< 0.0001
4	Shoulders	23.77	0.921	< 0.0001
	Side	22.31	0.921	< 0.0001
	Rump	25.29	0.921	< 0.0001
5	Shoulders	24.39	0.845	< 0.0001
	Side	23.04	0.845	< 0.0001
	Rump	27.25	0.845	< 0.0001
6	Shoulders	27.18	0.912	< 0.0001
	Side	27.86	0.912	< 0.0001
	Rump	28.41	0.912	< 0.0001
7	Shoulders	27.80	1.545	< 0.0001
	Side	24.31	1.545	< 0.0001
	Rump	32.35	1.545	< 0.0001
8	Shoulders	28.35	0.967	< 0.0001
	Side	26.16	0.967	< 0.0001
	Rump	26.06	0.967	< 0.0001
9	Shoulders	23.14	1.139	< 0.0001
	Side	23.42	1.139	< 0.0001
	Rump	27.76	1.139	< 0.0001

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Effect of Curing and Top Removal Time on Quality and Shelf Life of Onions (*Allium Cepa* L.)

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Abstract- Onion (*Allium cepa* L.) is an important vegetable crop for small and commercial growers in Ethiopia where it is produced for both the local and export markets. But loss can be as high as 66% during storage due to loss in bulb fresh mass and sprouting. A study was therefore, conducted with the objective of optimizing curing and topping time for maximum bulb and storage life of onion quality and maximum days of storage on Onion cv. Bombay Red, at Melkassa Agricultural Research Center, Ethiopia, from January to May 2012. Bulbs were cured under shade for 0, 5, 10 and 15 days, respectively. The tops removed immediately, or removed 5, 10 or 15 days after curing or not at all. The experiment was laid out as a RCBD factorial(4x5x7 curing, topping, storage time respectively) and each treatment combination replicated three times. Data were collected with 15 days interval up to 90 days after curing. Data collected included spouted and rotted bulb percentage, bulb total soluble solids (TSS), bulb dry matter, and bulb fresh mass total loss and bulb color.

Keywords: *TSS, marketable bulbs, bulb fresh mass, bulb dry mass, sprouting bulbs.*

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Effect of Curing and Top Removal Time on Quality and Shelf Life of Onions (*Allium Cepa* L.)

Getenesh Nega [α], Ali Mohammed [σ] & Temesgen Menamo [ρ]

Abstract- Onion (*Allium cepa* L.) is an important vegetable crop for small and commercial growers in Ethiopia where it is produced for both the local and export markets. But loss can be as high as 66% during storage due to loss in bulb fresh mass and sprouting. A study was therefore, conducted with the objective of optimizing curing and topping time for maximum bulb and storage life of onion quality and maximum days of storage on Onion cv. Bombay Red, at Melkassa Agricultural Research Center, Ethiopia, from January to May 2012. Bulbs were cured under shade for 0, 5, 10 and 15 days, respectively. The tops removed immediately, or removed 5, 10 or 15 days after curing or not at all. The experiment was laid out as a RCBD factorial(4x5x7 curing, topping, storage time respectively) and each treatment combination replicated three times. Data were collected with 15 days interval up to 90 days after curing. Data collected included spouted and rotted bulb percentage, bulb total soluble solids (TSS), bulb dry matter, and bulb fresh mass total loss and bulb color. The analysis of variance showed that a significant difference (P=0.05) in curing, topping and storage (after curing) time. Cured bulbs for 10 days and none topped combination showed that highest marketable bulb (65.56%), less moisture loss (34.43%), no rotted bulbs; minimum sprouted bulbs (23.5%) and less total loss (23.5%). Therefore, cured bulbs for 10 days and none topped bulbs selected as the best practice until 90 days of storage. This combination was the only treatment with the longer storage time with maintained quality; solve the shelf life problem and prolong the shelf life of 'Bombay Red' cultivar to encourage the cultivation.

Keywords: *TSS, marketable bulbs, bulb fresh mass, bulb dry mass, sprouting bulbs.*

I. Introduction

Onion (*Allium cepa L.*) is one of the oldest bulb crop, known to humankind and consumed worldwide. It is one of the most important commercial vegetable crop believed to be originated in Central Asia [17] and important vegetable crop grown in most parts of the world as food materials [21]. It is valued for its distinct pungent flavor and is an essential ingredient for the cuisine in many regions. The onion is preferred mainly because of its green leaves, immature and mature bulbs that used either raw or cooked as a vegetable. The bulb used in soups, sauces, condiments, spice, in medicine, seasoning of many foods and for the preparation of value added edible products like powder, flakes and salts [21].

Onion is important in the daily Ethiopian diet and all the plant parts are edible, although the bulbs are widely used as a seasoning or a vegetable in various dishes. It is one of the most economically important horticultural products in the country [1]. Edible alliums have been cultivated since ancient times. According to Boise [5], onion is a high value bulb crop produced by small farmers and commercial growers for both local and export markets in Ethiopia. It is an indispensable part of the daily meal of the Ethiopian dish as it improves the taste and scent of the food. Its production is concentrated in the central rift valley of the country, particularly in the upper Awash and Lake Zeway areas. Most of the farmers currently prefer 'Bombay Red' onion cultivar because of its early maturing character and in anticipation of reduction of production cost and time.

According to CSA report in 2006 [7], onion covered about 16578.72 ha of lands and more than 0.17 million tons of bulbs were obtained with an average yield of 10.6 tons/ha. The average yield of onion was 6.5 tons per ha which is far less than from the national and world average yield of 10.5 and 13.4 tons per ha, respectively [7,11].

Since onion is a seasonal crop sometimes with excess production, bulbs are prone to long storage, or farmers will sell in low price due to the postharvest and storage loss. Even farmers who store for next use will not be beneficial because of short storage life. As Biswas *et al.* [4] stated, after getting a good harvest of onion, farmers face storage problems in all conditions. Being a semi-perishable crop, onion is subject to deterioration during storage. Rotting, sprouting, and physiological weight loss cause storage loss of onions. Significant postharvest or storage losses occur in quality and quantity of onion including sprouting, diseases incidence, rotting and physiological weight loss due to variation in environmental condition, curing and drying method, storage condition etc. The shelf life of onion is influenced by various factors such as dry matter content, pungency, skin color, skin number and quality and length of natural dormancy period of the variety fertilizers and water regime during cultivation, treatment of sprouts suppressants and fungicides and postharvest factors (time and method of harvesting, curing and

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storage condition packing materials). Rabbani [23] reported that storage losses in onion could be as high as 66%. Many factors, such as cultivars, bulb maturity, moisture content of the bulb, temperature, relative humidity, etc. are associated with spoilage of onion during storage.

Curing is the most important operation in the post-harvest technology of onion that helps in reducing the post-harvest decay and moisture loss due to the removal of excess moisture from the outer skin and neck of freshly harvested onion to a level where shrinkage from the interior will be less and reduction in microbial infection. Storage methods and condition have their own impact on post-harvest life and keeping quality of onion. Storage temperature and relative humidity are related with sprouting, rotting, and physiological weight loss and with storage periods.

The purpose for curing onion is to remove excess moisture from onion scales and neck, thereby reducing infection from disease carrying organisms, and minimizing shriveling by removing moisture from the interior [28]. FAO [9] reported that, it is not recommend to cut-off the green tops of bulb onions for small-scale producers because it greatly increases the risk of losses from decay if the bulbs cannot be dried quickly under controlled conditions. In large-scale commercial production, where the green tops are cut-off mechanically before harvest, drying is often carried-out using artificial heat with forced ventilation. This technique is not economical for small-scale production. Field-dried onions for small-scale production can be stored for up to two months under ambient conditions in well-ventilated trays on pallets or in a field windbreak. As stated by Fritz *et al.* [13], if onions are to be bulk-stored it is best to store them without their tops.

Farmers are forced to sell the crop immediately after bulbs cured on the field at very low prices because of lack of storage awareness (topping without curing). Among other postharvest practices that can enhance shelf life of onion, proper top removal (neck) at appropriate time, curing for some days and keeping at good storage condition are the major one. However, the exact days of topping and curing need to optimum quality. The problem related to cv 'Bombay Red' is shelf life <3 months but proper leaf removal and curing before storing may enhance shelf life provided that it is done properly and timely. In view of the limited information on the appropriate curing and topping studies in the Ethiopian context and the concomitant high post-harvest loss and limited shelf life of Bombay Red, the determination of proper date to top removal and curing will be of paramount importance to producers and handlers. Therefore, the objective of this study was to optimize the number of days required for curing and toping of bulbs of onion cv 'Bombay Red' for better shelf life and quality.

II. Materials and Methods

a) *Description of the Study Site*

The experiment was conducted at Melkassa Agricultural Research Center (MARC) from January to May 2012. Geographically, MARC is situated in the eastern part of Ethiopia, at 8°24' North and 39°21' East with altitude of 1550 m above sea level. The mean rainfall for this area is about 928 mm with a mean maximum temperature of 28.5°C and a mean minimum temperature of 12.6°C. The average relative humidity is 56%.

b) *Experimental Material*

Onion bulbs used for this study were purchased from three local farmers and were all from the cultivar Bombay Red. This cultivar was selected due to the fact that this cultivar is recommended by the MARC because it is well adapted to this area in Ethiopia. Bombay Red is a high yielding cultivar with a growth season of 90-110 days. All bulbs were produced under the same management practices recommended by the MARC. The farmers were selected based on management practice i.e. they were following the management practice recommended by the MARC and they were model farmers. The bulbs were purchased from the farmers' farm during harvesting. All bulbs were collected on the same day.

c) *Treatments and Design*

The bulbs were sorted based on uniformity with absence of defects and then cured under shade for 0, 5, 10 and 15 days after harvesting then stored at room temperature (average 22.10 ^{O}C) under corrugated iron roof with shade iron mesh of onion store constructed at MARC until half of the stored bulbs became unmarketable. Topping was done immediate after harvesting and after curing treatment with the five days interval for 15 days (i.e. none topped (T0), immediate topped after cured (T1), topped after 5 days of cured (T5); topped after 10 days cured (T10) and topped after 15 days cured (T15)). After cured, the bulbs stored at room temperature under corrugated iron roof with shade iron mesh and then topped within five days interval. For storage, 18 kg bulbs from each cured day were taken and further grouped into three equal lots, each representing a replicate. The experiment was laid out in a 4x5x7 factorial experiment curing, toping and storage, respectively. The experimental design was RCBD because one side of the mesh storage room was covered by shade. There was no equal distribution of sunlight.

d) *Data Collected and Analysis*

Every 15 days interval the data were recorded on bulbs fresh mass loss (%), sprouted bulbs (%), rotted bulbs (%), bulbs dry matter (%), Total soluble solids (TSS) (^{o}B), bulbs color scale, marketable bulbs

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(%). The normality test checked; non-normal data transformed into $\log_{10}$ and statistically analyzed using SAS version 9.2. Mean separation was carried out using LSD (Least Significance Difference) test at $P<0.01$ and $P=0.5$ level.

The sprouting and rotted bulbs were counted separately in each treatment combination with interval of 15 days for 90 days and divided by the total number of bulbs then multiply by 100 to calculate sprouted and rotted percentage. Dry Matter was calculated as three healthy bulbs were randomly selected from each treatment, cut in to pieces, weighted, and dried by oven drier at 70°c for 2 hours and then checked until constant weight has been obtained then follows: dry matter percentage= (fresh weight/dry weight)*100.

Bulbs color scale was determined visually as qualitative data and changed to semi-quantitative at each storage period. The color of bulbs was rated as 5 (Deep Red), 4 (Red), 3 (Light Red), 2 (Pink) and 1 (Light pink). Marketable Bulbs (%) were recorded as: marketable bulbs percentage= (marketable bulbs weight/total bulbs weight)*100. Marketable bulbs excluded rotted and sprouted bulbs. Fresh mass loss was determined by the weight of the bulbs on 0 (initial weight), and 15 days interval for 90 days after storage using an electronic balance then follow: fresh mass loss percentage= ((P0-Pn)/P0)*100 where as P0= initial weight and Pn n^{th} days weight). Total loss was determined by using of the sum of sprouted and rotted bulbs.

III. Results and Discussion

a) Dry Mass (%)

The effect of curing, topping and storage combinations with the advancement of storage time showed a highly significant difference ($P<0.01$) regarding dry mass percentage. It showed that gradual increment in both curing and topping treatments until 75 days storage (Fig. 1). Gradual increment of dry matter content could be resulted from lower moisture content of the bulbs that regardless drying and helped to increase in chemical constituents leading to the ultimate accumulation maximum dry matter. A finding by Hansen and Henriksen [15] showed slight increase in dry matter that was due to loss of moisture from the outer surface whereas the reduction corresponded well to hydrolysis of fructans and termination of the dormancy period where the bulbs began to sprout. This finding is in agreement with Pak *et al.* [22] who indicated that through storage, fructans were gradually hydrolyzed to fructose increasing dry matter during initial storage weeks and at the time of sprouting, sucrose was synthesized and transported to the sprout and basal plate for growth. Similar finding [32] reported that composition of cured and not-cured shallot bulbs showed that the treatments had highly significant effect on dry matter content of cured bulbs at harvest and during the first two weeks of storage.

b) Bulb Skin Color

The color development of stored bulbs showed a statistical difference ($P<0.01$) with the combination of curing, topping and storage (after curing) time. At the beginning of storage, the bulbs were light pink color then it changed to pink (15 days after storage) and light red (30 days after storage) in curing and toping combination (Fig. 2). Light redness was constant until 90 days for all combinations. The bulbs color changes might be the reduction of flavonol and anthocyanin glucoside concentrations found in the skin tissue during storage [29].

c) Total Soluble Solids (TSS)

The combination effect of curing, topping and storage (after cured) time showed a significant difference ($P=0.05$) on TSS value. There was no clear trend on TSS value during 90 days storage after curing. However, the maximum (15.67) TSS was observed in with the combination of C5T1, C15T0 and C15T10 during 15 days storage; C15T0 during 30 days storage; C15T0 during 45 days storage and C15T0 and C10T0 during 60 days storage (Table 1). According to EARO [11], the TSS of Bombay Red is 9.00 – 11.00 °Brix. The maximum value of TSS might be due to proper drying of the bulbs and the conversion of polysaccharides into soluble form of sugars [26]. According to the finding of Wheeler et al. [31], lowest level of TSS appeared with uncured and non-topped bulbs and the highest for cured and non-topped bulbs, which was 13.17 % and 15.87 %, respectively stored for 400 days. These authors described that the difference for TSS was the movement of TSS from the foliage to the bulb until total fall over of the top and that bulb loss moisture by curing increase concentration of soluble solids of the bulb.

d) Marketable Bulbs

Curing, topping and storage (after curing) time combination significantly ($P=0.05$) affected the percentage of marketable bulbs. The percentage of marketable bulbs started to decline after 15 days of storage (Figure 3). On the 60^{th}day, 60% of the treatments had 70 to 80% of marketable bulbs. On the 75 days, 5% treatments had 70 & 80% marketable bulbs. On the 90th day, 90% of treatments recorded a value of <50%. The minimum value of 15.3 % was recorded in bulbs without curing and topped after 15 days of curing during 60 days of storage. The maximum marketable bulbs were recorded curing for 10 days and without topping (65.56%) during 60 days of storage. This might be due to immediate or topping after curing may favor for rot diseases, which increase rotted bulbs (Figure 4). Storage (90 days) without curing or storing after 5 days curing would also not be suitable for long time storage. It also may create good environment for disease development.

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e) Bulbs Fresh Mass Loss

The effect of curing, topping and storage (after curing) combinations showed a significant difference (P=0.05) on bulb fresh mass loss. With the advancement of storage period, the bulbs fresh mass loss was increased (Figure 5). Except bulbs cured for 10 days and none topped bulbs in which the fresh mass loss was 34.43 % on the 90 days of storage. The maximum fresh mass loss was 71.33 % on the 90 days of storage when the bulbs were cured for 15 days and topped after 5 days of curing.

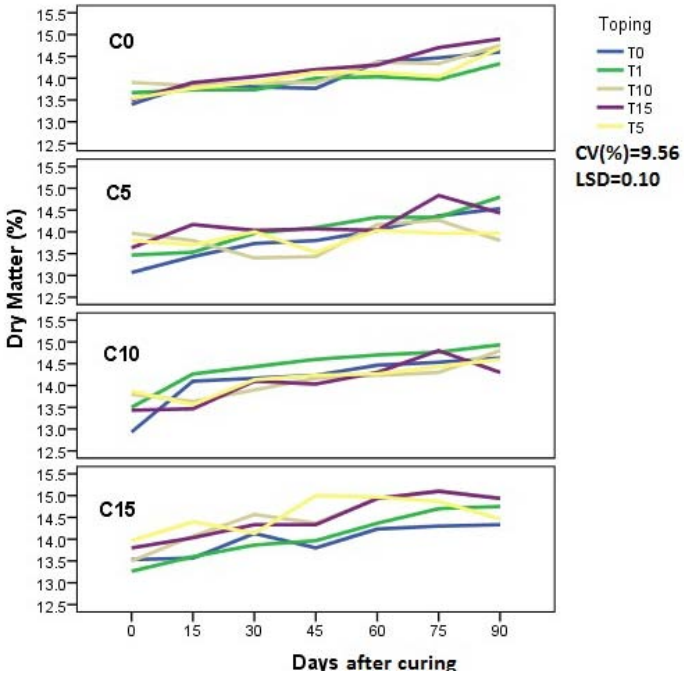

Fig. 1 : Effect of curing and topping time on percent dry mass of onion cultivar 'Bombay Red' C0 =not-cured, C5= cured for 5 days, C10= cured for 10 days, C15= cured for 15 days, T0=not topped, T1= topped immediately of curing, T5= topped 5 days after curing, T10= topped 10 days after curing, T15= topped 15 days after curing

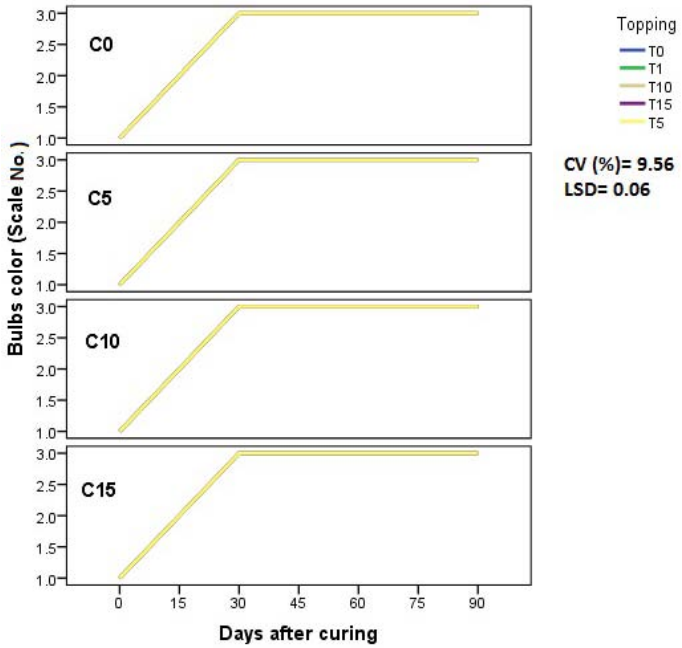

Fig. 2 : Effect of curing, topping and storage (after curing) time on bulb color of onion cultivar 'Bombay Red'

Color scale: 5 =Deep Red, 4=Red, 3=Light Red, 2=Pink and 1=Light pink, C0 =not cured, C5= cured for 5 days, C10= cured for 10 days, C15= cured for 15 days, T0=not topped at all, T1= topped immediately of curing, T5= topped 5 days after curing, T10= topped 10 days after curing, T15= topped 15 days after curing

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After 90 days of storage, 90% of the most of curing and topping combinations showed >50.00% bulb fresh mass loss. Bulbs cured for 10 days without topped recorded 34.43 % of bulbs fresh mass loss, which was the least loss. The least fresh mass loss may be attributed to the proper curing of bulbs that makes the outer scales and tight neck checking further escape of moisture and thus reduced the fresh weight loss during storage.

The findings of Thamps on *et al.* [30], Sidhu and Chadha [27] showed that fresh bulbs weight loss was lesser in cured bulbs during storage than the not-cured bulbs stored for 87 days. The maximum fresh bulbs weight loss may be due to absence of foliage resulting in full exposure of the bulbs to the radiant temperature leading to increased surface temperature of the bulbs helping to hasten the process of moisture reduction. This result is in agreement with the results obtained by Satish and Ranganna [25] and Kukanoor [17].

f) Rotted Bulbs

The effect of curing, topping and storage (after curing) time combinations showed a significant difference (P=0.05) on rotted bulbs. Until the 30 days of storage, there were not rotted bulbs observed in all treatment combinations and on the 45th days of storage none cured bulbs and topped after 15 days of curing and bulbs cured for 5 days and topped after 10 days of curing recorded 0.50 % and 0.52 % of rotted bulbs, respectively (Figure 5). No rotted bulbs were recorded until 90 days of storage in none cured bulbs and none topped and topped immediately of curing (T1), bulbs cured for 5 days and none topped bulbs and bulbs cured for 10 days with topped immediately. On the other hand, bulbs cured for 10 days with none topped bulbs no rotted bulbs were recorded until 90 days of storage after cured. At the end of the storage period (90 days), the maximum percentage of rotted bulbs were recorded in bulbs cured for 15 days and without topped (4.71 %) followed by bulbs cured for 15 days and topped after 10 days of curing (4.41%). While the minimum were in bulbs cured for 10 days and none topped bulbs (0.00 %).

Kukanoor [17] and Sidhu and Chadha [27] observed similar findings. The least rotting percentage may be because of dried and closed bulb neck, which helps in reducing the chances of microorganism entry into the bulbs and lower order of pathological decay of microorganisms due to reduction in the moisture content of the onion bulbs. Maude *et al.* [19], Fenwick and Hanley [12] and Srivastava [28] stated that curing dries the thin outer layers of the bulb to form one or more complete outer skins and these outer skins act as a barrier against infection from pathogens (rot). Metthananda [20] estimated that bulb rot contributes to 10 – 15% of storage losses of different varieties during three months storage period Rajapakse and Eidrimanna [24].

g) Sprouted Bulb

The effect of curing, topping and days of storage showed a statistical difference (P=0.05) regarding to sprouted percentage 'Bombay Red' (Figure 6). Sprouting leads to the transfer of both dry matter and water from the edible fleshy scales into the sprouts resulting in increased shriveling and loss of market quality of such bulbs. Kukanoor [17] reported that, sprouting is one of the major causes for qualitative as well as quantitative deterioration of stored onion bulbs.

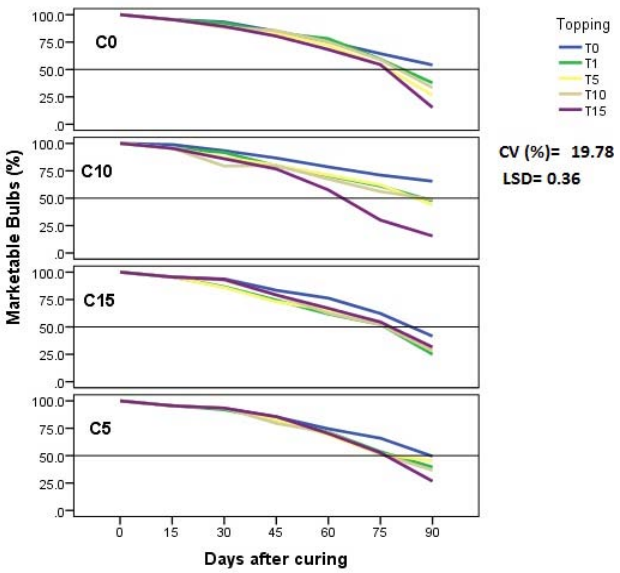

Fig. 3 : Effect of curing, topping and storage on marketable bulbs of 'Bombay Red'

C0 =not cured, C5= cured for 5 days, C10= cured for 10 days, C15= cured for 15 days, T0=not topped at all, T1= topped immediately of curing, T5= topped 5 days after curing, T10= topped 10 days after curing, T15= topped 15 days after curing

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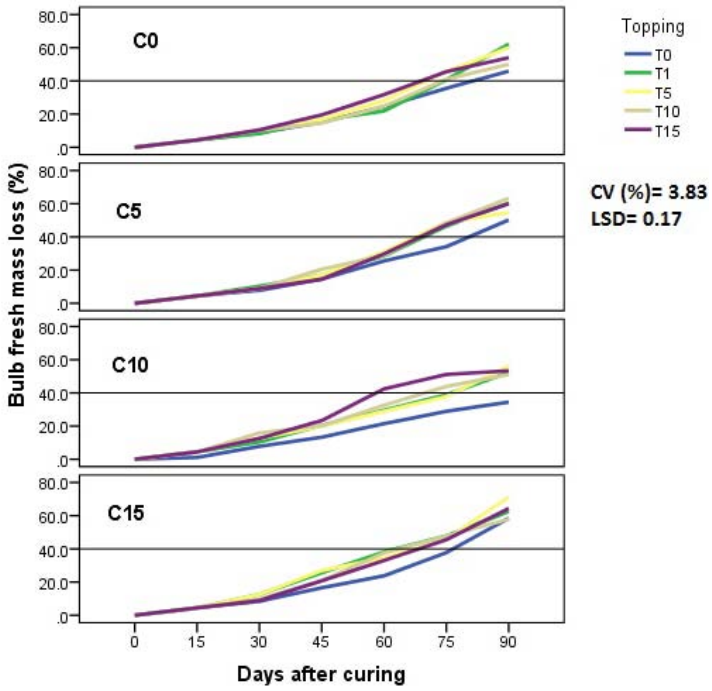

Fig. 4 : Effect of curing, toping and storage (after curing) time on bulb fresh loss of 'Bombay Red'

C0 =not cured, C5= cured for 5 days, C10= cured for 10 days, C15= cured for 15 days, T0=not topped at all, T1= topped immediately of curing, T5= topped 5 days after curing, T10= topped 10 days after curing, T15= topped 15 days after curing.

With regard to sprouted bulbs percentage from the effect of days of storage, no sprouted bulbs were recorded until 15 days of storage in all treatment combinations. The percent of sprouted bulbs were increasing with the advancement of storage period (45 days) and the maximum percentage of sprouted bulbs were recorded at the end of the storage period (90 days) which was 68.09 % in bulbs cured for 10 days and toped 15 days after cured. The lowest bulbs sprout (23.5%) was observed in bulbs cured for 10 days and without topped.

As reported by Anike [2], the end of onion dormancy can be judged by the appearance of internal sprouting which eventually extends from the neck of the bulb. According to the findings of Benkeblia *et al.* [3], onion sugar content and dormancy are related with sprouting of onions. TSS in onion bulbs stored under ambient condition between 5 and 7 weeks coincided with the onset of sprouting [3]. In the same study, the reduction in TSS coincided with sprouting after 5 - 8 weeks storage at both 10°C and 20°C. Wheeler et al. [31] reported that sprouting in storage was associated with lower levels of total water-soluble solids in the center of bulbs.

h) Total Loss of Bulbs

The combinations of curing, topping and storage (after curing) time showed highly significant difference ($P<0.01$) regarding the total loss of bulbs. The maximum percentage of total bulb loss were recorded after 90 days storage in bulbs cured for 10 days and topped after 15 days of curing (71.9 %) followed by bulbs stored without cured and then topped 15 days after curing (61.2%) (Figure 7). On the other hand, the minimum bulb loss was recorded in bulbs cured for 10 days and stored without topping (23.5 %) at the end of storage (90 days).

The mean storage loss of onion bulbs in this study comprised of physiological weight loss and sprouted bulbs ranked in their order of importance. Since the experiment has conducted from January to May when the temperature is high (19.32-23.42^{O}C) and low humidity that resulted highest bulb fresh loss and lower sprouted. Ctripathi [8] reported that 40 to 50% of the stored onion never reaches to the consumers because of various types of losses. These losses are comprised of bulbs fresh loss and shrinkage (30-40 %) and sprouting (8-10 %).

The highest storage loss was from bulbs fresh mass loss followed by sprouted and rotted bulbs. This was due to the highest temperature and low humidity during the experimentation.

As Goburdham [14] reported, Curing of onion bulbs specifically involves drying of external scales to protect the bulbs against subsequent microbial infection. Moreover, Goburdham [14] concluded that the storage life bulbs cured for 14 to 21 days and stored at the room temperature, could be extended up to two months over the control. Purpose of curing is the removal of excess moisture from the outer skin and neck

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portion of onion that helps in reducing the infection of diseases. This also helps in minimizing shrinkage due to moisture loss from the interior portion. Further, curing is an additional measure for the development of skin color. It is also practiced to remove field heat before onion bulbs are stored. Onions are considered for curing when neck is tight and outer scales are dried until they rustle and curing can take place either in field or in open sheds or by artificial means before or in storage even if the time length required for curing operation largely depends on the weather condition.

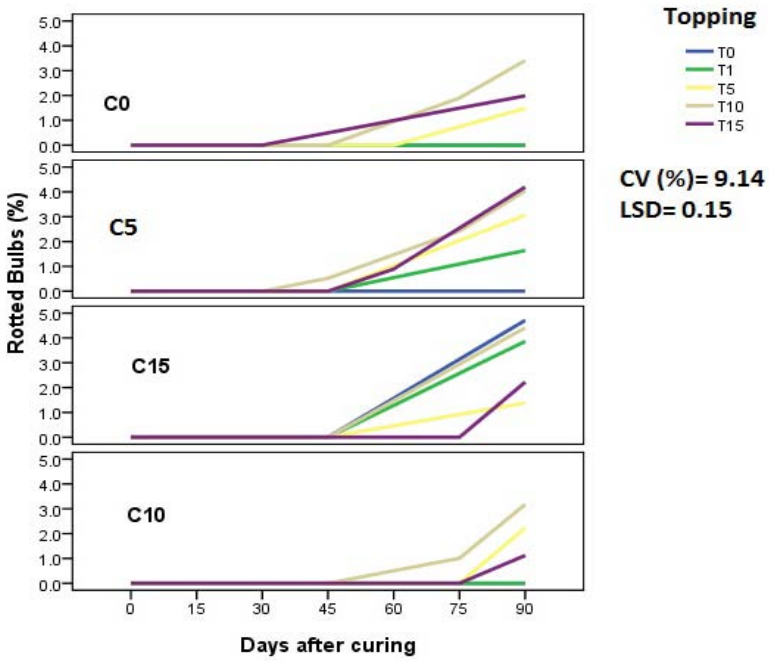

Fig. 5 : Effect of curing, topping and storage (after cured) time on rotted bulbs of 'Bombay Red'

C0 =not cured, C5= cured for 5 days, C10= cured for 10 days, C15= cured for 15 days, T0=not topped at all, T1= topped immediately of curing, T5= topped 5 days after curing, T10= topped 10 days after curing, T15= topped 15 days after curing

Table 1 : Effect of curing, topping and storage (after curing) time on TSS of bulb of onion 'Bombay Red'.

Curing (C) and Topping (T)		Days after curing						
		0	15	30	45	60	75	90
C0	T0	14.67(2.11)c	15.33(2.18)ab	15.00(2.18)ab	14.67(2.18)ab	14.67(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T1	12.67(2.10)c	15.33(2.18)ab	15.00(2.17)ab	15.00(2.17)ab	15.33(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T5	13.00(2.11)c	14.33(2.16)c	15.33(2.18)ab	15.33(2.18)ab	15.33(2.18)ab	15.00(2.18)a	15.03(1.78)ab
	T10	13.00(2.11)c	14.67(2.17)abc	15.33(2.18)ab	15.33(2.18)ab	15.33(2.18)ab	15.00(2.18)a	15.53(1.79)ab
	T15	12.67(2.10)c	14.67(2.17)abc	14.67(2.17)ab	14.67(2.17)ab	15.00(2.18)ab	15.00(2.18)a	14.94(1.39)b
C5	T0	14.00(2.16)b	15.33(2.18)ab	14.67(2.17)ab	15.00(2.17)ab	15.33(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T1	14.00(2.15)b	15.67(2.19)a	15.50(2.19)ab	15.33(2.18)ab	15.33(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T5	14.33(2.16)ab	15.33(2.18)ab	14.33(2.16)b	15.33(2.18)ab	15.33(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T10	14.67(2.17)ab	15.00(2.17)abc	14.67(2.17)ab	15.33(2.18)ab	15.33(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T15	14.33(2.16)ab	15.00(2.17)abc	15.00(2.18)ab	14.33(2.16)b	15.67(2.19)a	15.00(2.18)a	15.00(2.18)a
C10	T0	13.00(2.17)ab	15.00(2.17)abc	15.33(2.17)ab	15.33(2.17)ab	15.33(2.17)b	15.00(2.18)a	15.33(2.18)a
	T1	15.00(2.18)a	15.33(2.18)ab	15.50(2.19)ab	15.00(2.18)ab	15.00(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T5	14.67(2.17)ab	14.67(2.16)bc	15.33(2.18)ab	15.00(2.17)ab	15.00(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T10	14.67(2.17)ab	14.67(2.17)abc	15.50(2.19)ab	15.00(2.17)ab	15.33(2.18)ab	15.00(2.18)a	14.67(2.17)a
	T15	15.00(2.18)a	14.33(2.16)c	14.67(2.17)ab	14.67(2.17)ab	14.67(2.17)b	14.67(2.17)b	15.00(1.39)b
C15	T0	14.67(2.17)ab	15.67(2.19)a	15.67(2.19)a	15.67(2.19)a	15.67(2.19)a	15.00(2.18)a	15.00(2.18)a
	T1	14.67(2.17)ab	15.33(2.18)ab	15.33(2.18)ab	15.00(2.17)ab	15.00(2.18)ab	15.00(2.18)a	15.03(1.78)ab
	T5	14.33(2.16)ab	14.67(2.17)abc	15.00(2.18)ab	15.00(2.18)ab	15.00(2.18)ab	15.00(2.18)a	15.00(2.18)a
	T10	15.00(2.18)a	15.67(2.19)a	15.00(2.18)ab	15.00(2.17)ab	15.00(2.18)ab	15.00(2.18)a	14.96(1.78)ab
	T15	15.00(2.18)a	14.67(2.17)ab	14.67(2.17)ab	15.00(2.18)ab	15.00(2.18)ab	15.00(2.18)a	15.00(2.18)a
CV (%)					18.39			
LSD (5%)					0.61			

C0 =not cured, C5= cured for 5 days, C10= cured for 10 days, C15= cured for 15 days, T0=not topped at all, T1= topped immediately of curing, T5= topped 5 days after curing, T10= topped 10 days after curing, T15= topped 15 days after curing

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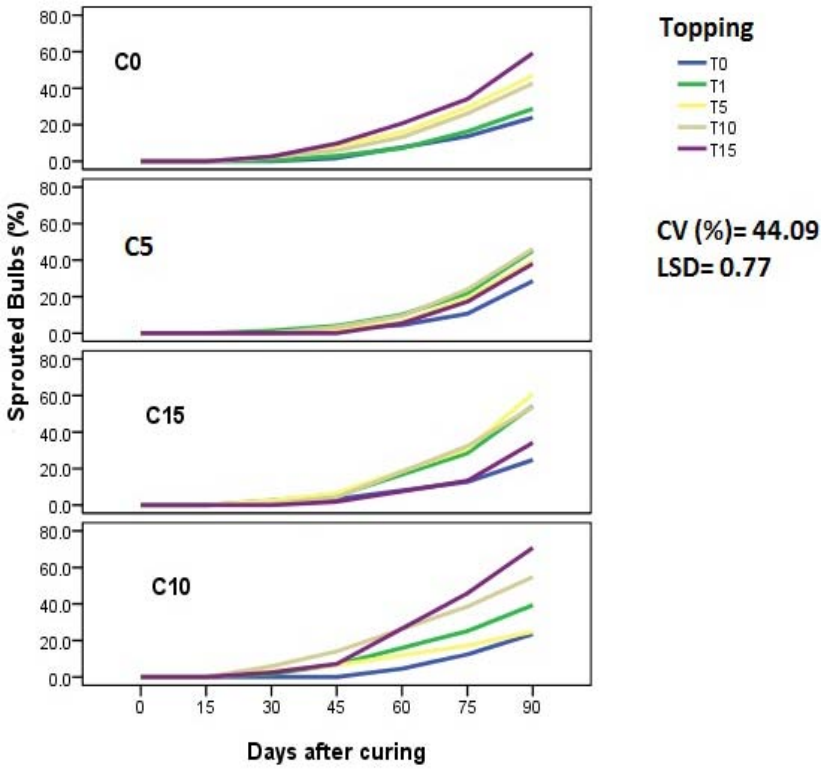

Fig. 6 : Effect of Sprouted bulbs of Bombay Red during 90 days of storage

C0 =not cured, C5= cured for 5 days, C10= cured for 10 days, C15= cured for 15 days, T0=not topped at all, T1= topped immediately of curing, T5= topped 5 days after curing, T10= topped 10 days after curing, T15= topped 15 days after curing

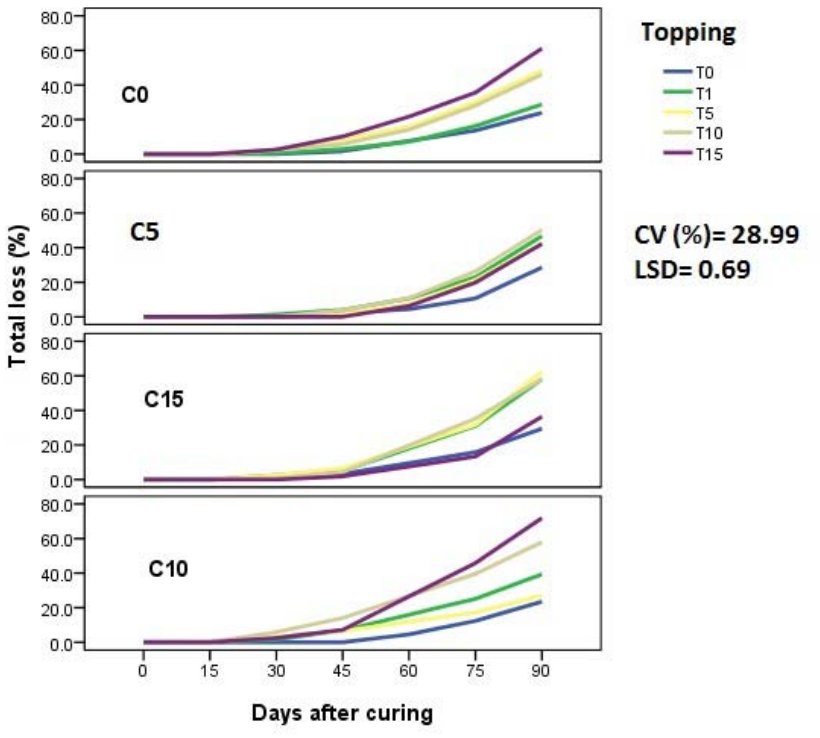

Fig. 7 : Effect of curing, topping and storage (after curing) time on bulbs total loss of 'Bombay Red'

C0 =not cured, C5= cured for 5 days, C10= cured for 10 days, C15= cured for 15 days, T0=not topped at all, T1= topped immediately of curing, T5= topped 5 days after curing, T10= topped 10 days after curing, T15= topped 15 days after curing

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IV. Conclusions and Recommendations

During the storage period of 90 days, the maximum values of Dry Matter (14.9 %) were observed in bulbs cured for 15 days and topped after 15 days of curing. Maximum total soluble solid (15.330B), marketable bulbs (65.56 %) were observed in bulbs cured for 10 days and without topped. The minimum physiological weight loss (34.44%), rotted bulbs (0 %), sprouted bulbs (23.50 %) and total loss (23.5 %) were recorded in bulbs cured for 10 days and without toping. Therefore, bulbs cured for 10 days and none topped until 90 days storage time would recommended as the best practice to maintain quality, solve the shelf life problem and prolong the shelf life of Bombay Red to encourage the cultivation.

Competing Interests

Authors have declared that no competing interests exist.

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Farmers' Perception and Adoption of Yam Minisett Technology in Anambra State, Nigeria

By Okoro, B. O. & Ajieh, P. C.
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Abstract- This study examined farmers' perception and adoption of yam minisett technology. The study was carried out in Anambra State, Nigeria. A sample size of 120 yam farmers was used for the study. Data were collected using a structured and validated interview schedule. Data generated for the study were summarized using descriptive statistics such as frequency count, percentage and mean scores while the Sigma method was used for calculating adoption scores to ascertain the level of adoption for the various yam minisett technology items. Results of the study revealed that there were more male yam farmers (82 percent) than females. The mean age of respondents was 45years and the mean household size was 11 persons. Also, a mean farming experience of 12years was found for the respondents. Results on perception of yam minisett technology reveal that respondents had favourable perception on four statements out of the thirteen statements used to investigate their perception. These were statements 5,6,11 and 12. The remaining 9 statements were not favourably perceived. They include statements 1-4; 7-10 and 13.

Keywords: *yam ministt technology, adoption, perception, yam farmers.*

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Abstract- This study examined farmers' perception and adoption of yam minisett technology. The study was carried out in Anambra State, Nigeria. A sample size of 120 yam farmers was used for the study. Data were collected using a structured and validated interview schedule. Data generated for the study were summarized using descriptive statistics such as frequency count, percentage and mean scores while the Sigma method was used for calculating adoption scores to ascertain the level of adoption for the various yam minisett technology items. Results of the study revealed that there were more male yam farmers (82 percent) than females. The mean age of respondents was 45years and the mean household size was 11 persons. Also, a mean farming experience of 12years was found for the respondents. Results on perception of yam minisett technology reveal that respondents had favourable perception on four statements out of the thirteen statements used to investigate their perception. These were statements 5,6,11 and 12. The remaining 9 statements were not favourably perceived. They include statements 1-4; 7-10 and 13. There was a low adoption of 7 and an average adoption of 2 yam minisett technology items with an overall adoption score of 3.38, which indicates a low utilization of yam minisett technology by the yam farmers. The study recommends that more awareness should be created about the benefits of the technology and farmers should be trained on how to effectively use the technology.

Keywords: yam ministt technology, adoption, perception, yam farmers.

I. Introduction

Yam is among the principal root and tuber crops of the tropics consumed mainly by rural and urban communities. It is well adapted to diverse soils and environmental conditions and a wide variety of farming systems. Yam tuber size ranges from 100mg to 10kg depending on the specie. The production pattern of yams reflects the agro-climate of an area. Yam grows for 6 – 10 months requiring about 1500mm uniform rainfall distribution. It is principally produced by small-scale and large- scale farmers using traditional tools and available inputs especially for weed and pest control.

It is a prestigious staple carbohydrates food celebrated among the Igbos of Nigeria, second to cassava in terms of land area under cultivation (Chukwu and Ikwelle, 2000). Yam is ranked third in the production list of root and tuber crops rating in developing countries after cassava and potato (FAO, 1993). According to Pamplona (2003), yam is a source of food and cash. It has industrial values and can be processed into various forms.

Yams also have high nutritional and medicinal values. Its commendable good nutritional profile include potassium 816mg, Manganese 4.40mg, Vitamin E 0.39g, Vitamin K 2.6mg and Beta Carotene 83meg. These values are higher when compared with nutrient contents of major staple foods such as rice, wheat, potato, cassava, soybean, Sweet potato, sorghum, maize and plantain (Wikipedia, 2012). Its vitamin B6 is used as a supplement with respect to premenstrual and Menopausal syndrome in women. According to the Food and Agriculture Organization (FAO), the average minimum daily energy requirement from yam is about 1800 kilocalories (7,500kj) per person. Thus, yam is a good contributor to the daily energy requirement of Nigerians since the daily energy consumption per capita status for Nigeria is put at 2710 kilocalories (11,340 kilojoules).

Nigeria cultivates about 69% of the world's total hectare of yam, out of which the south eastern states, comprising Abia, Anambra, Enugu, Imo and Ebonyi provide 40% of the total land area (Onwueme, 1994). Table 1 shows the total land area cultivated by small holder farmers between 1999 and 2009 in the Southeast zone of Nigeria.

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Table 1 : Land area cultivated by yam farmers in the Southeast Zone, 1999 - 2009 ('000HA)

State	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anambra	42.25	41.27	41.00	43.42	46.12	50.42	60.04	61.04	61.04	64.73	65.18
Abia	24.98	26.00	27.00	27.00	28.00	28.50	30.64	31.22	31.50	37.38	38.78
Ebonyi	44.07	41.23	42.00	42.00	44.08	54.88	70.01	89.22	89.27	98.14	104.88
Enugu	209.02	188.11	193.52	194.49	194.60	196.00	204.47	222.87	228.13	246.42	261.2
Imo	41.02	41.02	39.00	41.00	42.00	42.28	39.55	40.45	11.45	51.37	54.2

Source: NPAFS, FMA & WR Abuja 2010

A glean at entries in Table 1 reveals that the Southeast zone has potentials for the production of large quantity of yams on yearly basis. Yam farmers in the zone are however confronted by the twin problems of scarcity and high cost of seed yams. One of the measures that have been evolved to tackle these problems is the the yam minisett technology which was developed by the National Root Crops Research Institute (NRCRI), in collaboration with the International Institute of Tropical Agriculture (IITA).

The technology which has been transferred to farmers in Nigeria through the various State Agricultural Development Programmes (ADP_S) has the potential for overcoming seed yam scarcity. It has however been reported that the acceptance of the technology by yam farmers still remains questionable. This study was therefore conceived to examine the perception and adoption of the technology by yam farmers in Anambra State. Specific objectives of the study were to: a) describe the socioeconomic characteristics of yam farmers; b) ascertain farmers' perception on yam minisett technology and c) determine the level of adoption of yam minisett technology.

II. Methodology

All the yam farmers in Anambra State formed the population of the study. Sample for the study was drawn through a multistage sampling technique.

In the first stage, one extension block (LGAs) was randomly selected from the each of the four agricultural zones. This gave a total four extension blocks that were selected for the study. In the second stage, two (2) extension circles were randomly selected from each of the selected extension blocks; this also gave a total of eight extension circles. In the third stage, 15 respondents were randomly selected from each of the eight circles using a list of yam farmers provided by the extension agents covering the circles. This gave a total 120 yam farmers who served as respondents in the study. Data for the study were collected through a validated interview schedule.

Respondents' perception on yam minsett technology was determined by developing some perceptual statements and respondents were asked to respond to the statements along a four- point Likert - type scale of strongly agree= 4; agree= 3; disagree= 2; and strongly disagree= 1. The mean value of the response options which is 2.50 was taken as the cut=off point. Statements with mean score of 2.50 and above were therefore considered as those that respondents had favourable perception, while those statements with mean score of below 2.50 are those respondents did not perceive favourably. Adoption of yam minisett technology was determined by requesting the respondents to indicate the yam minisett items they have adopted. The percentage of adopters for each item was computed and used to calculate the adoption score using the Sigma method (Agbamu, 1995; Ajieh, 2010). For the purpose of the study, adoption level was grouped as follows: Low adoption (for items with score of 0-3.9); Average adoption (for items with score of 4-6.9); and High adoption (for items with score of 7-10)

Table 2 : Sample composition

Agricultural Zones	Extension blocks	Extension circles	No of farmers selected
Aguata	Orumba north	Ezira	15
		Eziagu	15
Anambra	Ayamelum	Omor	15
		Anaku	15
Awka	Njikoka	Abagana	15
		Nimo	15
Onitsha	Ogbaru	Odekpe	15
		Atani	15

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III. Results and Discussion

a) Socioeconomic characteristics of respondents

Entries in Table 3 show the socioeconomic characteristics of respondents. Results reveal that 82 percent of the respondents are males, while 18 percent are females. This suggests that more male respondents participated in this study. Information on age of respondents show that 80 percent of the respondents were within the age bracket of 20 – 49 years, while the remaining 20 percent of the respondents fell within the ages of 50 and 69. The mean age of the respondents was 43 years.

Data on respondents' household size reveal that 85 percent of them had household size of 2 – 13 persons, while 15 percent of the respondents had a household size of 14 – 21 persons. The mean household size of respondents in this study was found to be 11 persons. This is an advantage for family labour. Farming experience of farmers ranged between 1 and 25years with a mean farming experience of 12 years.

Table 3 : Distribution of respondents according to their socio-economic characteristics (n=120)

Socio-economic characteristics	Frequency	Percentage	Mean
Sex			
Male	98	82	
Female	22	18	
Age (years)			
20 – 29	13	11	
30 – 39	25	21	
40 – 49	58	48	43
50 – 59	21	17	
60 – 69	3	3	
Marital status			
Married	104	87	
Single	16	13	
Household size			
2 – 5	14	12	
6 – 9	36	30	
10 – 13	51	43	11
14 – 17	15	12	
18 – 21	4	3	
Farming experience (years)			
1-5	16	13	
6-10	48	40	
11-15	28	23	12
16-20	15	12	
21-25	3	2	

b) Respondents' perception on yam minisett technology

Information on Table 4 shows respondents' perception on yam minisett technology. Results reveal that respondents perceived four statements in favour of yam minisett technology out of the thirteen statements used to ascertain their perceptions. The four statements include; 5, 6, 11, and 12. The remaining nine statements were not favourably perceived by respondents. These include statements 1- 4, 7-10 and 13.

A careful study of the information in the Table further reveals that all the nine statements that respondents did not perceive favourably are negative statements. This suggests that farmers in the study area are not favourably disposed to yam minisett technology. Furthermore, an overall perception score of 2.32 which is a low perception further confirms the fact that the farmers do not favour yam minisett technology.

Table 4 : Mean scores of respondents' perception on yam minisett technology

Statements	Mean score	Rank	PC
1* Size of recommended tuber is scarce	1.67	A	NF
2* Size of minisett is too small	2.25	A	NF
3* Cutting tubers into minisett consumes time	2.20	A	NF
4* Minisett dust is expensive	2.42	A	NF
5. Minisett technology increases yield	2.84	A	F

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6. Minisett technology controls weeds	2.60	A	F
7* Minisett technology is complex	2.35	A	NF
8* Recommended spacing is difficult to achieve	1.26	A	NF
9* Intercropping pattern is too complex	1.85	A	NF
10* Minisett technology involves many steps	2.12	A	NF
11* Minisett technology is costly to implement	3.24	D	F
12* Minisett technology breeds pest	2.68	D	F
13* Recommended planting depth too shallow	2.66	A	NF
Overall mean	2.32	D	NF

*Key: A = agree; D = disagree; Rmk = remarks; F = favourable; NF = not favourable; *= negative statement*

c) Respondents' Adoption of yam minisett technology

Data in Table 5 show the adoption scores for the adoption of yam minisett technology items. Results reveal that there was a low adoption of seven out of the nine yam minisett technology items. The seven items and their adoption scores include: Size of tuber for cutting (3.62); Cutting into minisett (3.84); Air drying of minisett (3.55); Application of minisett dust (3.84); Curing of minisett (3.55); Spacing (3.60); and Planting depth (3.70). There was an average adoption of only two technology items. These are: time of planting (4.42) and intercropping (4.24). An overall low adoption score of 3.38 indicates that there is a low utilization of the technology by yam farmers in the area of study.

Table 5 : Adoption scores for yam minisett technology items

S/N	Minisett technology items	No. of Adopters	Percentage of adopters	Adoption scores
1	Size of tuber for cutting	35	29	3.62*
2	Cutting into minisett size	34	28	3.84*
3	Air drying of minisetts	26	22	3.55*
4	Application of minisett dust	34	28	3.84*
5	Curing of minisetts	26	22	3.55*
6	Spacing	33	23	3.60*
7	Planting depth	28	25	3.70*
8	Time of planting	52	43	4.42**
9	Intercropping	45	38	4.24**
	Overall adoption score			3.38*

*Key: *= Low adoption; **=Average adoption*

IV. Conclusion

Nigeria cultivates about 69 percent of the world's total hectare of yam, out of which the Southeast zone provide about 40 percent of the total land area. It has however been reported that there is a dwindling trend in the total land area cultivated in recent times due to the problem of scarcity and high cost of seed yams. This situation is compounded by the low adoption of yam the miniestt technology developed to overcome problems associated with seed yams. In order to enhance increased yam production in the southeast, there is the need to create more awareness among yam farmers on the benefits of the mimisett technology. Also farmers need to be given adequate training on how best to use the technology.

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Cluster Analyses based on Yield and Yield Components in Fenugreek (*Trigonella Foenum-Graecum* L.) Accessions

By Asebe A. Wojo, Sentayehu Alamerew, Amsalu Nebiyu & Temesgen Menamo

Jimma University, Ethiopia

Abstract- In Ethiopia, there are insufficient information on genetic diversity in the Ethiopian fenugreek germplasms and need to study associations among seed yield and yield related traits. The overall objective of this investigation was cluster analysis using divergence and ranging the traits which were the most contributors to variation by principal component analysis. It was undertaken on 36 geographically diverse Ethiopian germplasms of fenugreek. The germplasms were collected from different regions of the country. These germplasms were tested in a 6x6 simple lattice at South Nation and Nationality Peoples Region (NNPR), Gesha Woreda, Kefa Zone, Deka, Ethiopia in 2013 main cropping season. Distances square (D^2) analysis showed that 36 fenugreek germplasms grouped into six clusters. The distances were significant difference which helps for maximum genetic segregation and genetic recombination for crosses as well as obtaining heterotic response in breeding program for improving yield and yield related traits. Clustering pattern of genotypes was not related to geographical differentiation.

Keywords: *variability, divergence, principal component analysis.*

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Asebe A. Wojo [α], Sentayehu Alamerew [σ], Amsalu Nebiyu [ρ] & Temesgen Menamo [ω]

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Keywords: variability, divergence, principal component analysis.

I. Introduction

Fenugreek belongs to the Trigonella genus, which is closely related to the Medicago and Melilotus genera (Small, 1989). It is best known for presence of the distinctive, pungent aromatic compounds in the seed that impart flavor, color and aroma to foods, making it a highly desirable supplement for use in culinary applications (Max, 1992). As a spice, it constitutes one of the many ingredients that make up curry powders (Srinivasan, 2006). In countries such as India, fenugreek leaves are consumed as leafy vegetables in the diet (Sharma, 1986), while in Ethiopia and Egypt, the plant is used as a supplement in maize and wheat flour for bread-making (Al-Habori and Raman, 2002).

Clustering using D^2 (genetic distance) matrix is useful for analyzing the divergence of the population to identify genotypic variability. The D^2 statistic measures the forces of differentiation at intra- and inter-cluster levels and determines the relative contribution of each component trait to the total divergent (Sharma *et al.*, 1990). Clusters separated by the largest D^2 (genetic distance) show the maximum divergence, while the genotypes in the same clusters or groups are less divergent (Chaudhary and Singh, 1975).

Several measurements of distances have been proposed over the past decades to suit various objectives (Amsal, 2001). Generalized genetic distance by using multiple measurements that are subjected to multivariate statistical analysis can provide such measure based on generalized distance as indicated by D^2 statistics (Mahalanobis, 1936; Radhakrishna Rao, 1952). A number of workers observed that D^2 statistics was a powerful tool in describing divergence among different lines based on multiple characters; fenugreek (Banerjee and Kole, 2004; Jain *et al.*, 2006) and wheat(Deshmukh *et al.*, 1999; Debebe *et al.*, 2000; Amsal, 2001; Mustefa, 2006).

In Ethiopia, selection of high yielding and promising genotypes and pure line development has thoroughly being carried out at Sinana and DebreZeit Agricultural Research Centers. As a result, one variety (Chella) was officially released by DZARC in 2004 (DZARC, 2004). The present investigation was aimed to study the extent of genetic divergence and cluster the 36 genotypes into different homogeneous groups which were collected from different region of Ethiopia.

II. Materials and Methods

a) Study Area

The experiment was conducted in South Nation and Nationality Peoples Region (NNPR), Gesha Woreda, Kefa Zone, Deka, Ethiopa in 2013 main cropping season. It was done at Ethiopian Evangelical church Mekane Yesus development farm site with the permission and approvals obtained from Terfasa Meko. The experiment site is about 585km southwest of Addis Ababa and lies at 6.24^{0}8.13' N and 35.48^0 36.78' E. The site is situated at an altitude of 2200 m.a.s.l. The mean annual rainfall is 2200mm, while the mean annual minimum and maximum temperatures of the area are

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10.1 and 27.5^0_C, respectively (Ayele, 2004).The area is characterized by Nitisols.

b) Experimental materials and design

Thirty six fenugreek accessions samples random were selected. The accessions were collected and maintained by the Ethiopia Institute of Biodiversity Conservation (IBC) from different region of the country (Table 1) and were obtained kindly from IBC. The experiment was laid out in a 6x6 simple lattice design with 2x1m plot size. The plot consists of four rows with 20x10cm spacing. Weeding and other cultural practices were done based on the recommendations adopted for the respective sites (Fikreselassie *et al.*, 2012).

Table 1 : List of fenugreek germplasms with collection regions and passport data in IBC

SN	Accession No.	Regional areas					
		regions	Zones	districts	longitude	latitude	altitude
1	53008	Amhara	South-Gonder	Tach-gayint	08-07-00N	40-12-00E	2480
2	53009	Amhara	South-gonder	Este	08-26-00N	32-15-00E	2330
3	53012	Amhara	South-wollo	Wereilu	06-19-00N	27-45-00E	2240
4	53013	Amhara	South-wollo	Wereilu	-	-	NA
5	53014	Amhara	South-wollo	Legambo	12-02-00N	41-32-00E	2300
6	53026	Amhara	East-gojam	Enarg-enawg	-	-	2115
7	53055	Amhara	East-gojam	Shebel-benta	-	-	2045
8	53059	Amhara	East- Gojam	Shebel-benta	-	-	NA
9	239065	Amhara	Bahrdar	Bahir dar	16-05-00N	26-08-00E	2000
10	239066	Amhara	West-Gojam	Merawi	10-06-00N	28-12-00E	2050
11	239068	Amhara	West-Gojam	Around-Bahirdar	11-39-18N	37-13-41E	1930
12	215261	Amhara	North-Wello	Guba-lafto	11-48-00N	39-33-00E	1910
13	215731	Amhara	South-Wello	Werebabu	08-44-00N	41-16-00E	2050
14	53060	Amhara	East-Gojam	Shebel-beret	-	-	1845
15	53063	Amhara	Agawui	Danigla	09-23-00N	32-14-00E	NA
16	53056	Amhara	East-Gojam	Shebel-bere	-	-	1950
17	53057	Amhara	East-Gojam	Shebel-bere	-	-	2115
18	53066	Benshangul	Metekel	Dangur	-	-	2000
19	53006	Oromia	Arsi	Gedeb	-	-	NA
20	53016	Oromia	East- Hararge	Tullo	09-07-00N	41-01-00E	2400
21	51012	Oromia	Harerghe	Deder	09-28-00N	28-12-00E	2410
22	53020	Oromia	Bale	Goro	09-32-00N	42-16-00E	2560
23	53022	Oromia	East-Wollega	Amuru-garte	-	-	NA
24	237984	Oromia	Balle	Gasserana	-	-	2330
25	230536	Oromia	East- Hararge	Gursum	09-24-00N	42-1700E	2200
26	237982	Oromia	West-Shewa	Decho	-	-	2110
27	53072	Oromia	Arsi	Chole	08-22-00N	39-53-00E	2520
28	53074	Oromia	Arsi	Chole	08-40-00N	39-50-00E	2660
29	53064	Oromia	Bale	Agrfa	07-17-00N	39-50-00E	2450
30	53030	Oromia	Harerghe	Girawa	-	-	2420
31	53032	SNNP	Kaffa	Telo	-	-	2010
32	Local	SNNP	Kaffa	Gesha	-	-	NA
33	238247	Tigray	Mehaklegnaw	Laelay-maychew	14-05-00N	39-06-00E	1990
34	234033	Tigray	Mehaklegnaw	Naederadet	14-03-00N	38-44-00E	2120
35	234034	Tigray	Mehaklegnaw	Laelay-maychew	14-04-00N	38-43-00E	2120
36	53065	Tigray	Adwa	Adwa	-	-	NA

Source: Ethiopian Institute of Biodiversity Conservation, (2012). NA: information is not available

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c) Data collected and analysis

Ten quantitative traits were recorded on five randomly selected plants from the two middle rows of each plot: included flowering days, maturity days, Plant height at maturity, number of primary branches, number of secondary branches, Pods number per plant, seeds number per pod, thousand seeds weight, Biological yield per plot and seed yield per plot. Cluster analysis was performed by canonical roots method using procedures of SAS version 9.2 (Institute Inc, 2008) based on divergence value. Principal component analyses were also performed by using correlation matrix by employing procedure print comp corr of SAS version 9.2 (Institute Inc, 2008).

III. Result and Discussion

a) Cluster Analysis

Divergence analysis is a technique used to categorize genotypes that are similar into one group and others into different groups. D-square statistics (D^2) developed by Mahalanobis (Mahalanobis, 1936), has been used to classify the divergent genotypes into different groups. The D^2 values based on the pooled mean of genotypes resulted in classifying the 36 fenugreek accessions in to six groups which were four clusters and two standalone based on ten traits (Table 2). Previous studied also showed that 36 fenugreek genotypes grouped into six clusters (Jain *et al.*, 2011). These groups were not depended the geographical locations which were collected. For instance, cluster I contained 13 germplasms: which were six from Amhara region (53012, 53026, 215731, 239066, 53063 and 53075) one Benishangul (53016), five Oromia (53016 51012 53074 53064 and 53030) and one SNNP (53032). This might indicate less environmental effect on the phenotypes expression. The distribution pattern of genotypes in different clusters indicated that the cluster was based genetic divergence rather than geographical diversity i.e. genetic drift and selection forces under diverse environments could cause greater diversity than geographical diversity (Jain *et al.*, 2011). It might be due to diversity of their pedigree along with natural and direction pressure for certain agronomic traits (Jain *et al.*, 2011). Similarly, the distribution pattern of Fenugreek genotypes in different clusters indicated that genetic divergence not related to geographical differentiation (Kole and Saha, 2009; Jain *et al.*, 2011).

The F- test for the six groups indicated that there was statistically accepted difference between all clusters (Table 3). The extent of diversity present between germplasms determines the extent of improvement gained through selection and hybridization. Cluster I was included 13 accessions (36.11%) which contained relatively plant height, seeds number per pod and thousand seeds weight when compared to other clusters. Cluster II was contained 10 accessions (27.77%). This cluster had high number of primary and secondary branches per plant and low in thousand seeds weight. Cluster III was contained four accessions (11.11%). This cluster was characterized by high number of pod per plant, seeds per pod, biological yields and seed yield per plot. It also had early maturity character. Seven accessions were included in Cluster IV. Cluster IV characterized by early flowering and low number of primary and secondary branches per plant, number of pod per plant, number of seeds per pod, thousand seeds weight and number of seed yield per plot. Each group V and VI was containing only one accession.

The maximum distance was found between group five and six (Table 3). The second most divergent clusters were group three and six (D^2= 290.87). The third most divergent clusters were group four and five (D^2=254.22), the forth most divergent clusters were between group one and six (D^2=217.42), followed by cluster four and three (D^2=145.67), cluster two and five (D^2=129.47), cluster two and six (D^2=126.78), cluster two and three (D^2=63.67).

Genotypes grouped into the same cluster presumably diverge little from one another as the aggregate characters are measured. Generally, maximum genetic segregation and genetic recombination is expected from crosses that involve parents from the clusters characterized by significant distances. In the present investigation, therefore, crossing of germplasms from cluster five and six will give rise to maximum genetic segregation. On the other hand, crossing between cluster II and VI, there may be a chance to recombine genes which are early maturity with high seed yields per plant. Among the six clusters formed, cluster one showed the maximum intra-cluster D^2 value of 8.04 followed by cluster two with 5.89. Since cluster six contains a single accession, the intra-cluster D^2 value is zero.

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Table 2 : Distribution of genotypes in to six clusters based on D^2 analysis for 36 Fenugreek genotypes tested at Deka, 2013

group	accessions	Proportion (%)	Mean									
			DF	DM	PH	NPB	NSB	NPP	SNP	TSW	BY	SYP
Cluster I	53012, 53026, 215731, 239066, 53063, 53057, 53066, 53016, 51012, 53074, 53064, 53030 & 53032	36.11	47.92	145.81	49.81	4.42	5.31	19.74	10.68	14.90	776.23	207.46
Cluster II	Local ,234034, 234033, 230536, 237984, 53072, 53020, 53006, 53060 & 239065	27.77	47.6	141.5	49.30	4.65	5.45	19.52	9.53	13.85	744.60	193.20
Cluster III	53055, 239068, 237982 & 53065	11.11	46.25	134.5	48.37	4.5	5.25	19.94	10.62	14.65	789.80	222.50
Cluster IV	53022, 238247, 53056, 215261, 53014, 53009 & 53008	19.44	45.64	140.71	48.85	4.14	4.86	19.18	9.28	14.21	772.27	190.42
V	53013	2.77	48.00	128.50	56.00	5.00	4.50	21.5	11.00	14.40	723.80	186.50
VI	53059	2.77	45.50	141.00	45.5	4.00	5.00	19.75	11.40	15.40	807.80	219.00

DF=days to flowering, DM=days to maturity, PH=Plant height at maturity, NPB=Number of primary branches/plant, NSB=Number of secondary branches/plant, NSP= number of seeds per pod, NPP=Number of pods/plant, TSW=Thousand seeds weight(g), BY=Biological yield per plot(g), SY=seed yield per plant (g)

Table 3 : Pair-wise generalized squared distance (D^2) among 6 clusters constructed from 36 *T. foenum-graecum* landraces

Group	Cluster 1	Cluster 2	Cluster 3	Cluster 4	5	6
Cluster 1	8.04*	14.16*	22.17**	45.33**	58.65**	217.42**
Cluster 2		5.63*	63.67**	23.56**	129.47**	126.78**
Cluster 3			3.89*	145.67**	23.19*	290.87**
Cluster 4				3.28*	254.22**	77.40**
5					2.19*	489.27**
6						0.00

,, significant at 5 and 1%, respectively.*

b) Principal Component Analysis

Principal component analysis (PCA) is one of the multivariate statistical techniques which are a powerful tool for investigating and summarizing underlying trends in complex data structures (Legendre and Legendre, 2012). Principal component analysis reflects the importance of the largest contributor to the total variation at each axis for differentiation (Sharma *et al.*, 1990).

The principal component analysis (Table 4) revealed that four principal components PC1 to PC4 with Eigen values 3.66, 1.82, 1.36, and 1.16, respectively. The first two principal components PC1 and PC2 with value of 33.3% and 16.55% respectively, contributed more to the total variation. According to Chahal and Gosal (Chahal and Gosal, 2002), characters with largest absolute values closer to unity within the first principal component influence the clustering more than those with lower absolute values closer to zero. Therefore, in the present study, differentiation of the genotypes into different cluster was because of a cumulative effect of a number of characters rather than

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to the small contribution of each character (± 0.01-0.54). Characters having relatively higher value in the first principal component (PC1) like day to maturity, seeds number, a thousand seeds weight, biomass yield, pods number per plant, number of primary and secondary branches per plant, number of seeds per pod and seed yield had more contribution to the total diversity and they were the ones that most differentiated the clusters. Likewise, 16.55% of the total variability among the tested germplasms for the second principal component originated from variation in day to flowering, day to maturity, number of primary branches, number of secondary branches and number of seeds per pod. Similarly, the third principal component, which accounted 12.4% of the total variation were obtained from day to flowering, plant height at maturity, number of primary and secondary branches, and biomass yield per plot . Further, the fourth principal component which explained 10.5% of total variations were chiefly obtained from variations of plant height at maturity, number of primary branches, a thousand seeds weight and harvest index.

Table 4 : Eigen vectors and Eigen values of the first four principal components (PCs) for ten Characters of 36 Fenugreek accessions tested at Daka (2013)

Traits	Eigen vectors			
	PC1	PC2	PC3	PC4
Days to 50% flowering	0.52	0.45	0.43	-0.15
Days to maturity	0.22	0.51	0.2	0.01
Plant height(Dekkers and Hospital)	0.01	-0.17	0.49	0.51
No of 1^0 branches/plant	0.39	-0.43	0.38	-0.06
No of 2^0 branches/plant	0.30	-0.31	0.35	-0.27

IV. Conclusion and Recommendation

Genetically, distant parents could be used in hybridization program to get better yielding recombinants. Thus, based on the relative squared distance values (D^2) between any two genotypes, the 36 fenugreek germplasms were grouped into six distinct clusters. Clusters I and II contained large number of germplasms (13 and 10 germplasms respectively) followed by Cluster IV (7 germplasms) and Cluster III (4 germplasms) whereas Cluster V and cluster VI had the least number of genotypes (1 germplasms each).The maximum distance was found between cluster five and six (D2=489.27) and the maximum intra-cluster D^2 value in cluster one (8.04).

Cluster analyses indicated that the geographic and genetic diversity might not necessarily to be in a group i.e. germplasms collected from the same geographic collection region fell in different cluster groups whereas those collected from different geographic region tended to be grouped in the same cluster. However, the analysis suggested that there was considerable diversity among the germplasms. There is a very good scope to bring about improvement through hybridization and selection by crossing germplasms from different clusters.

The principal component analysis revealed that four principal components (PCs) having Eigen values between 1.16 and 3.66, extracted a cumulative of about 72.8% of the total variation noted among the germplasms. It was also noted that differentiation of the germplasms into different cluster was because of a cumulative effect of a number of characters rather than the small contribution of each character.

In conclusion, the present investigation indicated that there is wide range of genetic variability and diversity in Ethiopian fenugreek germplasms though the present investigation was conducted on only a part of it. There is large scope of simultaneous improvement in seed yield through selection. Hybridization among germplasms from different clusters identified in this study could lead to considerable genetic improvement by following appropriate selection strategies in the segregating generations.

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Constraints and Strategies for Enhancing Pig Production in Delta State, Nigeria

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Abstract- This study examined constraints and strategies for enhancing pig production. The study was carried out in Delta State, Nigeria. A sample size of 90 respondents was used for the study. Data were collected using a structured and validated interview schedule. Data for the study were analyzed using descriptive and inferential statistics. Frequency count, percentage and mean scores were used to summarize data, while factor analysis was used to ascertain constraints to pig production. Results of the study reveal that economic, poor management and socio-cultural biases were the major factors hindering pig production in Delta State. Specific issues highlighting these factors were also identified. Strategies for enhancing pig production that were identified by the study include: establishment of functional market for pig and pig products, subsidy for pig housing and equipment, adoption of improved pig production technologies, provision of transport facilities, subsidy for pig feeds, special credit scheme for pig farmers, public enlightenment on the nutritional value of pigs, enacting legislation against discrimination of pig products, and making veterinary services available and affordable.

Keywords: *pigs, constraints, strategies, production delta state, nigeria.*

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Ajieh, P.C [α] & Okwuolu, U [σ]

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I. Introduction

With the ever increasing human population in Nigeria and virtually static agricultural productivity, animal protein consumption among Nigerians has worsened in the past few years (Okpor, 1999). Many Nigerians feed on carbohydrate. This is because the average man cannot afford the cost of animal protein which is richer in amino acid. The deficiency of animal protein in the diet of so many people is often attributed to low number of livestock (such as pig, cattle, poultry and their products) and the activities connected with their production which are not efficient (Morison, 1991).

According to Ugwu, (1996), animal protein apart from palatability is essential for normal physical and mental development of man. Pig industry in Nigeria is an important aspect among the livestock sub-sector in the overall agricultural sector. This assertion derives from the fact that pig production has high potential to contribute to high economic gain in three ways. Firstly, pigs have high feed conversion efficiency, early maturity, short generation interval and relatively small space requirement. Secondly, they are multipurpose animals providing about 40% of meat in the world market. Pig's dung serves as a good source of organic manure for enriching poor soils and provision of biogas (methane) for cooking. Thirdly, pig's skin is also useful for light leather production (Babatunde and Fetuga, 1990).

According to Food and Agriculture Organization (FAO, 2001), pork is the most popular meat consumed in the world today, forty percent protein is derived from pork and pork products. There is a greater output of meat from pigs than the combined output of meat from cattle, buffalo, sheep and goat. Pigs supply about 63.9 million metric tonnes of meat per year (Dennis and Lutwama, 2012).

In order to increase the quality and quantity of animal protein intake in the country, past and present governments in Nigeria have initiated various programmes aimed at enhancing pig production. In Delta State for instance, the government in 2009 under its Youth Empowerment through Agriculture (YETA) programme, trained prospective pig farmers. At the end of their training, 636 pig weaners, 450 in-pigs and the sum of nine hundred and eighty nine thousand naira (989,000) was shared to trainees as starters pack. It has however been observed that despite efforts made in this direction, the trend in pig production has been dwindling in the country. It is in view of this situation that this study was conceived to examine the constraints that are associated with the production of pig in Delta State. Specifically, this study focused on the following objectives: i) describe the socio economic characteristics of pig farmers; ii) identify constraints to pig production; and ascertain strategies for enhancing pig production.

II. Methodology

The study was carried in Delta State, Nigeria. A multistage sampling procedure was adopted in the selection of respondents for the study. The first stage involved a random selection of two extension blocks (LGAs) from each of the three agricultural zones in the State. This gave a total of six extension blocks. The second stage involved random selection of three extension cells from each of the six selected extension blocks. This gave a total of eighteen extension cells. The third stage involved the selection of five pig farmers from each of the selected extension cells. This sampling procedure gave a total of 90 pig farmers that served as respondents of the study.

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Data for the study were collected through a validated interview schedule. Constraints to pig production were determined by requesting respondents to rate the level of importance of possible constraints using a three point Likert-type scale of: not important = 1; important = 2; and very important =3. Scores obtained from their responses were then subjected to factor analysis. Strategies for enhancing pig production were measured by requesting respondents to indicate the extent to which certain strategies can enhance pig production using a four point Likert- type scale of: to a very great extent =4, to a great extent =3, to some extent =2, and to a very little extent =1. The mean score of the response values which is 2.50 was used as a cut-off point. Thus, strategies with scores of 2.50 and above are those that can enhance pig production to a great extent, while strategies with score of below 2.50 are those that can enhance pig production to a little extent.

Data generated for the study were analyzed using descriptive and inferential statistics. Percentage, mean scores, and frequency count were used to summarize data, while exploratory factor analysis procedure using the principal factor model with iteration and varimax rotation was used to determine constraints to pig production.

Table 1 : Sample composition

Agricultural Zones	Extension Blocks	Extension Cells	No. of pig farms selected
Delta North	Ukwuani	Obiaruku	5
		Umutu	5
		Amai	5
	Ika South	Ekuku-agbor	5
		Alisimie	5
		Agbor-nta	5
Delta Central	Ethiope East	Oria-abraka	5
		Eku	5
		Okurekpo	5
	Okpe	Mereje	5
		Ororokpe	5
		Aghalokpe	5
Delta South	Warri North	Koko	5
		Nana	5
		Ajiagbodudu	5
	Burutu	Ogulaha	5
		Burutu	5
		Kiagbodo	5

III. Results and Discussion

Entries in Table 2 reveal that 83 percent of the respondents were males, while females were 17 percent. This indicates that men were more involved in pig production than the female in the study area. This may be attributed to the fact that pig farming is more labour intensive. A similar finding was reported by Adu, Meduna and Adekunle (2004). Information on marital status reveals that 80percent of the respondents were married while 11 percent were single. Farmers who are married tend to be more productive because decisions are usually jointly taken thereby giving rise to better allocation and utilization of resources. Results on respondents' age revealed that 84 percent of them fell within the age bracket of 20 -49, while 16 percent were within the age of 50-69. According to Ugwumba and Eziolise (2010), age enables farmers to accumulate resources and experiences over year to enable them increase productivity.

Information on respondents' educational status revealed that all the respondents had formal education ranging from primary to tertiary. This indicates that majority of the pig farmers are literates. According to Madukwe (1995), educational level of farmers is one of the variables related to adoption of improved farm practices. Information on respondents' farming experience revealed that 66 percent had 1- 10 years farming experience, while 32percent had 21-25 years farming experience. Farming experience equips farmers with the necessary knowledge and skills that are necessary to manage farm resources more efficiently.

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Table 2 : Distribution of respondents according to their socio- economic characteristics (n=90)

Socio-economic Characteristics	Frequency	Percentage
Sex		
Male	75	83
Female	15	17
Marital status		
Divorced	5	6
Widowed	3	3
Single	10	11
Married	72	80
Age		
20-29 years	16	18
30-39 yeas	40	44
40-49 years	20	22
50-59 years	12	13
60-69 years	2	3
Educational Qualification		
Primary	5	6
Secondary	14	16
OND/NCE	39	43
HND/B.Sc	30	33
M.Sc/ PhD	2	2
Farm Size		
1-50 pigs	30	33
51-100 pigs	45	50
101-150 pigs	15	17
Farming Experience		
1-5 years	24	27
6-10 years	35	39
11-15 years	18	20
16-20 years	11	12
21-25 years	2	2

a) Constraints to pig production

Entries in Table 4 show results of factor analysis of constraints to pig production. Based on the item loadings, three factors were identified. These are: economic, poor management practices and socio-cultural biases. Specific constraints under the economic factor include lack of credit facilities (0.793); high cost of improved breeds (0.737); high cost of feeds (0.689); high cost of veterinary services (0.536) and high cost of labour (0.456).

The loadings under poor management practices includes poor breeding methods (0.752); poor extension services (0.639); disease and pest infestation (0.453) poor methods of servicing (0.668); poor methods of weaning (0.556) and poor feeding methods (0. 804). Specific constraints under the socio-cultural biases are: lack of market for pig products (0.411); religious belief about pig (0.607); limited sources of pig feeds (0.552) and social beliefs about pigs (0.639).

Table 4 : Analysis of constraints associated with pig production

	Constraints	Factors		
		Economic	Poor management	Socio cultural biases
1	Lack of credit facilities	**0.793**	0.117	0.096
2	High cost of improved breeds	**0.737**	0.080	0.105
3	High cost of veterinary services	**0.536**	-0.453	0.357
4	Poor breeding method	0.379	**0.752**	0.287
5	Poor extension services	0.117	**0.639**	0.387
6	Lack of market for pig products	0.388	0.277	**0.411**
7	Religious beliefs about pig	0.354	0.393	**0.607**
8	High cost of feed	**0.689**	0.155	0..167

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9	High cost of labour	**0.456**	0.325	0.209
10	Diseases and pests infestation	0.270	**0.453**	0..271
11	Poor methods of servicing	0.244	**0.668**	0..195
12	Limited sources of pig feeds	0.334	0.134	**0.552**
13	Poor method weaning	0.746	**0.556**	0..057
14	Poor feeding methods	0.1.66	**0.804**	-0.291
15	Social beliefs about pig	0.172	-.049	**0.639**

b) Strategies for enhancing pig production

Data in Table 5 show the mean score and standard deviation of the strategies for enhancing pig production. Results revealed that all the strategies investigated by the study will enhance pig production. The strategies and their mean scores include: establishment of functional market for pig and pig products (M= 3.84); subsidy for pigs housing and equipments (M=3.86), adoption of improved pig production technologies (M=3.82); provision of transport facilities (M=3.62); improved extension services for pig farmers (M=3.71); special credit scheme for pig farmers (M=3.76) and public enlightenment on the nutritional value of pigs (M=2.78).

Other important strategies for enhancing pig production as identified by the respondents are: enacting legislation against discrimination of pig products (M=2.61); making veterinary services available and affordable (M=3.85) and pig farmers should use good management practices (2.78).

Table 5 : Strategies for enhancing pig production

	Strategies	Mean	S.D
1.	Establishment of functional market for pigs and pigs products	3.84	0.58
2.	Subsidy for pig housing and equipment	3.86	0.47
3.	Adoption of improved pig production technologies	3.82	0.59
4.	Provision of transport facilities	3.62	0.78
5.	Improved extension services for pig farmers	3.71	0.60
6.	Subsidy for pigs feeds	3.57	0.62
7.	Special credit scheme for pig farmers	3.76	0.65
8.	Public enlightenment on the nutritional value of pigs	2.78	0.68
9.	Enacting legislation against discrimination of pig products	2.61	0.78
10.	Financial institution should give priority to pig farmers	2.80	0.68
11.	making veterinary services available and affordable	3.85	0.46
12.	Pig farmers should use good management practices	2.78	0.72

IV. Conclusion

Pig industry in Nigeria is an important aspect among the livestock sub-sector in the overall agricultural sector. This is because pigs have high feed conversion efficiency, early maturity, short generation interval and relatively small space requirement. Also, they are multipurpose animals providing about 40% of meat in the world market. Pig's dung serves as a good source of organic manure for enriching poor soils and provision of biogas (methane) for cooking. Increased pig production has however been hampered due to economic, poor management and socio-cultural constraints. These constraints can be removed through the adoption of strategies that enhance pig production such as establishment of functional market for pig and pig products; subsidy for pigs housing and equipments, adoption of improved pig production technologies; provision of transport facilities; improved extension services for pig farmers; special credit scheme for pig farmers and public enlightenment on the nutritional value of pigs.

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Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSS" title to individuals. The 'FARSS' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.

- The "FARSS" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSS or William Walldroff, M.S., FARSS.

FARSS accrediting is an honor. It authenticates your research activities. After recognition as FARSB, you can add 'FARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

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You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

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The FARSS can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSS, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

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The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.
Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

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The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

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The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The "MARSS" is a dignified ornament which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

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As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

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The MARSS member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

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AUXILIARY MEMBERSHIPS

Institutional Fellow of Global Journals Incorporation (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

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After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

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We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

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- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

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- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

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2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

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Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

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Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

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Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

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Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

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6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

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6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

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Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

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Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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