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Nutrition & Food science

Utilization of Finger Millet

Effect of Nitrogen Fertilizer

Highlights

Olive Fruit Blended Jam

Olivaris & Cyprinus Carpio

Discovering Thoughts, Inventing Future

VOLUME 15 ISSUE 1 VERSION 1.0

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Nutrition & Food Science

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Sustainable Methods for Improving the Feeding Patterns of Undergraduate Student of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria

By Umeh-Idika, Adaku. S & Chimechefulam Juliet
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Abstract- The study identified the sustainable strategies for improving the feeding patterns of undergraduate students of Michael Okpara university of Agriculture, Umudike. The purpose of the study was to identify the feeding patterns adopted by the students and to identify the sustainable strategies for improving the feeding patterns of these students. The study adopted a survey research design. The population of the study was made up of 14,779 students of the various colleges and levels. Data was collected using well structured questionnaire developed through an extensive literature review. Purposive random sampling techniques were used to select 389 respondents used for the study. Data were analyzed using means and percentages. Results showed that most of the students agreed that they skipped meals as a result of habit formed about foods and they obtain their foods from fast food centres.

Keywords: sustainable, strategies, feeding, patterns and undergraduates.

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Sustainable Methods for Improving the Feeding Patterns of Undergraduate Student of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria

Umeh-Idika [α], Adaku .S [σ] & Chimechefulam Juliet [ρ]

Abstract- The study identified the sustainable strategies for improving the feeding patterns of undergraduate students of Michael Okpara university of Agriculture, Umudike. The purpose of the study was to identify the feeding patterns adopted by the students and to identify the sustainable strategies for improving the feeding patterns of these students. The study adopted a survey research design. The population of the study was made up of 14,779 students of the various colleges and levels. Data was collected using well structured questionnaire developed through an extensive literature review. Purposive random sampling techniques were used to select 389 respondents used for the study. Data were analyzed using means and percentages. Results showed that most of the students agreed that they skipped meals as a result of habit formed about foods and they obtain their foods from fast food centres. The respondents enumerated the following as reasons for their pattern of feeding. Lack of times, insufficient money, health conditions, the presence of convenience foods amongst others was the major factors that affected their feeding patterns. The following strategies were identified; establishment of good school environment, access to good food, facilities, equipment, and quality school meal programme among others. Recommendations were made based on the findings of the study that the use of variety of social change campaign, employing social marketing approach, the use of prepaid meal plan among others should be encouraged.

Keywords: sustainable, strategies, feeding, patterns and undergraduates.

I. Introduction

The undergraduate student is faced with multiple challenges and more unforetold and frightening challenges continue to emerge every day. These include excess academic workload, poverty, accommodation problem, and lack of time and the presence of many junk foods hawked in the campuses. These create more challenges for youths like poor nutrients intake, obesity, wrong choice of food, poor feeding habits, excess carry over courses, and poor performance in the final grade, food insecurity and the list goes on. Adequate nutrition is important not only for the youth's survival but also for optimal physical, mental and good health of the undergraduates. Food affects the level of physical, mental and social well being of individuals (Ajala, 2006). Nutrition is an input to and foundation for health and development. Better nutrition means stronger immune system less illness and better health. Healthy undergraduates learn better. They are stronger and more productive and more able to create opportunities to gradually break the cycles of both poverty and hunger in a sustainable way. Therefore, better nutrition is a prime entry point to ending poverty and a milestone to achieving better quality of life for sustainable development.

Sustainable means the ability or capacity for something to be maintained or to be able to continue forever. According to the Brundtland Commission Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Holbrook, 2009). This concept of sustainable feeding means that the patterns of feeding of the undergraduate students should be such that they will not compromise with their patterns of feeding without hampering their health and the future generation. The concept of sustainable methods of feeding is intended to embrace the idea of ensuring that the future generations inherit the methods for improving the feeding patterns that support their livelihood in such a way that they are not worse off than generations of today. There are three dimensions of sustainability; social sustainability (i.e. people issues such as health, food safety, quality life, hunger), environmental sustainability (i.e. land use, energy use and gas emissions, soil pollution) and economic sustainability (Lingren, 2005). These must be coordinated and addressed to ensure long term viability of their feeding patterns especially in the pursuit of improved quality of life.

Feeding is the taking or giving of food by an individual. While pattern is the procedure adopted by the youths while eating a meal. This may consist of eating concentrates before roughages and it includes nibbling, gorging and sham feeding. Thus, sustainable feeding pattern is a form of feeding adopted by

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undergraduates that will not harm their health in the future. Strategy is the careful plan or method employed towards achieving a goal (Umeh & Anyakoha, 2007). They also opined that strategy may mean an adaption of behaviour that serves an important function in achieving success. Strategy could also mean a method or plan chosen to bring about a desired future such as achievement of a goal (Hoelscher & Johnson, 2004). Therefore, sustainable strategies could as well mean plans chosen to improve students feeding pattern that will last and be able to continue in the future without harming the undergraduates or their environment.

The undergraduate students are those between the ages of 17-25 years, even though there may be some who are younger or older than the required age. Based on WHO (2006) definition of an adolescent, Adolescent is a person between 10-19 years of age, it can be said that most of the undergraduates are in their late adolescent stage. Adolescents gain up to 50% of their adult weight, 50% of their adult's skeletal mass and more than 20% of their adult height during the period (WHO, 2006). Rapid changes in physical growth and psychological development have placed these young adults as nutritionally vulnerable groups with poor feeding habits, that fails to meet dietary requirements. The dietary habits and patterns of undergraduate students seems to change considerable during the short period of transition from home to universities which results to several future health consequences (Grace 1977) .

It has been observed that feeding patterns and behaviour of adolescents often follows them into adulthood. Longitudinal studies have found that unhealthy nutrition at this period increase the risk of several diseases in adulthood for instance obesity (Wardlaw, 2005), Also dietary habits also have great implications for the dental health of adolescence and the increase in the consumption of sugar sweetened drinks during the last decade has also led to arise of dental problems (Amorim, 2000), These factors present great challenges for the public health and its therefore important to focus on the strategies for improving the feeding patterns of these students while in the universities,

Purpose of the study: The main purpose of the study was to determine the sustainable strategies for improving the feeding patterns of undergraduate's students of Michael Okpara University of Agriculture, Umudike, Specifically, the study;

1. Determined the feeding patterns adopted by the students
2. Identify the sustainable methods for improving the feeding patterns of undergraduate students of Michael Okpara University of Agriculture, Umudike.

Research Questions: The study was guided by the following research questions.

1. What are the feeding patterns presently adopted by the undergraduate students of Michael Okpara University of Agriculture, Umudike?
2. What are the sustainable methods for improving the feeding patterns of undergraduate's students of Michael Okpara University of Agriculture, Umudike.

II. Methodology

Area of the study: The study was carried out in Michael Okpara University of Agriculture, Umudike about 10 kilometers away from Umuahia Capital Territory.

Design of the study: The study adopted a descriptive survey: This was used to obtain information about the feeding pattern adopted by the undergraduate students, of the university.

Population for the study: The total population for the study comprised of 14779 undergraduate students of 2012/2013 session (Statistics from the office of the Registrar, Michael Okpara University of Agriculture, 2014), it has eleven colleges, with various programmes of study, Sample for the study; purposive sampling technique was employed for the selection of the college. Taro Yamen formular was adopted in the selection of the 399 respondents from the population.

Instrument for data collection: The instrument for data collection was questionnaire gotten from extensive literature review.

Validation of the Instrument: The questionnaire was validated by three lecturers from the Department of Home Economics/HMT, Michael Okpara University of Agriculture, Umudike.

Data Collection and Analysis Techniques: The 389 copies of the questionnaire were administered to the respondents through personal contact by the researcher and with the aid of 3 trained research assistants. Data collected was analysed using means and percentages, any item from 3.00 and above were accepted while mean rating below 3.00 were rejected.

The findings are summarized in the tables below:

What are the feeding patterns presently adopted by the undergraduates:

S/N	Feeding patterns adopted	X	Decision
1	Eat three times every day	1.8	Rejected
2	Eat fruits and vegetables 5 meals daily	2.15	Rejected
3	Skip breakfast meals daily	3.32	Accepted
4	Always skip meals because of lack of time	3.36	Accepted
5	Skip meals because of weight control	1.83	Rejected
6	Skip meals because of religious reasons	1.83	Rejected
7	Eat in between meals	3.37	Accepted
8	Eat a lot of junk foods (empty calories)	3.38	Accepted
9	In between meals are eaten to make up for missed meals	3.10	Accepted
10	Eat cooked foods from home	2.26	Rejected
11	Obtain foods from canteen	3.10	Accepted
12	Eat only at lunch time	3.11	Accepted
13		3.23	Accepted
14	Eat snack every day	2.04	Rejected

Source: Field survey (20014)

Table 1: Shows the feeding patterns adopted by the undergraduate students of Michael Okpara university of Agriculture, Umudike, The mean ratings presented in table 1 shows that items 3,4,7,8,9,11,12 and 13 are feeding pattern adopted by the undergraduates because they are above the cut off point of 3.00 while items 1,2,5,6,10 and 14 were below 3.00 cut off mark. The result of the analysis in Table 1 implies that there are many feeding patterns adopted by the undergraduate students.

Table 2 : Sustainable Strategies for Improving the Feeding Patterns of Undergraduates

S/NO	Sustainable strategies for improving the feeding patterns of undergraduates	X	Decision
1	Establish school environment that support healthy eating	3.11	Accepted
2	They should have access to healthy food opportunities and safe space facilities and equipment for healthy eating	3.31	Accepted
3	Encourage a climate that encourage and does not stigmatize healthy eating	2.72	Rejected
4	Government should subsidize their meals for healthy eating	3.50	Accepted
5	Bursary allowance should be given to students	3.37	Accepted
6	School meal programmes should be encouraged by the university authorities	3.20	Accepted
7	Ensure that students have only appealing, healthy food and beverage choices offered outside of the school meal programme.	3.10	Accepted
8	Marketing of healthier foods and beverages by the food vendors should be encouraged	3.17	Accepted
9	Encourage participation in school meal programme among all students	2.59	Rejected
10	Implement healthy education programmes that provides students with the knowledge, attitudes, skills and experiences needed for healthy eating	3.03	Accepted

Table 2 shows the sustainable strategies for improving the feeding patterns of undergraduates. The mean rating in table 2 shows that items 1,2,4,5,6,7,8 and 10 falls within the criterion mean of 3.00 and above as the sustainable strategies for improving the feeding patterns of undergraduates in Michael Okpara University of Agriculture, Umudike, while items 3,9 were below the criterion mean of 3.00, they are not sustainable strategies for improving the feeding patterns of undergraduates.

Discussion of findings: Findings of the study showed that there are many feeding patterns adopted by the undergraduate students. The findings revealed that some of the patterns were good while others are not good and healthy. The feedings on skipping of meals due to lack of time is not in agreement with Okpara and Okponibuot (2013) who stated that regular meal consumption can have a multitude of positive health benefits, The study is also not in agreement with the American Dietetic Association ADA (2009) who also observed that the earlier in life individuals begin to eat regular breakfast, the more benefits they gain in terms of their health and nutritional status, including a lower risk for obesity. The study is in agreement with Yaman and Yabanci (2006), who stated that the reasons why students skipping breakfast are being late for school in the morning, getting up late for school in the morning, having no appetite and lack of time, Dickie and Bender. (1982) reported that people who skiped breakfast do less work, have difficulty in late morning hours. They further reported that students are often faced with one or more emotional imbalances as a result of skipping

breakfast. These occur because the brain cannot get enough energy when breakfast is skipped.

The findings on the item, they eat a lot of junk foods (empty calaries) is also in agreement with the Ozdogan, Ozcelik and Surucuoglu (2010) who observed that students consumer a lot of empty calories for breakfast. They stated that the consumption of the foods regularly for breakfast is a very unhealthy habit because these junk foods only suddenly boost the energy level of the students for a short while and they do not add any nutritive value to their body systems. The findings of the study is also in agreement with the third National Health and Nutrition Examination Survey (2010), who reported that adolescent and young adults who skip breakfast have significantly higher body mass index (BMI) than those who eat breakfast. This has been explained to be due to the fact that breakfast eaters tend to make healthier decisions in food choice later in the day due to breakfast intake and this leads to a healthier lifestyle in the future. They further observed that after consuming breakfast, the next meal typically does not consist of heavy highly calories, foods because eating breakfast prevents over whelming hunger while those skip breakfast may have the over whelming urge to get highly fattening and highly caloric food.

The findings of the study corroborates the findings of food and Agricultural Organization (2009), who stated that the food habit of undergraduate student are characterized by skipping of meals, reduced or avoidance of certain nutritious foods or refusal to eat. They also observed that there is high consumption of caloric foods, alcoholic and cigarette. In addition, they observed that alcohol consumption represses the absorption of some nutrients in the body. In addition, they observed that alcohol consumption depresses the absorption of some nutrients in the body system. The study is also in line with the findings of Ibeanu, Onyechi and Onuoha (2012) who observed that in University of Nigeria, Nsukka campus that there is no University managed cafeteria, where nutritionally adequate meals are planned, prepared and served to students and this has caused the students to be eating empty calories foods each time they are hungry.

The findings on the sustainable strategies for improving the feeding patterns of undergraduate were accepted as sustainable strategies except item 3 and 9 which had mean rating below the criterion level of 3.00, the finding on items 4,5,and 6 which had the highest mean are very important strategies for sustaining the feeding patterns of undergraduates, This finding is in agreement with Ibeanu et.al (2012) who stated that the choice of meals of the students were greatly influenced by money available, hunger and the type of meal available at a time. They also noted further that time and money constraints could have contributed to the consumption of snacks and junk foods which are energy dense and low in other nutrients but if government can subsidized their meals and bursary allowances made available, the undergraduate will feed sustainably well.

III. Conclusion

The study revealed feeding patterns adopted by undergraduate students of Michael Okpara University of Agriculture. It also revealed some sustainable strategies for improving the feeding patterns of the undergraduate students. The study observed that students skip meals because of lack of money, time and unavailability of good foods. It was also observed that the students indulge in eating empty calories foods that may not provide them all the nutrients needed for the normal functioning of the body and for academic work.

IV. Recommendation

Based on the findings that students have a lot of challenges in the institutions the following recommendation were made; There should be variety of social change campaign to advice the students on their feeding habits. Nutrition education teaching should also be given to the students from time to time since better nutrition means stronger immune system less illness and better health, Government should made bursary allowance available to students to enable them beef up their eating habits. Parent's salaries should be paid early so that they can attend to undergraduate students needs. Government should provided good and neat cafeterias to be manned by government officials in the institution.

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Effect of Nitrogen Fertilizer Application on in Sacco Rumen Degradability and Invitro Dry Matter Digestibility of Cenchrus Ciliaris and Panicum Maximum Grown Under Irrigation

By Abdi Hassan, Tessema Zewdu, Mengistu Urge & Sisay Fikru
Jig-Jiga University, Ethiopia

Abstract- The study was conducted to determine the In vitro dry matter digestibility and In sacco rumen dry matter degradability of Cenchrus ciliaris and Panicum maximum grown under irrigation at Gode, Somali region. 2 x 3 factorial arrangements in randomized complete block design with three replications were used. Treatments were three level of fertilizer application (0, 50, 100 kg ha-1 of urea) and two grass species, which make up six treatments. The IVDMD and IVOMD increased as a result of increased urea fertilization levels. Conversely the in sacco DMD was not significantly different. The addition of urea fertilizer with the grass species in the present study improved the digestibility of the forage grasses. It could be recommended that of Cenchrus ciliaris with urea fertilizer application of 50 and 100kg ha-1, because it has more digestibility than Panicum maximum, so that agro-pastoral farmers along the Wabi-Shabelle River could increase the livestock production and productivity.

Keywords: *Cenchrus Ciliaris, in Sacco Degradability, Invitro Digestibilty, Nitrogen Fertilizer, Panicum Maximum.*

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Keywords: Cenchrus Ciliaris, in Sacco Degradability, Invitro Digestibilty, Nitrogen Fertilizer, Panicum Maximum.

I. Introduction

Ethiopia is one of the east African countries that constitute the majority of the pastoralists. There are an estimated 23 million pastorals in the country that cover about 37 % of the national population. In terms of proportion, about 17 % are mobile pastoralists and 20 % are agro-pastoralists Amha (2002). The pastoralists inhabit the semi-arid and arid agro-ecologies that are located around the periphery of the country Kidane (1993). These areas are classified as marginal arable and non- arable land which consist of about 67 % of the national land area. Most of these areas are below 1500 m.a.s.l. with the southwest and southeastern areas having an altitude of around 1000 meters and southeastern and southwestern rangelands rising up to 1700 meters and above Kidane (1993) and EARO (2000). In arid and semi-arid rangelands of Ethiopia, the primary livelihoods of the pastoralists are the management of livestock such as cattle, goats, sheep, and camels. Thus, as stated by Alemayehu (2004) livestock is vital to the well being of lowland households in terms of income, food security, employment, and, social prestige. The livestock production in these areas thus contributes about 50 % of the agricultural GDP, and 90 % of the annual live animal export earnings. According to EARO (2000), the pastoral livestock production also consists of about 45-55 % of the cattle, 75 % of the small ruminants, 20 % of equines and 100 % of camels out of the national livestock population.

The development of the livestock sub-sector in Ethiopia is hindered by many constraints, of which the unavailability of both quantity and quality feed is a major factor Mnaye et al. (2009). The main feed resources for livestock in Ethiopia are natural pasture and crop residues, which are low in quantity and quality for sustainable animal production Tessema et al. (2002a), Tessema and Baars (2004). Alemayehu (2004) also noted that more than 90% of the livestock feed is contributed by crop residues and natural pasture, this results in low growth rates, poor fertility and high mortality rates of ruminant animal Odongo et al. (2002), Shem et al. (2003).

In order to solve the shortage of feed and increase livestock productivity, it is necessary to introduce and cultivate high-quality forages with high yielding ability and adaptability to the biotic and a biotic environmental stresses Tessema and Halima (1998), Tessema et al. (2002b), Kahindi et al. (2007). Among the improved forage crops introduced in Ethiopia, *Panicum maximum* and *Cenchrus ciliaris* could play an important role in providing a significant amount of quality forage both under the smallholder farmers and intensive livestock production systems.

Nitrogen fertilization is one of the most common practices since this nutrient was found to be one of the most limiting factors influencing yield and chemical composition of grass pasture. It is also the major factor for increasing the pasture yield and nutritive value of the

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plant including Crude protein (CP) content and digestibility, which can improve livestock production Peyraud and Astigarraga (1998). Nevertheless, information regarding the effect of fertilizer on Invitro dry matter digestibilty and Insacco Dry matter degradability of improved forage grasses in the study area is lacking.

II. Materials and Methods

a) Description of the Study Area

The field experiment was conducted from September to December, 2013 using irrigation at Gode, one of the nine administrative zones of the Somali Regional State. The experimental site was located about three Km west of Gode town, the main town of Gode Zone, which is located in the southern part of the region and the Wabi-Shabelle River forms the southern and the eastern boundaries of the district.

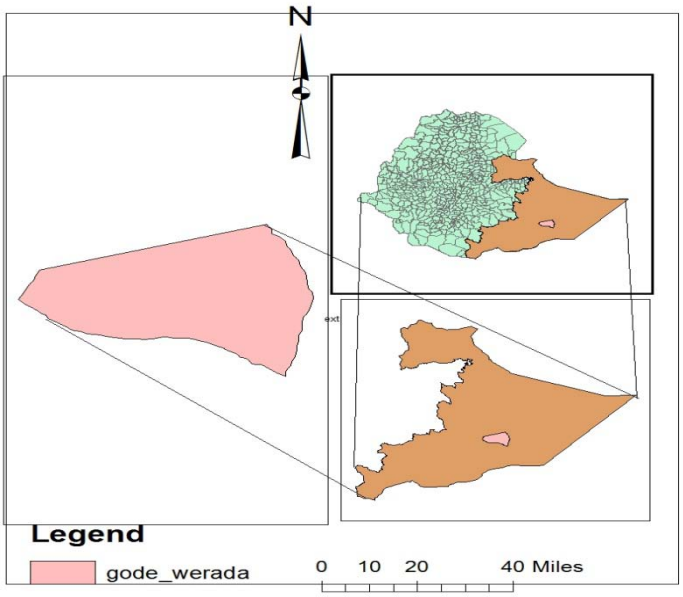

Figure 1 : Map of the study area, Gode Zone, Eastern Ethiopia.

The experimental site is located at an elevation of 300 meter above sea level (m.a.s.l.) with latitude of 5 ^{0}N and longitude of 43 ^{0}E. The climate of Gode is characterized as arid to semi-arid agro-ecology, where livestock is the main occupation and cultivation is undertaken along Wabi-Shabelle river bank. Rainfall pattern is characterized by two rainy seasons and two dry seasons. The main rainy season termed locally as Gu, in Somali language extend from April to June and the short rainy seasons (Deyr) stretches from October to December. The mean maximum and minimum annual temperatures are 35 ^{0}C and 22.9 ^{0}C, respectively. The mean annual rainfall of the area is 150 to 344.06 mm NMA (2013).

The soil characteristic in the study site was sandy loam. The topography of Gode district is an extensive flat to gently sloping. It accounts for about 94% of the district's total area. Areas with steep to very steep topography are very small and accounts about 2.4% of the district's total area. Several soil types exist in the Gode district. The predominant soil types are Calcic xerosols, Orthic solonchacks, Gypsic yemosols and Fluvisols Ayele (2005).

Gode woreda, where this study was conducted, is one of the nine woreda of Gode Zone of Somali regional sate (SRS), the farming system in Gode district mainly characterized by livestock production and crop farming practices along the river bank of Wabi-Shabelle River. The majority of the populations are pastoralists and agro-pastoralists Ayele (2005).

Gode Woreda has an estimated livestock population of 165,277 cattle; 517,668 sheep; 985,869 goats and 115,498 camels CSA (2009). The district has an estimated total human population of 179,444 of which 99,466 are males and 79,978 females CSA (2007).

b) Experimental Layout, Design and Treatments

The study was conducted using 2 x 3 factorial arrangements in randomized complete block design with three replications. The factors were three levels of urea fertilizer application (0, 50, and 100 kg ha^{-1}) and

two species of grass, *Panicum maximum* (Guinea grass) and *Cenchrus ciliaris* (Buffle grass) forming six treatments. The treatments were laid out as below in the table1.

c) Plot preparation and Management

The land was prepared by a tractor and levelled by human power. The seed rate used was 5 kg ha^{-1}. The seeds were sown in a plot in a row (6 rows per plot and 30 cm, space between rows within a plot) by drilling method at a depth of about 2.5 cm and lightly covered with soil to ensure adequate emergence. Fifteen days irrigation interval was used throughout the experiment period. The urea fertilizer was applied after the grasses were well established (one month after planting) by placing near root slips depending on the treatment. Grass from all the plots was harvested at 50% flowering stage of 80 days of growth after planting and on the same day. The grass was cut 5cm above the ground excluding the border rows.

d) Soil sample

Prior to planting and after harvesting soil samples were taken randomly per replication at a depth of 0 to 20 cm layer at each corner and center of each replication using soil sampling auger. The collected samples were mixed per replication to make one composite sample and used to determine organic matter content (OM), total nitrogen, available phosphorous (P), pH and Electrical conductivity of extracts (ECe). The soil organic matter was calculated indirectly from organic carbon (OC) concentrations by rapid dichromate oxidation technique of Nelson and Sommers (1982). Total nitrogen in the soil was analysed by using Kjeldhal procedure Barmner and Mulvaney (1982) and Olsen's procedure was used to determine the available P Olsen et al. (1954). The soil pH was measured potentio-metrically using a digital pH meter in the supernatant suspension of 1:25 liquid ratios where the liquid is water Mclean (1982). Soil texture was determined by using the hydrometer method Black et al. (1965). The soil chemical analysis was under taken at Haramaya university soil laboratory.

e) Sample Collection and Preparation

The representative plant of the two grass species were collected and weighed in the field. Then the samples were air dry in a well-ventilated room until transported to Holeta Nutrition Laboratory and further dried in an oven at 105^0C for 24 hours. Then the samples were separately ground in a Willey mill to pass through 1 mm sieve for IVDMD. The Other set of samples were ground to pass through a 2 mm sieve and used for incubation in rumen fistulated cattle to determine *In sacco* degradability parameters of the feed samples. The samples were then put in plastic bags individually and sealed for further analysis.

f) In vitro dry matter digestibility Procedures

In vitro dry matter digestibility (IVDMD) was determined by the two-stage rumen inoculums pepsin method of Tilley and Terry (1963). Dried samples were ground to pass through a 1 mm screen. A duplicate sample of about 0.5 g each was incubated with 30 ml of rumen liquor in 100 ml test tube in water bath at 39 ^{O}C for a period of 48 hour for microbial digestion. This was followed by another 48 hour for enzyme digestion with acid pepsin solution. Blank samples containing buffered rumen fluid only also was incubated in duplicates for adjustment. Drying of samples residues was done at 105^OC for 24 hours. the *In vitro* dry matter digestibility *(*IVDMD) was analyzed at Holeta Agricultural Research Center.

IVDM was calculated as Dry sample weight-(residue- blank) / Dry sample weight x 100.

The sample was then ashed to estimate *In vitro* OM digestibility. The ME content was estimated using the equation: ME (MJ kg DM) = 0.15*IVOMD.

g) In Sacco rumen Degradability Procedure

In sacco rumen degradability of DM was determined by incubating about 3g of duplicate samples contained in nylon bags (41μm pore size and 6.5 x 14 cm dimension) in three rumen fistulated Boran x Holstein Friesian steers for 0, 6, 12, 24, 48, 72, 96 hours. Upon the removal of nylon bags at the end of each incubation hours, all bags including zero hour were washed manually under a running tap water until the water is clean, gently squeezed to remove excess water, and dried at 60 ^{o}C for 48 hours in a forced draft oven. The dried bags were then taken out of the oven and allowed to cool in desiccators and weighed immediately. DM and OM contents were determined in the original samples as well as in the residues according to standard procedure AOAC, (1990).

The disappearance of DM was expressed as percentages and determined for each bag using the following formula:

Dry matter disappearance (DMD) = ((BW+S) – (BW+RW)) / (S x DM) x 100, where;

BW = Bag weight

RW = Residue weight

S = Sample weight

DM = Dry matter content of the original sample

The DMD data were fitted to the equation described by Orskov and McDonald (1979) using the Naway Excel programme Chen, (1995) to get the potential disappearance of DM.

$$Y= a+b\ (1-e^{-ct}),\ \text{where}$$

Y = the potential disappearance of DM at time t; a = rapidly degradable fraction

B = the potentially, but slowly degradable fraction; c = the rate of degradation of b

E = the natural logarithm; t = time

Effective degradability (ED) was calculated following the method of Orskov and McDonald (1979) assuming a passage rate of 0.03/h

The potential degradability, PD = a+b, where as

$$ED = a + bc / k+c$$

k = passage rate

The in sacco dry matter degradability was analyzed at Holeta Agricultural Research Center.

h) Statistical Analysis

Data on *in vitro* digestibility and in *sacco degradability* parameters were subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of the statistical analysis system SAS (1999). Means was separated using least significance difference (LSD).

The statistical model used was:-

$$Y_{ijk} = \mu + A_i + B_i + Nj + AB_kNj + e_{ijk},$$

Where;

Yijk = individual observation

μ = overall mean

A_i = effect of forage species

B_k = k^{th} block effect

Nj = N-fertilizer rate

AB_kNj = interaction effect of species and fertilizer rate

e_{ijk} = the random error

Since fistulated animals were used as a replication, the analysis of variance model for the *in sacco* degradability parameters was:

$$Y_{ijk} = \mu + A_i + Nj + AB_kNj + e_{ijk},$$

Where;

Yijk = individual observation

μ = overall mean

A_i = effect of forage species

Nj = N fertilizer rate

AB_kNj = interaction effect of species and fertilizer rate

eijk = random error

III. Results and Discusion

a) In vitro dry matter digestibility (IVDMD) and In vitro organic matter digestibility (IVOMD)

The IVDMD and IVOMD are significantly ($P < 0.05$) different among the grass species (Table 2). This might be explained by the variation between morphology of the grass species such as leaf to stem ratios and variation in growth patterns. The effect of urea fertilizer on IVDMD and IVOMD of the grass species had also revealed highly significant ($P < 0.01$) difference and it increased with increasing level of fertilization. This may be because urea fertilizer application improves and stimulates new growth of tillers, shoots, leaves and accelerates the rate of stem development and accumulation of dead materials, which are low in cell wall and lignin contents, leading to higher digestibility. However, the interaction effect between grass species and level of urea fertilizer application did not show significant difference among treatments ($P > 0.05$). This result is in agreement with that of Tegegn (2001) who reported that the application of different levels of urea fertilizer had significant effects on IVDMD of Panicum at all stages of harvest. The present result is also supported by the findings of Naroon Waramit et al. (2006) who reported that Nitrogen fertilization increased the IVDMD value across four grass species. Owen and Jayasuriya (1989) Noted that the critical threshold level of IVDMD for feeds to be 50% in order to be considered as having acceptable digestibility. Similarly, Mugerwa et al. (1973) stated that digestibility higher than 65% indicates good nutritive value and values below this level limit intake. Hence, the value of IVDMD observed in grass species used in the present study could be considered to be acceptable.

b) In Sacco dry matter degradability and its rumen degradability characteristics

Among the factors considered in the study, differences between the grasses species had revealed significant difference ($P < 0.05$) at 72 hrs incubation time; while the other incubation times had no significant difference on rumen degradability ($P > 0.05$) ((Table 3). Both fertilizer application levels and its interaction and between grass species did not show significant effect on DM degradability and degradability characteristics between grasses at all incubation times ($P > 0.05$), except that readily soluble fraction as influenced by fertilizer applications ($P < 0.05$).

IV. Acknowledgment

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Tables

Table 1 : Treatment arrangement layout

block1	*Panicum**0k g urea ha^{-1}	*Panicum**50kg Urea ha^{-1}	*Panicum**100kg Urea ha^{-1}	*Cenchrus**0k g Urea ha^{-1}	*Cenchrus**50kg Urea ha^{-1}	*Cenchrus* 100kgUrea ha^{-1}
block2	*Cenchrus**50kg Urea ha^{-1}	*Panicum** 100kg Urea ha^{-1}	*Cenchrus* *0kg Urea ha^{-1}	*Panicum**50k g Urea ha^{-1}	*Cenchrus**100k g Urea ha^{-1}	*Panicum* 0kgUrea ha^{-1}
block3	*Panicum** 100kg Urea ha^{-1}	*Panicum**0kg Urea ha^{-1}	*Cenchrus** 50kg Urea ha^{-1}	*Cenchrus** 100kg Urea ha^{-1}	*Cenchrus**0kg Urea ha^{-1}	*Panicum** 50kg Urea ha^{-1}

There were 3 blocks, each containing 6 plots resulting to eighteen plots in total, with each plot measuring 2 x 3 meter. Distance between plot and replications (blocks) were 0.50 and 1meter, respectively. Plots in each block were randomly assigned to the six treatments.

Table 2 : Means of *In vitro* dry matter digestibility (IVDMD) and *In vitro* organic matter digestibility (IVOMD) of grass species as influenced by urea fertilization and their interaction effect

Factors and levels	Parameters	
	IVDMD	IVOMD
Grass species		
Panicum maximum	67.83 [b]	63.75[b]
Cenchrus celiaris	70.65 [a]	66.17[a]
P-value	0.0372	0.0189
±SE	2.12	1.83
Urea levels		
U0 kg ha^{-1}	62.78[c]	58.34[c]
U50 kg ha^{-1}	68.30[b]	66.41[b]
U100 kg ha^{-1}	76.64 [a]	70.14 [a]
P- value	. 0001	. 0001
±SE	1.06	0.90

[a-c] Means with same latter are not significant different; SE= standard error of mean; (P < 0.01) = highly significant; (P > 0.01) = non significant; (P < 0.05) = significant difference; (P > 0.05) = non significant; IVDMD = in vitro dry matter digestibility; OMD = organic matter digestibility; U0kg ha^{-1} = Urea zero kg ha-1;U50kg ha^{-1}= Urea 50kgha-1; U100kg ha^{-1} =Urea100kg ha-1.

Table 3 : Means of *in sacco* DM degradability (%) and its rumen degradability characteristics of the *Panicum maximum* and *Cenchrus ciliaris* grass species as influenced by urea fertilization

	Parameters											
	Incubation period (hours)							Degradability characteristics				
Factors	0	6	12	24	48	72	96	A	B	A+B (PD)	C	L	ED
Grass species													
Panicum	20.19	23.50	36.04	38.72	50.67	56.59[a]	60.14	20.19	44.45	64.64	0.0296a	-0.42	40.57
Cenchrus	20.33	20.40	35.37	37.83	48.78	53.99[b]	59.05	20.33	41.49	61.82	0.0330a	2.27	38.84
P- Value	0.7483	0.1176	0.5152	0.6743	0.2076	0.0277	0.1874	0.7483	0.3154	0.3466	0.6796	0.3055	0.0614
±SE	0.33	1.16	0.67	1.25	1.29	0.71	0.59	0.33	1.73	1.77	0.005	1.59	0.57
Urea(kg)													
U0 kg ha^{-1}	19.37[b]	21.91	36.34	40.27	49.00	56.27	60.20	19.37[b]	43.38	62.76	0.0345	0.717	40.10
U50kg ha^{-1}	20.41[ab]	20.76	34.61	36.71	49.55	55.02	58.36	20.41[ab]	41.33	61.75	0.0320	2.767	38.70
U100 kg ha^{-}	21.01[a]	23.17	36.17	37.85	50.62	54.59	60.23a	21.00[a]	44.19	65.19	0.0274	0.710	40.31
P- Value	0.0297	0.5718	0.3323	0.3832	0.6412	0.4013	0.1254	0.0297	0.6995	0.6145	0.7736	0.5405	0.2626
±SE	0.29	1.54	0.86	1.58	1.04	1.01	0.66	0.29	2.23	2.24	0.006	1.92	0.73

[a-b] Mean with different superscripts are significant different; A= readily soluble fraction; B= insoluble but fermentable fraction; C= rate of degradation of B per hour; L= lag phase; ED = effective degradability; PD= potential degradability; SE= standard error of mean; (P < 0.05) = significant difference; (P > 0.05) = non significant; U 0kg ha^{-1} ; U50 kg ha^{-} ; U100 kg ha^{-} .

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Quality Evaluation and Preparation of Apple and Olive Fruit Blended Jam

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Abstract- The present research work was carried out to investigate the effect of storage and treatment on overall quality of the apple olive blended jam, and to develop a suitable combination of olive and apple fruits pulps for jam preparation. Jam prepared from various blends of apple and olive were studied for physico chemical properties such as,% acidity, pH, (TSS), % non-reducing and % reducing sugar and for sensory attributes namely, taste, texture, color and overall acceptability during three months of storage with an interval of fifteen days. Results indicated that titratable acidity was increased from 0.64 to 0.77%, with reduction in pH from 3.57 to 3.40. Non reducing sugar was decreased from 44.57 to 27.52%. On the other hand reducing sugar of all jam samples increased from 16.62 to 30.52%. TSS of jam samples was increased during storage from 69.37 to 70.43 0Brix.

Keywords: *olive fruit, apple fruit, jam evaluation.*

GJMR-L Classification: *NLMC Code: QU 145.5*

Strictly as per the compliance and regulations of:

Quality Evaluation and Preparation of Apple and Olive Fruit Blended Jam

Wasif Shah [α], Arsalan Khan [σ], Alam zeb [ρ], Muhammad Ali Khan [ω], Falak Naz Shah [¥], Noor UL Amin [§], Muhammad Ayub [χ], Said Wahab [ν], Ali Muhammad [Θ] & Sher Hassan Khan [ζ]

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Keywords: olive fruit, apple fruit, jam evaluation.

I. Introduction

Jam is semi-solid mass, which attained from the cooking fruit pulp and sugar followed by acid, pectin, flavors and coloring substances. Jams contain about 68.5% total soluble substances and 45% at least fruit pulp, while the (7) revealed that jam should contain more than 65% total soluble solids in finished product (5). Jam, jellies and marmalade is one simple fruit product prepared from fruit individually or combination of different fruit (15).Olive (*Oleaeuropaea*L.) is a small tree fruit mostly grown in temperate zones. Olive is an egg shaped fruit, with sizes varying from 2 to 3 cm and flesh to stone ratio of 3 to 6.5. Olive is famous for its nutritious edible oil with a lot of health benefits. Other constituents are water, sugar, protein, oleouropein and anthocyanins. Oleouropein cause bitterness must be removed (10). Composition of olive fruit, moisture 65 to 75%, lipids 10-15%, reducing sugar 3-6%, non reducing sugar < 0.3%, fiber 1- 4% and protein 1-2 % (9).Olive fruit also contain1-3% phenolic compounds, 1.5% inorganic matters and 5.8% cellulose organic acid, pectin and pigments in small amount (6).Jam Apple (*MalusSylvestris*) is a member of rosaceae family and sub family pomoidae. Apple is the chief tree fruit of the globe. It was originated from the south western Asia. Nutrition facts include 84.7% water, 13.9 gcarbohydrates, 0.3g lipids, 0.4g protein and vit.C 8mg per 100 from of edible fruit. Apples are rich source of antioxidants including flavonoids and polyphenols mainly occurs in its skin. Thus eating whole apple is recommended to obtained full health benefits (11). Nonetheless, the future of olives production and processing might be very much bright in our country in general and Khyber Pakhtunkhwa in particular because this fruit fetches maximum economic returns for the farmer. To promote the olive fruit production and processing, this research work was designed to prepare a value added product from olive fruit i.ejam, which will be available throughout the year in a market. The farmers will be benefitted while getting proper return for their produce.

II. Materials and Methods

Good quality, fresh, mature and healthy olive & apple fruits was selected for the research work and was brought from the Sungbatti Olive Research Farm Swabi and apple was purchased from the local market. The selected fruit were washed with water in order to remove dust, and any other foreign material. Olive has a bitter taste, which is due to a natural glucoside called oleuropein Olive fruit were first dipped in 2% Sodium Hydroxide (Lye solution) for 36 hours in order to remove the bitterness. The removal of oleuropein is tested with 1% phenolphthalein indicator which gives red color. The lye is leached out from the olive fruit by washing in running water for 24 hours, The removal of lye is again test with 1% phenolphthalein giving no color indicating that lye is completely removed from the olive fruit. (13) After removal of bitterness from the olive fruit the pulp was obtained through pulper machine. Similarly apple fruit was washed, peeled, trimmed, cut and dipped in 1% citric acid solution to prevent oxidation. Then the fruit was blended in order to get the pulp. Treatments with different combination of olive and apple pulp were made. All the treatments were replicated three times.

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After the jam were preserved in 450gm of glass jars and3 stored at room temperature for 90 days.

a) Research Plan

Treatments	Apple pulp	Olive pulp	Sugar
Apple olive (AO_o)	1000 g	-	1000g
Apple olive (AO_1)	900 g	100 g	1000g
Apple olive (AO_2)	800 g	200 g	1000g
Apple olive (AO_3)	700 g	300 g	1000g
Apple olive (AO_4)	600 g	400 g	1000g
Apple olive (AO_5)	500 g	500 g	1000g

b) Chemical Used

Sodium Benzoate (Analytical grade-Merck Germany), Potassium sorbate (Analytical grade-Merck), Sodium hydroxide (Analytical Grade-Sigma), Copper sulphate (Analytical Grade-Merk Germany), Oxalic Acid (Analytical Grade- Sigma), Potassium hydroxide (Analytical Grade-Sigma), Methylene Blue (Sigma), Phenolphthalein (Analytical Grade-Merk). Sodium Potassium tartrate (ChemPol England).

c) Physiochemical analysis

Physiochemically all of the samples were analyzed for pH, titratable acidity, total soluble solids (TSS), reducing sugar and non-reducing sugar by (1).

d) Organoleptic Evaluation

The apple olive blended jam samples were sensory evaluated for color, texture, flavor and overall acceptability by 10 trained judge's panel. Organoleptic study was carried out at each 15 days interval for 3 month storage. The evaluation was conceded out by using 9 points hedonic scale of (14). The results are of scoring rate 1-9 awarded by judges of panel

e) Statistical Analysis

All the data concerning treatments and storage interval were statistically analyzed using factorial experiment in completely randomized design and the means were separated by applying least significant difference (LSD) Test at 5% possibility level as defined by (16). A statistical softwere STATISTIX 8.1 were used for the analysis of the data

III. Result and Discussion

a) Chemical Analysis

i. *pH*

pH of all the samples of apple olive blended jam were reduced during the total period of storage. The mean values of all the treatments showed considerable decreased from AO_o to $AO_5$3.53, 3.56, 3.48, 3.55, 3.48 and 3.55 respectively. The least mean value was noted for AO2 and AO4 (3.48) followed by AOo (3.53) and highest mean value was noted for AO1 (3.56) followed by AO3 (3.55) as shown (Table 1).Statistical analysis shows that treatment and storage has considerable effect ($P< 0.05$) on all the samples. The largest percent decline was examined in AO0 (5.33%) followed by AO1 (4.93%), while smallest decline was examined in AO5 (3.59%) followed by AO 2 (4.49%) (Table 1).Decreasing trend in pH might be due the hydrolysis of pectic bodies and formation of acidic compound during degradation of sugar contents. The gradual decrease in mean value of the pH may partly due to their varying composition, observed in mixed fruit jam prepared form water melon flesh part and lemon (8) who reported decrease in trend in pH of all treatments of mixed jam prepared from watermelon and during storagethe change in pH might be due to the change and formation acidic compound during storage of the jam

Table 1 : pH of Apple olive blended jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% Decrease	
AO_0	3.38	3.34	3.3	3.27	3.24	3.22	3.2	5.33	3.53d
AO_1	3.65	3.62	3.59	3.56	3.53	3.51	3.47	4.93	3.56a
AO_2	3.56	3.53	3.51	3.48	3.46	3.43	3.4	4.49	3.48c
AO_3	3.63	3.61	3.58	3.55	3.52	3.49	3.46	4.68	3.55b
AO_4	3.57	3.53	3.51	3.48	3.45	3.42	3.4	4.76	3.48c
AO_5	3.62	3.6	3.58	3.55	3.53	3.51	3.49	3.59	3.55ab
Mean	3.57a	3.54b	3.51c	3.48d	3.46e	3.43f	3.40g		

Values having different alphabetical letters are significantly different ($P<0.05$)

ii. *Titratable Acidity (%)*

Acidity of all the samples of apple olive blended jam was greater than that observed before storage. The mean values of all the treatments significantly decreased from AOo to AO5 0.68, 0.70, 0.69, 0.71, 0.72 and 0.73successively. The least amount mean value was noted for AOo (0.68) followed by AO2 (0.69) and highest mean value was noted for AO5 (0.73) followed by AO4 (0.72). Maximum increased was obtained in AOo (20.00) followed by AO1 (20.51) least amount increased was observed in AO5 (15.19) followed by AO4 (15.38). Results are shown in table 2. The increased in acidity of the apple olive blended jam might be due to the break down of pectic bodies to pectenic acid. The reason for increasing trend of acidity was due to the formation different organic acid during carbohydrates degradation and hydrolysis at storageThese results are in agreement with (4) who reported increasing trend in acidity of all treatments observed 0.65 to 0.70% after in 60 days storage interval of apricot jam (Table 2). Increase in acidity was due to the formation of acids by degradation of polysaccharides and oxidation of reducing sugar or by break down pectic substance and uronic acid reported by (12).

Table 2 : Titratable Acidity (%) of Apple olive blended Jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% inc	
AO_0	0.6	0.62	0.65	0.68	0.7	0.73	0.75	20.00	0.68e
AO_1	0.62	0.64	0.67	0.7	0.73	0.75	0.78	20.51	0.70d
AO_2	0.62	0.65	0.67	0.69	0.72	0.74	0.76	18.42	0.69d
AO_3	0.64	0.67	0.69	0.71	0.74	0.76	0.77	16.88	0.71c
AO_4	0.66	0.68	0.7	0.72	0.74	0.76	0.78	15.38	0.72b
AO_5	0.67	0.69	0.71	0.74	0.76	0.78	0.79	15.19	0.73a
Mean	0.64g	0.66f	0.68e	0.71d	0.73c	0.75b	0.77a		

Values having different alphabetical letters are significantly different (P<0.05)

iii. *Reducing sugar*

Mean of Reducing sugar significantly difference from AO0 to AO5 27.08, 23.44, 24.10, 23.30, 23.20 and 22.80 respectively. The minimum mean value was noted for AO5 (22.80) followed by AO4 (23.20) and maximum mean value was noted for AO0 (27.08) followed by AO2 (24.10). Maximum increased was observed in AO0 (48.72 %) followed by AO1 (46.35%) minimum increased was observed in AO5 (42.59%) followed by AO4 (44.39%).The reason for increasing the reducing sugar might be due to the presence of invertase enzymes but invertase enzymes works properly at 4.6 pH and 50 ^{0}C temperature And since the temperature was ambient in this condition, thus making it inadequate for activity of invertase enzyme. The increase in reducing sugar might be due to the inversion of non reducing sugar to during storage. The inversion of non reducing sugar was due to the presence of acid along with high temperature speed up the inversion process. Results are presented in table 3. These results are in agreement with (2) reported increased trend in reducing sugars of strawberry jam during 90 days storage. Similarly, increase in reducing sugar of apricot jam during storage was also observed by (4)

Table 3 : Reducing sugar (%) of Apple olive blended Jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% inc	
AO_0	16.64	19.34	20.89	23.13	25.67	29.78	32.45	48.72	23.99ab
AO_1	16.7	18.36	20.67	23.21	25.67	28.31	31.13	46.35	23.44bc
AO_2	16.63	19.34	22.31	24.78	26.23	28.55	30.89	46.16	24.10a
AO_3	16.6	18.76	20.56	23.48	25.89	27.88	29.95	44.57	23.30cd
AO_4	16.55	18.99	20.79	22.98	25.34	27.97	29.76	44.39	23.20cd
AO_5	16.61	18.52	20.47	22.78	25.43	26.86	28.93	42.59	22.80d
Mean	16.62a	18.89b	20.95c	23.39d	25.71e	28.23f	30.52g		

Values having different alphabetical letters are significantly different (P<0.05)

iv. *Non Reducing sugar*

Non-Reducing sugar of all the apple olive blended jam samples was decreased during storage. The mean values of all the treatments showed significant difference from AO0 to AO5 34.58, 35.40, 34.73, 37.53, 38.22 and 38.23 respectively. The minimum mean value was noted for AO0 (34.58) followed by AO2 (34.73) and maximum mean value was noted for AO5 (38.23) followed by AO4 (38.22). Maximum decreased was observed in AO0 (44.43%) followed by AO1 (40.02%) minimum increased was observed in AO4 (34.31%) followed by AO5 (35.12%). Results are presented in table 4. The decreased in non reducing sugar of apple olive blended jam might be due the inversion of acid. These results are in agreement with (2) reported decreasing trend in non-reducing sugars from 44.64 to 32.35% of strawberry jam during 90 days storage. (8) observed decreased in non-reducing sugar of grape fruit apple marmalade. The maximum decreased recorded 49.41to 34.85% and minimum decreased was recorded from 49.50 to 34.60%.

Table 4 : Non Reducing Sugar (%) of Apple olive Blended Jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% Dec	
AO_0	42.4	39.28	36.2	33.3	30.12	27.34	23.56	44.43	33.17e
AO_1	44.1	41.45	38.67	35.56	32.12	29.45	26.45	40.02	35.40c
AO_2	43.2	40.43	37.89	34.78	31.67	28.9	26.23	39.28	34.73d
AO_3	46	43.45	40.49	37.69	34.77	31.33	28.98	37.00	37.53b
AO_4	45.5	43.78	40.99	38.9	35.67	32.78	29.89	34.31	38.22a
AO_5	46.21	43.21	41.12	38.89	35.41	32.79	29.98	35.12	38.23a
Mean	44.57a	41.93b	39.23c	36.52d	33.29e	30.43f	27.52g		

Values having different alphabetical letters are significantly different (P<0.05)

v. *Total Soluble Solid (TSS)*

Total soluble solid of all the apple olive blended jam samples was increased during 90 days storage interval. The mean values of all the treatments show significant difference from AO0 to AO5 70.06, 70.63, 70.13, 70.31, 69.04 and 69.29 respectively. The minimum mean value was noted for AO4 (69.04) followed by AO5 (69.29) and maximum mean value was noted for AO1 (70.63.) followed by AO3 (70.31). Maximum increased was observed in AO 1 (1.82%) followed by AO4 (1.58%) minimum increased was observed in AO3 (1.41%) followed by AO5 (1.43%). The increasing in total soluble solid of the apple olive jam might be due to the degradation of polysaccharides in the presence of acid.Results are presented in table 5.Increased in TSS of watermelon lemon jam from 68.62 up to 68.90 and during 60 days of storage in grapes fruit marmalade from 70 to 70.8 ^{0}brix by (8)

Figure 1: Showing Apple olive Blended jam stored at ambient temperature

Table 5 : Total soluble solid (^{0}Brix) of Apple olive Blended Jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% inc	
T0	69.5	69.7	69.9	70.1	70.3	70.5	70.4	1.28	70.06c
T1	70	70.2	70.4	70.6	70.8	71.1	71.3	1.82	70.63a
T2	69.6	69.8	69.9	70.1	70.3	70.5	70.7	1.56	70.13c
T3	69.8	69.9	70.2	70.3	70.5	70.7	70.8	1.41	70.31b
T4	68.5	68.7	68.8	69	69.2	69.5	69.6	1.58	69.04e
T5	68.8	68.9	69.1	69.3	69.5	69.6	69.8	1.43	69.29d
Mean	69.37g	69.53f	69.72e	69.90d	70.10c	70.32b	70.43a		

Values having different alphabetical letters are significantly different (P<0.05)

b) Organoleptic Evaluation

i. *Color*

Color of all the apple olive blended jam samples was decreased during 90 days storage interval. The mean values of all the treatments showed significant difference from AO0 to AO5 9.77, 7.64, 7.87, 8.00, 7.93 and 8.23 respectively. The minimum mean value was noted for AO1 (7.64) followed by AO2 (7.87) and maximum mean value was noted for AO0 (9.77) followed by AO5 (8.23). Maximum decreased was observed in AO0 (27.38%) followed by AO1 (21.84%) minimum increased was observed in AO5 (15.73%) followed by AO3 (16.09%). Changes in color might be attributed to Millard reaction, enzymatic browning ascorbic acid degradation and polymerization of color pigments (carotenoids and anthocyanin's) with other phenolic compound. Results are presented in table 6. The effect of low storage temperature and freezing techniques on ascorbic acid content and additional qualitative characteristics of Iranian strawberries and affirmed that the storage temperature of 18 and 24 0c were mostly excellent for preserving the qualitative individually (flavor, texture color and entirety) of the strawberries (3).

Table 6 : Color Score of Apple olive Blended jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% Decrease	
AO_0	8.4	8.1	7.7	7.3	6.8	6.4	6.1	27.38	7.26d
AO_1	8.7	8.2	7.9	7.6	7.3	7	6.8	21.84	7.64c
AO_2	8.6	8.4	8.2	7.9	7.6	7.3	7.1	17.44	7.87b
AO_3	8.7	8.5	8.3	8	7.7	7.5	7.3	16.09	8.00b
AO_4	8.8	8.6	8.3	7.9	7.6	7.3	7	20.45	7.93b
AO_5	8.9	8.7	8.5	8.2	8	7.8	7.5	15.73	8.23a
Mean	8.68a	8.42b	8.15c	7.82d	7.50e	7.22f	6.97g		

Values having different alphabetical letters are significantly different (P<0.05)

ii. *Taste*

Taste of all the apple olive blended jam samples was decreased during 90 days storage interval. The mean values of all the treatments showed significant difference from AO0 to AO5 10.54, 7.77, 8.21, 8.29, 8.29 and 8.37 respectively. The minimum mean value was noted for AO1 (7.77) followed by AO2 (8.21) and maximum mean value was noted for AO0 (10.54) followed by AO5 (8.37). Maximum decreased was observed in AO0 (34.12%) followed by AO1 (20.69%) minimum increased was observed in AO5 (14.44%) followed by AO2 (15.73%). Results are presented in table 7. Organic acid and sugar ratio primarily creates a sense of taste which is perceived by specialized taste buds on the tongue. Decrease in taste score might be due to the fluctuation in acids, pH and sugar/acid ratio.These results are in accordance with (8) reported decreasing trend from 6.2 to 4 during initial and 150 days during storage of watermelon and lemon jam.

Table 7 : Taste Score of Apple olive Blended Jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% Dec	
AO_0	8.5	8.1	7.7	7.2	6.8	6.3	5.6	34.12	7.17c
AO_1	8.7	8.3	8	7.8	7.5	7.2	6.9	20.69	7.77b
AO_2	8.9	8.7	8.5	8.2	8	7.7	7.5	15.73	8.21a
AO_3	9	8.8	8.6	8.3	8.1	7.8	7.4	17.78	8.29a
AO_4	9	8.7	8.5	8.3	8.1	7.9	7.5	16.67	8.29a
AO_5	9	8.8	8.6	8.4	8.2	7.9	7.7	14.44	8.37a
Mean	8.85a	8.57b	8.32c	8.03d	7.78e	7.47f	7.10g		

Values having different alphabetical letters are significantly different (P<0.05)

iii. *Texture*

Texture of all the apple olive blended jam samples was decreased during 90 days storage interval. The mean values of all the treatments showed significant difference from AO0 to AO5 5.9, 6.5, 6.7, 6.5, 6.7 and 7.1 respectively. The minimum mean value was noted for AO0 (5.9) followed by AO1 and AO3 respectively (6.5) and maximum mean value was noted

for AO5 (7.1) followed by AO2 and AO4 (6.7). Maximum decreased was observed in AO0 (34.7%) followed by AO1 (28.9%) minimum decreased was observed in AO5 (16.9%) followed by AO2 (23.7%). The textual properties of the jam are usually attributed pectic bodies composition. The pecticbodies in olive fruit are very low as compared to apple fruit. The decrease in pecticsubsatance with storage significantly affect the texture score of the apple olive blended jam; Results are presented in table 8. These results are in accordance with (17) studied the structural changes in strawberry tissue during glacial and stated that the textural attributes in particular were statistically significantly different among the strawberry jams.

Table 8 : Texture Score of Apple olive blended Jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% Dec	
AO_0	7.2	6.9	6.3	5.8	5.3	5	4.8	34.7	5.9d
AO_1	7.6	7.2	6.8	6.5	6.2	5.8	5.4	28.9	6.5c
AO_2	7.6	7.2	6.9	6.7	6.4	6.1	5.8	23.7	6.7bc
AO_3	7.4	7.1	6.8	6.5	6.2	5.9	5.6	24.3	6.5c
AO_4	7.6	7.4	7.1	6.7	6.3	6	5.7	25.0	6.7b
AO_5	7.7	7.5	7.3	7.1	6.8	6.6	6.4	16.9	7.1a
Mean	7.52a	7.22b	6.87c	6.55d	6.20e	5.90f	5.6g2		

Values having different alphabetical letters are significantly different (P<0.05)

iv. *Overall Acceptibility*

Over all acceptability of all the apple olive blended jam samples was decreased during 90 days storage interval. The mean values of all the treatments showed significant difference from AO0 to AO5 6.91, 7.42, 7.68, 7.70, 7.73 and 7.72 respectively. The minimum mean value was noted for AO0 (6.91) followed by AO1 (7.42) and maximum mean value was noted for AO4 (7.73) followed by AO5 (7.72). Maximum decreased was observed in AO0 (31.84%) followed by AO1 (22.92%) minimum decreased was observed in AO5 (17.43%) followed by AO2 (18.18%). The apple olive blended jam remains acceptable after 90 days of storage period. Sensory traits are non-generally inter related and contributes independently towards the overall sensory perception.Results are presented in table 8. These results are in accordance with (8) reported decreasing trend from 8.80 to 7.96 in apple marmalade.

Table 9 : Overall acceptability of Apple olive blended Jam

Treatments	Storage intervals								Mean
	Initial	15	30	45	60	75	90	% Decrease	
AO_0	8.2	7.8	7.4	6.9	6.5	6.0	5.6	31.84	6.91c
AO_1	8.4	8.0	7.7	7.4	7.1	6.8	6.5	22.92	7.42b
AO_2	8.4	8.2	8.0	7.7	7.4	7.1	6.9	18.18	7.68a
AO_3	8.5	8.2	8.0	7.7	7.4	7.2	6.9	18.90	7.70a
AO_4	8.5	8.3	8.1	7.8	7.5	7.2	6.8	19.92	7.73a
AO_5	8.5	8.3	8.0	7.7	7.4	7.2	7.0	17.43	7.72a
Mean	8.42a	8.14b	7.86c	7.53d	7.22e	6.90f	6.61g		

Values having different alphabetical letters are significantly different (P<0.05)

Figure 2: Showing treatment AO_5 and its replication of the Apple Olive blended jam stored at ambient temperature

IV. Conclusion

Apple olive blended jam was prepared from apple and olive pulp and was examined during time interval of 90 days. Statistically it is concluded that storage and treatment has significant effect on the quality and stability of the apple olive blended jam. Results investigated that good quality jam with equal amount of apple and olive pulp could be prepared and storage with minimum damages among the other treatment both physiochemically and organoleptically even after 90 days of storage interval.

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Ways for Better Utilization of Finger Millet through Processing and Value Addition and Enhance Nutritional Security among Tribals

By S. Patel & Veenu Verma

Abstract- Finger millet is in food use since time immemorial, and large number of traditional food preparations is in practice in the rural areas (predominantly tribal areas), particularly in the production catchments. Finger millet also known as ragi in India is one of the important cereals occupies highest area under cultivation among the small millets. Finger millet is comparable to rice with regard to protein (6-8%) and fat (1-2%) and is superior to rice and wheat with respect to mineral and micronutrient contents. It is a major source of dietary carbohydrates for a large section of society. However, its utilization in the daily dietary at present is largely restricted to rural areas/tribal areas only. Unavailability of products to the taste of urban community is the main reason. Processing the finger millet using traditional as well as modern techniques for the development of value added and convenient food products would be the possible solution for its promotion and enhancement of consumption, nutritional status and thereby increasing profitability and better livelihood to the tribal community. This will also help the country to diversify the food basket for nutritional sustainable food availability to the common mass with low purchasing capacity. The present paper describes some of the possible value added products from finger millet.

Keywords: *millet, millet processing, value addition and traditional food.*

GJMR-L Classification: *NLMC Code: QU 145*

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Ways for Better Utilization of Finger Millet through Processing and Value Addition and Enhance Nutritional Security among Tribals

S. Patel [α] & Veenu Verma [σ]

Abstract- Finger millet is in food use since time immemorial, and large number of traditional food preparations is in practice in the rural areas (predominantly tribal areas), particularly in the production catchments. Finger millet also known as *ragi* in India is one of the important cereals occupies highest area under cultivation among the small millets. Finger millet is comparable to rice with regard to protein (6-8%) and fat (1-2%) and is superior to rice and wheat with respect to mineral and micronutrient contents. It is a major source of dietary carbohydrates for a large section of society. However, its utilization in the daily dietary at present is largely restricted to rural areas/tribal areas only. Unavailability of products to the taste of urban community is the main reason. Processing the finger millet using traditional as well as modern techniques for the development of value added and convenient food products would be the possible solution for its promotion and enhancement of consumption, nutritional status and thereby increasing profitability and better livelihood to the tribal community. This will also help the country to diversify the food basket for nutritional sustainable food availability to the common mass with low purchasing capacity. The present paper describes some of the possible value added products from finger millet.

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I. Introduction

Of the estimated total of 80000 plants with possible economic use, approximately 30,000 plants have been found edible in nature, and 7,000 have been cultivated by the mankind at one time or the other; but out of these, only 158 plants are used widely for food. Among these, 30 crops provide 90% of world's food, 10 supply 75% of world's food basket; and over 60% of world's total protein and calories are provided by only three crops – rice, wheat and maize. Our food security, with such a high dependence on these narrow food-base, faces and will face high risk owing to growing uncertainties in the climate and emergence of new biotic and abiotic stresses. Consequently, there is a global concern to collect, introduce, evaluate and utilize vast array of lesser known, under-exploited, alternative crop-plants for diversifying agricultural systems.

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India is the leading producer of small millets namely, finger millet (*ragi*), kodo millet (*kodo*), foxtail millet (*kangni*), barnyard millet (*sawan*), proso millet (*cheema*) and little millet (*kutki*). Annual planting area under them is around 2.5 million hectares; and nearly 1.5 million hectares is under finger millet comprising about 40-50% of crop's global area. During the last three decades, area under finger millet has declined but with the significant improvement in the productivity (1,500 kg/ha), its annual production is maintained at around 2.4 million tonnes. At present, small millets account for less than 1% of food grains produced in the world (ICAR, 2010). Their cultivation dates back to nearly 5000 years, and in India, they form an important component of the traditional cropping systems and contribute significantly to the regional food and nutritional security and diversity in the national food basket; and they are important in areas of their production as dryland crops, as well as for hill agriculture. The small millet grains have longer storage life, and can be termed as famine reserve. The resilience exhibited by them may prove good for their adjustment to different eco-systems and make them potential crops for contingency plantings.

Cereals form a major portion of human diet and are an important source of starch and other dietary carbohydrates (dietary fibre), which play an important role in the energy requirement and nutrient intake of human. The millets are with higher fibre content, and their protein quality and mineral composition contribute significantly to nutritional security of a large section of population residing in the millet growing areas, considered to be the most disadvantaged groups. Millets are most recognised nutritionally for being a good source of minerals magnesium, manganese and phosphorus. Research has linked magnesium to a reduced risk for heart attack and phosphorus is important for the development of body tissue and energy metabolism. Millets are also rich in phytochemicals, including phytic acid, which is believed to lower cholesterol, and phytate, which is associated with reduced cancer risk. Thus, millets are strategic in terms of their food, nutritional and livelihood security and their role in local agro-ecosystems.

Food uses of millets have, however, been confined only to traditional consumers; limited especially

to areas of their cultivation, and still have remained underutilized. Processing them using traditional as well as contemporary methods for preparation of value added and convenience products would certainly diversify their food uses. Their exploitation for preparation of ready-to-use or ready-to-cook products would help in increasing the consumption of millets among non-millet consumers and thereby nutritional security. The present paper is an attempt to describe some basic information about finger millet, the processing requirement and some avenue for its value addition and food uses.

Finger millet (*ragi*) is rich in protein, iron, calcium, phosphorus, fibre and vitamin content. The calcium content is higher than all the cereals and iodine content is said to be highest among all the food grains (Desai et al., 2010). *Ragi* has best quality protein along with the presence of essential amino acids, vitamin A, vitamin B and phosphorus (Gopalan et al., 2004). Finger millet (*ragi*) provides highest of level of calcium, antioxidants properties, phytochemicals, which make it easily and slowly digestible. Hence it helps to control blood glucose levels in diabetic patients very efficiently.

II. Methodology

a) Nutritional composition of finger millet

Like other cereals grains small millets are predominantly starchy. The protein content is more or less equal and comparable to that of wheat, rice and maize. Finger millet has slightly lower protein content but is in fact nutritionally superior because the protein quality is generally as good as or better than other cereals. Finger millet contains lowest fat. One of the characteristic features of the grain congestion of millet is their high ash content (mineral composition). They are relatively rich in iron and phosphorus. Finger millet has the highest calcium content≈(300 - 400 mg/100 g) among all the food grains. High fibre content and lower digestibility of nutrients is the other characteristic feature of millet grains. The nutritional composition of small millets has been reported and published many places by researchers. However, an average nutritional composition of finger millet along with other cereals is being reproduced here for easy look of the readers (Malleshi, 2007).

b) Processing and value addition

Similar to other cereal grains finger millet is also required to undergo certain basic steps of primary processing operations, such as cleaning, grading and separation wherein removal of unwanted materials like, stones, soil particles, stalks, chaffs, grains of other crops etc. These operations are also important for adding value to the produce from the point of view of getting better returns from their sale. The finger millet grain is essentially covered with an outer thin pericarp known as glume which needs to be removed from the kernel prior to further processing as it is non-edible tissue. Glume is separated by giving mild abrasive action with the help of hand or foot pounding operation. This is also possible with the help of hullers used for dehusking of paddy. Specially designed ragi polishers are also used for this purpose in southern part of India. Pre-cleaning operations are accomplished by using cleaners and destoners used for other cereals after making suitable modifications.

c) Milling

The most common primary processing of finger millet is to convert the grain in the form of flour which is achieved by pulverizing or milling. Different types of conventional and modern equipments/machines are available for milling the finger millet grains into flour. Some of them are; conventional stone mills, burr mills (steel or emery type), hammer mills, ball mills etc. Since the whole meal is used for different preparations, the fineness of the flour or the machine by which it is prepared does not arise. On demand of the recipe the coarser flour is separated by sieving the whole meal. Till date, no scientific definition about the millet flour for traditional preparations like chapatti (*roti*), mudde of Karnataka, *pez* of Bastar *etc.* has been established. However, finer flour is preferred for making chapatti whereas comparatively coarser flour is suitable for *mudde* and *pez* making depending upon the cooking methods. *Mudde* is a typical preparation of Karnataka and very often prepared during social functions. *Ambli* is another traditional preparation but it is something like thin porridge and not the stiff like *mudde*. *Pez* is a typical traditional preparation of Bastar in the form of thin porridge or gruel like cooking; it also contains few cooked rice grains. Coarser flour helps in lump formation during mudde preparation and that of finer flour absorbs more water due to higher surface area and facilitates flattering for chapatti making.

In recent years the consumption of finger millet along with other millets has been increased particularly in the urban sector due to awareness about the inherent nutritional and medicinal properties of millets. Looking to the growing demand of ready-to-eat and ready-to-cook products, there is a need exists to prepare the millet flour suitable for different traditional food products. Fortified ready mixes for the conventional preparation of popular traditional foods combining finger millet (ragi) as one of the ingredients are available in the market which further encourages for milling of ragi into flour. Millet is gluten-free and safe to eat for those who experience gluten sensitivity.

III. Results and Discussion

a) Value addition and value added products

In the foregoing paragraphs, some of the examples of value added products and possibilities of utilizing finger millet as one of the basic ingredients are

discussed. Finger millet can be used in a variety of ways and is a great substitute for other grains such as rice and other starchy grains. These products are either in practice or have been demonstrated/ tested as avenue for enhanced consumption of finger millet. However, not much scientific studies have been carried out about their preparation and meaningful popularization on large scale.

i. *Multi-grain flour /Composite flour*

The concept of multi-grain flour/composite flour is not new to the mankind. Mixing of two-three types of grains or grain and pulses has been in practice since long ago depending upon the availability of such commodities locally or the food habits, but in such cases, the understanding of nutritional security is not necessarily linked. Multi-grain flour by combining wheat and finger millet in the ratio of 7:3 (wheat:finger millet) is one of the simple semi-finished products suitable for making chapatti (roti), as no Indian meal is complete without Indian style bread or roti. In the proposed blend, though the gluten content is reduced significantly the making of chapatti while flattering is not affected. However, the colour of the chapatti turns to slightly dark. Fortification of finger millet in chapattis not only improves the taste but also helpful in controlling glucose levels in diabetic patients very efficiently. The bulkiness of the fibres and the slower digestion rate makes us feel fuller on, fewer calories and therefore may help to prevent from eating excess calories. Its high fiber content is further helpful to the individuals having the problem of constipation.

ii. *Papad*

Addition of finger millet as one of basic ingredient to the tune of 15-20% (w/w) along with other essential ingredients such as black or green gram, rice and spices has become a tradition in millet growing areas of South India. According a report, addition of finger millet up to 60% in papad is possible and practised in some parts of Karnataka (Begum, 2007).

Papad from finger millet flour is also prepared in which it is used as base material mixed with spices and salt. Flour is first cooked in water till it is gelatinized and dough is prepared. Thin sheet from the dough is prepared by rolling it and cutting into desired shapes and sizes followed by drying of these papad pieces to desired moisture content of 7-8% (db). Since the pericarp is not separated out from the starch, it gives a little dark colour to the papad which again upon frying or roasting turns to lighter with good consumer acceptability.

iii. *Puffing or popping*

Puffing or popping of cereals is an old practice of cooking grains since time immemorial to be used as snack or breakfast cereal like corn either plain or with some spices/salt/sweeteners. Popping or puffing of finger millet is one of the popular traditional methods and the popped millet and its flour is a ready-to-eat (RTE) product with pleasing texture and appealing flavour. Popping improves the nutritional value by inactivating some of the antinutritional factors (enzymes and enzyme inhibitors) and thereby enhancing the protein and carbohydrate digestibility; it also enhances the appearance, colour, taste and aroma of the processed raw material (Mangala et al., 1999). The flour can be used for different types of RTE food preparations depending upon the taste and likings. For puffing, the whole finger millet grain is conditioned by mixing additional water so as to reach its moisture content in the range of 18-20% and tempered for about 4-6 hours under shed. The conditioned grains are puffed by agitation on the hot sand surface maintained at about 230 - 250˚C for short time following HTST (high temperature and short time) process. During this process, the sugars present in the aleurone layer react with amino acids of the millet causing Millard reaction and as a result, a pleasant and highly desired aroma is developed. Further, during this process, the vapour pressure of the grain increases and the moisture present in the grain turns into steam; gelatinization of the starch takes places and explodes. Since during popping or puffing grains are dehydrated to the extremely low level of moisture content, nearly 3-5%, the shelf-life is enhanced. Now a day modern air puffing machines have been developed which can be used for mass production of puffed or popped millet grains. In addition to this, there will be no risk of sticking sand particles with the product in machine popping or puffing.

iv. *Puffed finger millet mix*

Puffed finger millet grains can be converted into powder by simple grinding which can further be enriched with additional ingredients. Various combination of ingredients can be taken and mix well, this nutritious mix so prepared forms ready-to-eat (RTE) food. The selection and combination of the ingredients is done based on the requirement of the target groups like children, pregnant and lactating mothers etc. The ingredients are selected in such a way that no further cooking requires and hygienically packed in suitable packaging materials. The following table give an example of such mix, similar other combination of ingredients can be selected which should be nutritious as well as acceptable to the target group. The mix contains higher amount of protein, energy, calcium and iron with higher bioavailability.

v. *Malting – Weaning food*

Traditionally the millet malt is utilized for infant feeding purpose and also to prepare beverages either with milk of luke warm water with the addition of sugar since pretty old times. Finger millet being good malting characteristics, its malting is popular in the area of cultivation particularly in Karnataka and part of Tamilnadu. Malting of finger millet improves its

digestibility, sensory and nutritional quality as well as pronounced effect in lowering the antinutrients (Desai et al., 2010). Finger millet has some of the inherent qualities which make it superior compare to other cereals and also qualify for malting and preparation of malted foods. It is resistant to fungal infection and elaboration of alpha and beta amylase during germination and during roasting/ kilning a desirable aroma as well as is developed which makes it an ideal grain for malt foods. In addition to these, finger millet is a good source of sulphur amino acids and calcium. An example of composite malt flour (malted weaning food) preparation combining finger millet, green gram and bengal gram is presented in the following process flow chart. This blend is nutritional in addition to rich source of protein and calcium.

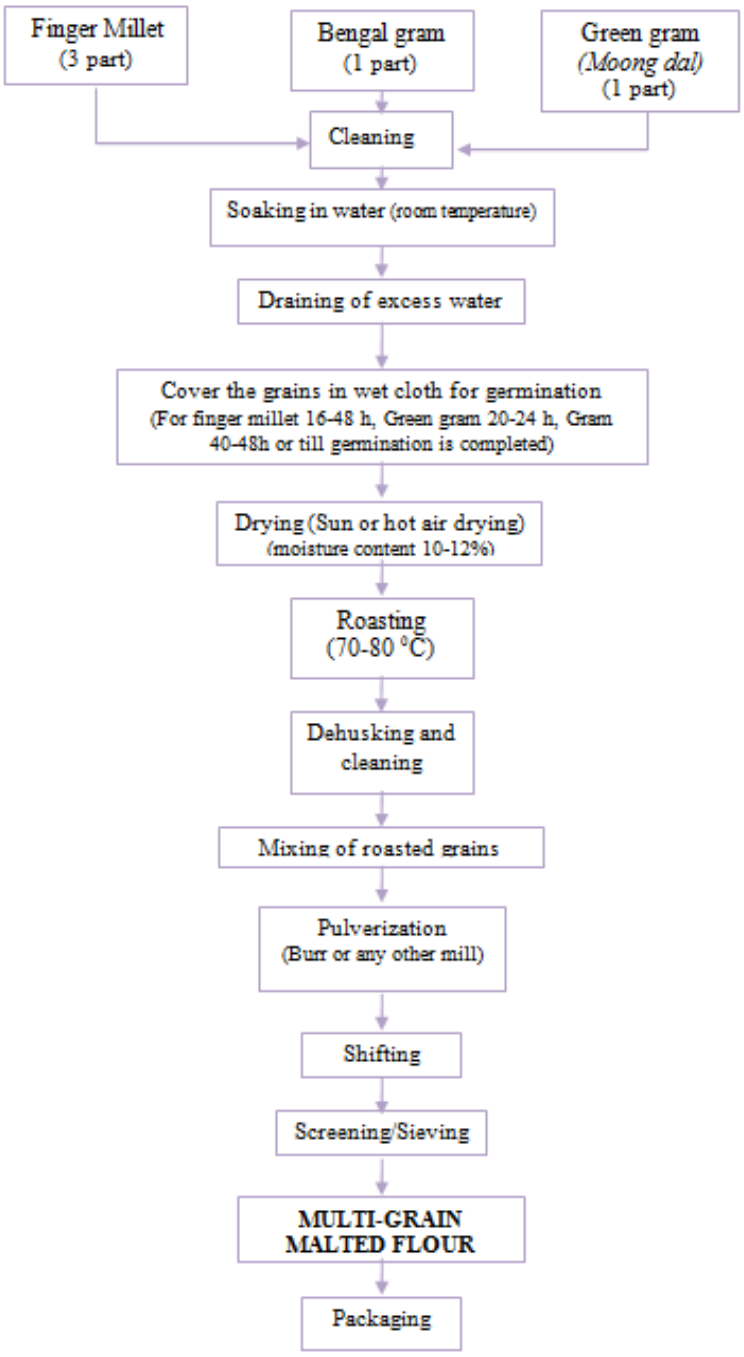

Figure 1 : Process flow chart for multi-grain malted flour preparation

In the above unit operations, the germination is an important unit operation which needs greater attention. During germination process, the hydrolytic enzymes bring changes in the endosperm. Some of the vitamins are also synthesized and the bioavailability of minerals increases. During soaking, the soak water is

required to be changed once or twice to prevent the excessive growth of micro-organisms and also to make it free from CO_2 formed during soaking. During germination, it is essential to mix or turn the grains to provide good aeration to facilitate better germination. Germination period of about 48 hours is desired but in summer it can be reduced to 36 hours. To stop the germination process, the grains are dried either sun or mechanically drying. While drying it should be kept in mind that the drying temperature should not exceed 75˚C. Higher drying temperature may cause parboiling effect and hardening of the grains which may have adverse effect on milling and quality of the malt flour. The sprouted grains should be dried to a final moisture content of nearly 10-12% and subsequently the separation of roots and shoots is done which can be accomplished by various traditional and modern methods by giving a mild rubbing or abrasion action to the grain mass. These grains (malted) are then roasted uniformly at 70 - 80˚C either by conventional toasting pan or heaters. Uniform heating and roasting helps in developing characteristic aroma and desirable quality of the product. The malt so obtained is pulverized to convert it into ready-to-eat (RTE) form. The pulverization can be accomplished by any size reduction facilities suitable to convert into fine flour. The pulverized malt is then subjected to sieving through the fine sieve to separate the husk and fine malt flour is obtained.

The malted weaning food is mixed with powdered sugar, milk powder or whole milk along with flavouring agents to make as milk based beverage. This preparation is a good source of nutrition and suitable for all the age groups. This preparation is popularly known as 'ragi malt' and can be used as health drink or energy drink. Now-a-days about 5% ragi malt is invariably blended with the energy food to improve its texture and mouth feel.

vi. *Noodles – Vermicelli*

The changing food habits of children and teen aged groups have created a good market of noodles in India and abroad. The demand for millet noodles particularly the noodles made out of finger millet is growing due to awareness about its nutritional properties. Noodles are the pasta products also known as convenience foods prepared through cold extrusion system which become hard and brittle after drying. The cooking of these noodles is very convenient and requires few minutes (2 minutes), they are cooked with water, some vegetable pieces, spices etc. also added and served hot. Noodles of different combinations are prepared such as noodles exclusively made of finger millet, finger millet and wheat in the ratio of 1:1 and finger millet blended with wheat and soy flour in the ratio of 5:4:1. In case of exclusive millet based noodles, pre-treatment to the millet flour is given to facilitate extrusion and smooth texture which should retain while drying and cooking. Generally, in the preparation of noodles, wheat flour is invariably used as an important member of blend because the presence of wheat gluten has an added advantage which not only helps in easy extrusion but also gives a smooth and fissure free texture to the noodles. Several other combinations of blends can be explored in the preparation of noodles keeping food values of ingredients and their availability in mind.

vii. *Extruded products*

Extrusion technology is another novel way of transforming ingredients into value added products. Extruded products prepared from different grains are very popular now-a-days among the all age groups and their demand is growing, one such example is 'Kurkure', very popular among children. The change in life-style is also bringing a drastic change in the food habits, and the extruded foods being ready-to-eat (RTE) products have become a good choice as snack foods. All the cereals containing good amount of starch can be extruded after making flour and conditioning to required condition. Finger millet flour or grits exhibit good extrusion characteristics. Extrusion cooking has ability to gelatinize and cook the product to the fullest extent and enables its uses as a RTE food. In extrusion cooking the combined effects of shear along with heat and pressure are mainly responsible for the modification of starch properties. The flour/grit with 16-18% moisture content has ability to extrude in the barrel temperature range of 100-120˚C well with good expansion index with crunchy, porous and smooth surface texture. Like other preparations, the finger millet flour can be blended with other legume ingredient flours in appropriate proportion with further fortification of minerals and vitamins to design a balanced nutritional food. Alternatively, the extrudates can be pulverized and blended with calculated amount of other pre-prepared/cooked ingredients to prepare supplementary food mix for infant babies and lactating mothers etc. A further value addition of extrudates so prepared from finger millets can be done by coating with sweet or savoury to attract children.

viii. *Bakery products*

Incorporation of finger millet flour in the preparation of bakery products like biscuit, nan-khatai, muffins and bread has been attempted and efforts are being made to standardize the recipe and product quality. The use of millets in bakery products will not only superior in terms of fibre content, micronutrients but also create a good potential for millets to enter in the bakery world for series of value added products. In a recent study attempts have been made to improve the nutritional quality of cakes with respect to the mineral contents and fibre content by supplementing with malted finger millet flour (Desai et al., 2010). In recent years finger millet has received attention and efforts are

under way to provide it to consumers I n convenient forms (Malleshi and Desikacher, 1986).

ix. *Fermented foods*

Fermented foods like *Dosa* and *Idli* are popular in many parts of India. These are very common as breakfast foods and even as the evening meals in southern part of the country. Finger millet is widely used as one of the ingredient for these kind of fermented foods. It not only improves the taste but at the same time enriches the food value in terms of protein, calcium and fibre. Sprouting of finger millet grain or the malted grains are also used for fermented foods depending on the taste and choice. Ragi flour is blended with the other base ingredients for fermented foods following other procedures.

x. *Ragi Soup*

Mix Ragi flour in Water without any lumps. Heat this Ragi water mix in medium heat for 15 minutes or till its cooked. Stir this mix frequently to avoid forming lumps. Then remove from heat, mix Curd and Salt to it. Serve warm or cold.

xi. *Ragi Pakora (finger millet fritters)*

Cut Onion lengthwise. Crush the Garlic using a knife. Keep them aside. Mix Ragi flour, crushed Garlic, Cumin seeds, Red chili powder and Salt to a bowl. Add 1/2 to 3/4 cup of water to the ingredients and make a more liquid like paste. Add the cut Onion to the flour mix and coat it well with the mix. Heat oil in a pan. Once the oil is hot enough, add the flour coated Onion to the oil and fry till it becomes crispy. Serve Hot.

xii. *Ragi Vada*

Chop Onion and Greens (Keerai). Keep aside. Take a vessel and mix all the ingredients except Oil. Add required Water and make a soft dough (like chapati dough), but slightly thinner than chapati dough. Heat Oil in a pan. Take a small amount of dough, press that with help of fingers and drop that in hot Oil. Fry till it turns into crispy or till the bubbles are almost stopped.

In addition to the above preparations many other local preparations are in practice making use of finger millet depending upon the local habits and choice of the groups, some of them are common across the regions but some typical products remain in the domain which need to be popularized. Few modern products incorporating finger millet are now available in the market such as, ragi health drink (baby vita), foodles, multi-grain noodle, ragi biscuit, ragi vermicelli etc.

IV. Conclusion

Finger millet is well comparable and even superior to many cereals in terms of mineral and micronutrient contents. Its major use as food has remained only in the area where it is cultivated and to the traditional preparations. Finger millet has good potential of providing nutritional security to the consumers. Its consumption in urban area can be increased through its proper processing and value addition. With the advancement of post harvest processing and value addition technologies, it has become possible to process and prepare value added products which are acceptable by both rural and urban consumers. This will not only help in increasing the profitability of its cultivators but will also help in providing income and employment opportunities in rural area.

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Table 1 : Nutritional composition of finger millet compared to other cereals (g/100 g)

Food grain	Proteins	Carbohydrates	Fat	Dietary fibre	Minerals	Calcium (mg)	Phosphorus (mg)
Finger millet	7.3	72.0	1.3	18.8	2.7	344	283
Wheat	11.8	71.2	1.5	12.9	1.5	41	306
Rice	6.8	78.2	0.5	5.2	0.6	10	160
Barley	11.5	69.6	1.3	22.3	1.2	26	215
Maize	11.1	66.2	3.6	10.5	1.5	20	348
Sorghum	10.4	72.6	1.9	12.0	1.6	25	222
Oats	11.6	69.8	5.2	20.0	2.9	94	385

Table 2 : Example of a RTE mix

Ingredients	Per 100 g
Puffed finger millet flour	33
Sugar powder	30
Defatted soy flour	10
Dried coconut powder	25
Cardamom or other spice as per taste	02

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Effect of Drying Methods and Pre- Treatments on Shelf Life and Microbial Quality of Fish (Oreochromis Niloticus, Pylodictis Olivaris and Cyprinus Carpio) Species Commonly used in Gambella Region

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Abstract- A study was conducted to assess the effect of drying methods and pre-treatments on shelf-life and microbial quality of dried fish. The experiment was conducted in factorial arrangement of 2×3×2 with two drying methods (sun and oven drying,) three fish species (tilapia, cat fish and carp) and two preservatives treatment (garlic and ginger juice) laid out in Completely Randomized Design (CRD). Fresh fillets were analyzed for their microbiological quality. Drying reduced the moisture contents making it safe for long term storage. The dried fillets were stored at ambient condition and the samples were analyzed for microbial status every twenty days starting from the end of drying operation. Fresh fillet and untreated dry fillet were used as control. In the fresh fillets, a high load of aerobic bacteria of 5.11 log10 cfu/g was observed on carp, and E.coli was detected in all three species whereas no Salmonella spp.

Keywords: microbial quality, fish handling, fish preservation, fish slicing, drying methods, dried fish shelf life, gambella region, ethiopia.

GJMR-L Classification: NLMC Code: QU 145.5

Strictly as per the compliance and regulations of:

Effect of Drying Methods and Pre-Treatments on Shelf Life and Microbial Quality of Fish (Oreochromis Niloticus, Pylodictis Olivaris and Cyprinus Carpio) Species Commonly used in Gambella Region

Dagne Tarle [α], Mitiku Eshetu [σ], Solomon Abera [ρ] & Getahun Asebe [ω]

Abstract- A study was conducted to assess the effect of drying methods and pre-treatments on shelf-life and microbial quality of dried fish. The experiment was conducted in factorial arrangement of 2×3×2 with two drying methods (sun and oven drying,) three fish species (tilapia, cat fish and carp) and two preservatives treatment (garlic and ginger juice) laid out in Completely Randomized Design (CRD). Fresh fillets were analyzed for their microbiological quality. Drying reduced the moisture contents making it safe for long term storage. The dried fillets were stored at ambient condition and the samples were analyzed for microbial status every twenty days starting from the end of drying operation. Fresh fillet and untreated dry fillet were used as control. In the fresh fillets, a high load of aerobic bacteria of 5.11 $\log_{10}$ cfu/g was observed on carp, and *E.coli* was detected in all three species whereas no *Salmonella* spp. was detected at all. Regarding freshly dried fillets, high load of aerobic bacteria (5.82 $\log_{10}$ cfu/g) was observed in untreated tilapia whereas the initial load of moulds was <1 $\log_{10}$ cfu/g in all freshly dried fillets. After sixty days of storage, the load of aerobic bacteria and moulds was 8.03 and 7.92 $\log_{10}$ cfu/g, respectively, in untreated sundried carp, tilapia and cat fish fillets, higher than that in treated samples.

Keywords: microbial quality, fish handling, fish presser-vation, fish slicing, drying methods, dried fish shelf life, gambella region, ethiopia.

I. Introduction

Different species of fish had benefits for the world as food for human consumption (Mdegela *et al*., 2010). The global traditional and improved fish processing technologies in aquatic food production had more than double since 1970, with a total of approximately 93.2 million metric tons in 1997 (Akinneye *et al*., 2007).

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The drying of different species of fish was one of world's oldest known preservation methods, and dried fish had a storage life. Freshwater fish should be preserved to assure best possible consumption quality, provide a proper form of semi-processed final product, assure safety of products, and reduce wastes to the barest possible extent. To keep the quality and safety of fish, it was essential to minimize water activity in fish in appreciable quantities in good condition until its use is required (FAO, 1990). Akinola *et al*. (2006) reported that different types of preservation methods like; drying, smoking, freezing, chilling and brining were used for prolonging shelf-life of fish products. The techniques of preservation also important for thousands of tons of fish wasted annually through poor handling and unhygienic treatment as well as absence of improved technologies for processing and preservation. Fish is highly susceptible to deterioration without any preservatives or processing measures (Clucas and Sctcliffe, 1987 and Okonta and Ekelemu, 2005).

The common methods of fish preservation in Ethiopia include drying, salting, smoking, and their combinations (Okorely and Kwarten, 2006). Sun drying was one of the traditional methods employed to preserve fish in Gambella region. It had been observed as the most convenient and cheapest form of preservation (Eyo, 1986).

Major problems with traditional sun drying were loss of quality due to contamination and infestation by insects, and inappropriate drying rates (Sa blani *et al*, 2002).These made change in nutritional and organoleptic characters of traditionally processed fish (Afolabi *et al*., 1984). Akinola *et al.* (2006) reported that in the process of traditional methods, lack of control over the drying rate, sometimes results in over-*drying* or under-drying, and expose the fish to unexpected winds, dust, dirt, insect infestation, and contaminants such as flies. Because of fish dried slowly and un-hygienically in direct sunlight in the absence of moving air, possibility of contamination was obvious in dried fishes (Siukumar *et al.*, 1995). Therefore, the main objective of

the present study was to examine the effect of drying methods on shelf-life and pretreatments on microbial quality of three fish species commonly used in Gambella region.

II. Materials and Methods

a) Experimental Location

Three experimental fish species namely tilapia (Oreochromis niloticus), flathead cat fish (Pylodictis olivaris) and carp (Cyprinus carpio) were collected from Alwero reservoir, Abobo District, Anywaa zone, Gambella regional state south west Ethiopia, where drying and pre-treatments were conducted. Microbiological analyses of fresh and dried samples including analysis of bacterial count (aerobic plate count and enumeration of Enterbacteriaceae) and detection of pathogens (Escherichia coli and Salmonella spp.) were conducted in veterinary microbiology laboratory of the same University.

b) Experimental Materials

Fish: The experimental materials included three fish species namely, tilapia (Oreochromis niloticus), cat fish (Pylodictis olivaris), and common carp (Cyprinus carpio). These were obtained from the Alwero-reservoir which is located in Abobo District, Anywaa zone, Gambella regional state, the Southwest part of Ethiopia. After the fish were caught, selection of right quality fish was done based on age and type followed by descaling and deboning. Total of 14.69 kg fillets of the three fish species with 4.19 kg of tilapia, 5.51 kg from cat fish and 4.99 kg from carp were collected for this study.

Ginger (Zingiber officinale) and Garlic (Allium sativum): This was obtained from the local markets at Gambella town. A total of 12 kg ginger and 12kg of garlic were cleaned, washed, and stored in a refrigerator.

c) Experimental Design and Treatment Planning

The experiment of this study was laid out in a factorial arrangement of 2 x 2 x 3 in a completely randomized design (CRD) with three replications. These were three species of fish (tilapia, cat fish and common carp) with two types of preservatives (garlic, and ginger) and two methods of drying (oven drying and sun drying). The controls are fresh and dried fish fillets with no treatment.

Table 1 : Experimental planning

Methods	Species					
	Tilapia		Cat fish		Common carp	
	Ga	Gi	Ga	Gi	Ga	Gi
Sun drying	SGaT	SGiT	SGaC	SGiC	SGaCr	SGiCr
Oven drying	OGaT	OGiT	OGaC	OGiC	OGaCr	OGiCr
Control	Fresh	Dried	fresh	Dried	fresh	Dried

Where: S (sun drying), O (oven drying), T (tilapia), C (cat fish), Cr (common carp), Ga (garlic), and Gi (ginger).

d) Sample Preparation

Fish fillets preparation: The process of fish slices preparation was carried out immediately after sufficient experimental fish was obtained. The descaled and deboned fish was split into fillets or cuts (slices).

Ginger juice preparation: The cleaned ginger was chopped and minced before being used for the treatment. Ginger juice was prepared based on FAO (1990 and 2010) for traditional fish drying of Qwanta.

Garlic juice preparation: The clean garlic was chopped and minced (Sallam *et al.*, 1995).

Pre-drying treatment of fish fillets: The slices of fish samples about (1000 g) of each fish type were submerged in 1000 ml (1:1 w/v) of ginger or garlic juice in flat bowl of 2000 ml capacity (Suleiman, 2010 and Wilson, 1981).

e) Data Collection about Microbial quality

Microbiological analyses were done to assess aerobic plate count (APC), Enterbacteriaceae count, and presence of the pathogens such as Escherichia coli and Salmonella spp:

The microbiological analyses were done on fresh fish fillets as well as on dried ones at the beginning of the experiment. Similar microbiological analyses were conducted on dried fillets of fish within twenty days up to the storage period of sixty days.

f) Bacterial count

Detection of presence of the pathogens *Escherichia coli* and *Salmonella spp.* was done by taking samples from the dilution level 1:10. Aerobic plate (APC) and Enterbaterceae counts, however, were done by taking samples from both 10^{-5} and 10^{-6} dilution levels. The total numbers of moulds were counted by taking scraps from the colony counted under APC. Aerobic plate count, enumeration of Enterbacteriaceae, and counting of molds were conduted according to the standards.

g) Detection of pathogens

i. *Detection of Escherichia coli*

Detection of *Escherichia coli* was done according to ISO (2006) method 4831. Samples were taken from 1:10 (10^{-1}) dilution level and presence of *Escherichia coli* was done by conducting three incubation steps transferring 1 ml representative from Lauryl Triptose (LT) broth.

ii. *Detection of Salmonella spp.*

In the detection on *Salmonella Spp* 5 incubations were done sequentially. Firstly samples were pre-enriched by incubating at 37^{0}C for 48h. Secondly samples were incubated at 41^{0}C for 24 h (ISO, 2002, method 6579).Thirdly samples were incubated at 37^{0}C for 24 h (ISO, 2002, method, method 6579). Fourthly samples were incubated at 37^{0}C for 24 h (ISO, 2002, method, method 6579) and fifthly about 10% of typical colonies grown on Nutrient agar were transferred and plated onto appropriately marked duplicate plates of Urea agar medium(Lab M Limited, UK). Samples were then incubated at 37^{0}C for 24 h. Finally, smooth colonies (colorless, translucent or pale colonies) that were 2-4 mm in diameter were considered as a positive test for the presence of *Salmonella spp.* In the samples analyzed (ISO, 2002, method 6579) (Libby, 1975; Maeda *et al.,* 1997).

h) Experimental design and statistical analysis

Statistical analysis conducted on all data collected after the conversion from CFU to log form to test for significance difference among treatment means. Analysis of variance was performed by one-way ANOVA procedures with statistical software (version SAS 9.1) and means were evaluated at the $P<0.05$ level of significance using fisher's LSD and Duncan's new multiple range test (AOAC, 2000).

III. Results and Discussion

The present study was conducted to evaluate the effect of sun drying, oven drying and two types of preservatives (garlic and ginger) juices on microbial quality and shelf-life of tilapia (Oreochromis niloticus), cat fish (Pylodictis olivaris), and common carp (Cyprinus carpio)fish fillets. The selected pathogens (*E. coli* and *S almonella*) and enumeration of aerobic total count, entro bacteriacae and moulds were observed.

Results of this study clearly revealed that microbial growth was increasing through the storage period. Standards guidelines often use much lower bacterial population as indices of acceptability. In a recent European study by consumers, fish was assumed ''not to be in a good enough condition to be stored for long'' when total plate count were 10^6 cfu/g (EU, 1995). Enumeration of Enterbacteriaceae, aerobic plate counting, total mould estimation and detection of pathogens were conducted under this study to estimate microbial load both in fresh and dried stored fillets of the common three species of fish.

a) Detection of pathogens in raw fish

Table 2 shows detection of pathogens namely *Escherichia coli* and *Salmonella* species in fresh fillets of the three species used in this study. It is found that *E. Coli* were detected whereas *Salmonella* species was not in the fresh fillets of the three species.

Table 2 : Occurrence of Escherichia *coli* and *Salmonella spp.* in raw fish

Species of fish	Pathogens	
	Escherichia coli	*Salmonella spp.*
Tilapia	+ve	-ve
Cat fish	+ve	-ve
Common carp	+ve	-ve

Where, -ve shows the absence of the pathogens and +ve shows the presence of the pathogens.

According to Spencer and Clifford (2000), *E. coli* was associated with animal products especially aquatic animals due to water pollution. Mendel (1999) stated that *E.coli* was an infectious pathogenic bacterium originally found in intestines of humans and other animals. This may explain the detection of the pathogen *E. coli* in the fresh fillets. According to Haberg *et al.* (1994), *Salmonella spp* is also most commonly associated with contaminated animal products (Salmon, 1885). It is pathogenic infectious bacteria that caused due to the lack of cleaning or presence of debris in water body that contaminate the fish. However, Salmon (1885) stated that animal products were with lower degree of contamination under appropriate cleaning and sanitation. This may explain the absence of the pathogen *Salmonella spp* in fresh fillets.

b) Detection of pathogens in dried fillets of fish

Occurrence of *Escherichia coli* and *Salmonella* spp. in treated and untreated fish fillets over the storage period of 60 days are presented in Table 3.

Table 3 : Detection of pathogens on differently treated dried fish stored for sixty days

MD	Treatment	Spp.	Pathogens							
			E.coli				Salmonella spp.			
			Storage period(days)							
			0	20th	40th	60th	0	20th	40th	60th
SD	control	T	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
		C	+ve	+ve	+ve	+ve	-ve	-ve	+ve	+ve
		Cr	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
	Garlic	T	-ve	-ve	+ve	-ve	-ve	-ve	-ve	-ve
		C	-ve	-ve	-ve	+ve	-ve	-ve	-ve	-ve
		Cr	-ve	-ve	-ve	-ve	-ve	+ve	-ve	-ve
	Ginger	T	+ve	+ve	+ve	-ve	-ve	-ve	-ve	-ve
		C	-ve	-ve	-ve	+ve	-ve	-ve	+ve	+ve
		Cr	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
OD	control	T	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve
		C	-ve	-ve	-ve	+ve	-ve	-ve	-ve	-ve
		Cr	-ve	-ve	-ve	+ve	-ve	-ve	-ve	-ve
	Garlic	T	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
		C	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
		Cr	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
	Ginger	T	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
		C	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve
		Cr	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve

Where, spp.= (species), MD= method of drying, SD= sun drying, OD= oven drying, -ve= shows the absence of the pathogens and +ve= shows the presence of the pathogens, T (tilapia), C (cat fish), Cr (carp), 0=Zero month storage period was the storage before the dried fish fillets were stored under ambient condition.

Escherichia coli were detected in all untreated sundried fillets of the three fish species from zero days to the 60 days storage periods (Table 3). However, *Salmonella spp.* was detected only in two of the untreated (tilapia and carp) sun dried fillets from zero days to the 20th day storage but it was detected in all untreated sundried fillets of the three fish species from 40th days to the 60th day's storage periods. Untreated sun dried fillets of the three fish species were highly susceptible to *E. coli* and *Salmonella spp* throughout the storage period of 60 days than treated fillets. This result showed that preservatives i.e. garlic and ginger play inhibitory effect on the drying of the fish fillets of the three experimental species. Since, garlic and ginger categorized under bacteria growth inhibitors, then according to Zaika (1988) inhibitors may reduce the levels of microbial growth in foods. The absence of *Escherichia coli* and *Salmonella spp.* in most of the treated dried fillets of three species throughout the storage periods (0-60 days) could necessarily be due to the inhibitory effects of garlic and ginger treatments. Dried fillets may cross-contaminated during storage/ through handling techniques.

c) Enumerations of microorganisms in fresh fish

The Aerobic plate and *Enterbacteriaceae* of the respective fresh fillets of the three fish species were indicated in Table 4.

Table 4 : Enterbacteriaceae and Aerobic plate counts in raw fish

Experimental fish species	Type of Bacterial count(log_{10} cfu/g)	
	Aerobic plate count (APC)	*Enterbacteriaceae* count
Fresh tilapia	<1 log_{10}	<1 log_{10}
Fresh flat head cat fish	5.09 ± 0.04^{a}	5.00 ± 0.02^{a}
Fresh common carp	5.11 ± 0.03^{ba}	<1 log_{10}
CV	1.90	3.03
LSD	0.19	0.29

Where, <(less than), log_{10} (logarism in base ten), CFU=colony forming units, CV=coefficient of variances, LSD=least significant differences.

Very few APC and Enterbacteriaceae count were found in fresh tilapia that reported as <1 log 10 cfu/g. However, mean value of APC of 5.09 log10 cfu/g and mean Enterbacteriaceae count of 5.00 log10 cfu/g were found in fresh cat fish. The mean APC of 5.11 log10 cfu/g was found in fresh carp whereas very few Enterbacteriaceae count was found in fresh fillets of the same spp which resulted as < 1 log 10 cfu/g in the same table 4. The low mean values of APC and Enterbacteriaceae count observed in the fresh fish were attributed to dilution levels (10-5 and 10-6) from which samples were used for plating. According to Maurine and James (2001), suitable colony counting range is 25 250.

When plates of all dilutions have no colonies it is reported as less than 25 colonies estimated count. Existence of APC and Enterbacteriaceae counts in fresh fillets of fish species may be due to the handling and cross-contaminations, through the process of deboning and filleting the fish.

An estimation of the total number of microor ganisms: named Aerobic plate count and Enterbacte riaceae enumerations of freshly caught fish were laid within (10^2-10^6 cfu/g) of an acceptability index in standards, guidelines and specifications (EU, 1995). Therefore, the results of the total Aerobic plate count and Entrobacteriacae in present study agreed with this standard acceptability index. Similar results about these micro-flora were also observed in reports of Huss *et al*., (1997) and Gram and Dalgaard, (2002) in which the number of microbials fitted the standards of load in shelf-life of fish (10^7-10^8). According to the Parallel Food Testing in the European Union (EU, 1995), freshly caught fish should contain a diverse micro-flora APC of 10^2 -10^6 cfu/g. These values are usual on whole fish and cut fillets.

d) Aerobic plate counts in dried fillets of fish

The total aerobic plate counts within the interval of twenty days in sixty days stored products are presented in Table 5. In that the minimum aerobic plate counts recorded in sample, the safe the products are illustrated within the Table 5. As compared to the Aerobic plate counts in the fresh fillets reported in Table 5, an increase in aerobic plate count (APC) was observed in the treated and untreated fillets over the storage periods (0-60th days).

The maximum and minimum APC of zero day storage were recorded in untreated sundried tilapia and treated tilapia with 5.82 and 5.11 log_{10} cfu/g, respectively. After the storage of 20 days the fillets were with the minimum 5.51 (untreated oven dried tilapia) and maximum 6.53 (untreated sundried carp) log_{10} cfu/g. Similarly the maximum (7.11) and the minimum (6.05) log_{10} cfu/g after 40th day storage were recorded in untreated sundried carp and garlic treated oven dried cat fish fillets. At the end of the 60th month storage the lowest (7.01) and the highest (8.03 log_{10} cfu/g) APC were recorded in garlic treated oven dried cat fish and untreated sundried carp, respectively.

Table 5 : Aerobic plate count of dried fillets stored for sixty days

			Aerobic plate count(log_{10} cfu/g)			
			Storage period (days)			
Method of drying	Treatment	Spp.	0	20th	40th	60th
Sun drying	Control	T	5.82±0.06^{c}	6.46±0.12^{c}	7.00±0.06^{e}	8.00±0.03^{f}
		C	5.75±0.04^{c}	6.37±0.06^{c}	7.09±0.07^{e}	8.01±0.05^{f}
		Cr	5.80±0.03^{c}	6.53±0.23^{c}	7.11±0.06^{e}	8.03±0.03^{f}
	Garlic	T	5.43±0.05^{b}	5.81±0.06^{b}	6.21±0.02^{cdb}	7.16±0.02^{dec}
		C	5.20±0.03^{a}	5.72±0.08^{ab}	6.19±0.04^{cdb}	7.14±0.04^{dbec}
		Cr	5.28±0.06^{ab}	5.58±0.06^{ab}	6.11±0.06^{cab}	7.07±0.06^{abc}
	Ginger	T	5.25±0.01^{ab}	5.61±0.09^{ab}	6.09±0.03^{ab}	7.05±0.03^{ab}
		C	5.20±0.12^{a}	5.68±0.10^{ab}	6.12±0.04^{cadb}	7.08±0.04^{adbc}
		Cr	5.20±0.03^{a}	5.66±0.03^{ab}	6.11±0.03^{cab}	7.06±0.03^{abc}
Oven drying	Control	T	5.14±0.05^{a}	5.51±0.06^{a}	6.23±0.06^{cd}	7.18±0.06^{de}
		C	5.20±0.06^{a}	5.70±0.06^{ab}	6.10±0.03^{ab}	7.05±0.03^{abc}
		Cr	5.14±0.01^{a}	5.54±0.10^{ab}	6.11±0.05^{cab}	7.06±0.05^{abc}
	Garlic	T	5.11±0.12^{a}	5.57±0.10^{ab}	6.24±0.03^{d}	7.19±0.03^{e}
		C	5.14±0.10^{a}	5.55±0.15^{ab}	6.05±0.03^{a}	7.01±0.03^{a}
		Cr	5.12±0.06^{a}	5.55±0.02^{ab}	6.14±0.03^{cadb}	7.10±0.03^{adbec}
	Ginger	T	5.17±0.01^{a}	5.75±0.06^{ab}	6.11±0.03^{cadb}	7.07±0.3^{abc}
		C	5.16±0.01^{a}	5.58±0.06^{ab}	6.20±0.03^{cdb}	7.16±0.03^{dec}
		Cr	5.12±0.10^{a}	5.59±0.12^{ab}	6.17±0.04^{cadb}	7.13±0.04^{dbec}
CV			2.06	2.94	1.21	0.92
LSD			0.18	0.28	0.13	0.11

Where, LSD= list significant difference, CV=coefficient of variation, Spp.=species, T=tilapia, C=cat fish, Cr=common carp, 0-60= Zero day up to sixty days storage period, values are mean ±SE and mean values followed by the same letter in a column are not significantly different at 5% level of significance.

All the fillets of fish had APC>5.0 log_{10} cfu/g. No significant differences (P>0.05) in APC were observed between the untreated sundried fish fillets of the three species throughout the storage periods (0-60th days). However, significant differences (P<0.05) were recorded between the untreated sundried fillets of the three species and all treated and untreated oven dried fillets of the respective species throughout the storage period of 60 days.

These significant variations between the untreated sundried fillets and all treated fillets showed that garlic and ginger have inhibitory effects on growth of these microorganisms through drying of the fish fillets of the three experimental fish species. The minimum number of APC in untreated oven dried fillets of the three species throughout the storage periods were due to the inhibitory effect of oven drying by reducing the water activity of the fillets lower than sun drying. All the treated fillets of fish reach at 10^6 cfu/g after the 40th day storage and it can be concluded that it is not appropriate to stored for such a long period.

The untreated sundried fillets reach points of sensory rejection at 40th days storage period were good evidence among the reasons of this thesis work. This was based on a recent European study by consumers, in which fish was assumed "not to be in a good enough condition to be stored for long" when CMT were 10^6 cfu/g (Parallel Food Testing in the European Union: Fish, 1995). After the 60th day storage period the load of APC reached 10^7-10^8 cfu/g. At the point of sensory rejection, the APC of fish products could typically be 10^7-10^8 cfu/g (EU, 1995).Therefore, this result showed that differently treated fillets have a shelf-life of less than three two months storage period. Nevertheless, standard guidelines and specifications often use much lower CMT as indices of acceptability.

e) Enterbacteriaceae count on dried fillets of fish stored for sixty days

All of the fillets from three fish species had Enterbacteriaceae count (EC) of >5.0 log10 cfu/g (Table 6). The maximum and minimum Enterbacteriaceae

count of zero day storage were recorded in untreated sundried tilapia and oven dried ginger treated tilapia with 5.43 and 5.01 log10 cfu/g respectively. After the storage of 20 days the fillets were with the minimum Enterbacteriaceae count of 5.64 (garlic treated oven dried cat fish) and maximum Enterbacteriaceae count of 6.04 (untreated sundried tilapia) log10 cfu/g. Similarly the highest (6.78) and the lowest E. count (6.45) log10 cfu/g after 40th day storage were recorded in untreated sundried carp and ginger treated oven dried tilapia fish fillets. At the end of 60th days storage the lowest (7.01) and highest (7.38 log10 cfu/g) E. count were recorded in ginger treated oven dried tilapia and untreated sundried tilapia respectively.

Table 6 : Enterbacteriaceae count on dried fillets stored for sixty days

			Enterbacteriaceae count(log_{10} cfu/g)			
			Storage period (days)			
Method of drying	Treatment	Spp.	0	20th	40th	60th
Sun drying	control	T	5.43±0.04^{b}	6.04±0.02^{d}	6.72±0.07^{c}	7.38±0.03^{c}
		C	5.38±0.03^{b}	5.99±0.06^{d}	6.77±0.03^{c}	7.35±0.05^{c}
		Cr	5.39±0.02^{b}	6.01±0.06^{d}	6.78±0.05^{c}	7.37±0.02^{c}
	Garlic	T	5.02±0.05^{a}	5.67±0.06^{bca}	6.48±0.05^{ab}	7.04±0.05^{ab}
		C	5.10±0.08^{a}	5.76±0.02^{bca}	6.51±0.03^{ab}	7.07±0.03^{ab}
		Cr	5.04±0.06^{a}	5.71±0.05^{bca}	6.49±0.06^{ab}	7.05±0.06^{ab}
	Ginger	T	5.15±0.07^{a}	5.79±0.03^{c}	6.57±0.03^{b}	7.13±0.03^{b}
		C	5.02±0.09^{a}	5.75±0.02^{bca}	6.52±0.01^{ab}	7.08±0.01^{ab}
		Cr	5.10±0.05^{a}	5.77±0.02^{bc}	6.48±0.05^{ab}	7.04±05^{ab}
Oven drying	control	T	5.11±0.06^{a}	5.77±0.06^{bc}	6.53±0.01^{ab}	7.09±0.01^{ab}
		C	5.04±0.12^{a}	5.66±0.06^{ba}	6.47±0.05^{ab}	7.03±0.05^{ab}
		Cr	5.04±0.08^{a}	5.68±0.01^{bca}	6.46±0.02^{ab}	7.02±0.02^{ab}
	Garlic	T	5.14±0.03^{a}	5.72±0.03^{bca}	6.53±0.03^{ab}	7.09±0.03^{ab}
		C	5.02±0.03^{a}	5.64±0.03^{a}	6.49±0.03^{ab}	7.05±0.06^{ab}
		Cr	5.09±0.04^{a}	5.74±0.09^{bca}	6.48±0.03^{ab}	7.04±0.03^{ab}
	Ginger	T	5.01±0.02^{a}	5.67±0.03^{bca}	6.45±0.02^{a}	7.01±0.02^{a}
		C	5.02±0.05^{a}	5.70±0.05^{bca}	6.48±0.05^{ab}	7.04±0.05^{ab}
		Cr	5.02±0.09^{a}	5.75±0.02^{bca}	6.47±0.01^{ab}	7.03±0.01^{ab}
CV			2.07	1.35	1.08	0.91
LSD			0.18	0.13	0.12	0.11

Where, LSD= list significant difference, CV=coefficient of variation, Spp.=species, T=tilapia, C=cat fish, Cr=common carp and the values are in mean ±SE.

No significant (P>0.05) differences in Enterbacteriaceae counts were observed among the untreated sundried fish fillets of the three species through out of storage periods of sixty days. Significant differences (P<0.05) were observed between the untreated sundried fillets of the three species and the rest dried fillets of fish species through the storage period of 60 days. No (P>0.05) variations in Enterbacteriaceae counts were observed among the untreated sundried fillets of the three species before storage. Significant (P<0.05) variations between the treated and untreated sundried fillets showed that pre-treatment technology in fish preservation have necessarily inhibitory effects on the number of Enterbacteriaceae count.

The low number of Enterbacteriaceae count in untreated oven dried fillets in relation to the untreated sundried fillets of the three species throughout the storage periods were due to the inhibitory effect of oven drying by reducing the moisture of the fillets much lower than sun drying. The result also showed scrupulous hygienic measures during handling and preparation of spice dilutions before applying them on filleted fillets. All the fillets after the 60th day storage period should not be stored further. The fish fillets reach at the point of sensory rejection of 10^{7}-10^{8} cfu/g after the storage of 60 days showed that shelf-life of differently treated fillets should be less than sixty days storage period (Gram and Dalgaard, 2002).

f) Total load of moulds in dried fish stored for sixty days

Results in present study indicated that samples treated with garlic and ginger juices were microbiologically stable than the control samples as these had longer shelf-life and were not covered by visible moldy mass of mycelium during 60 days of storage within twenty days interval of tests. There were steady increases in mould counts as storage period progressed in all the treatments. However, treated fillets showed lower mould counts as compared to untreated fillets in their respective drying methods. Therefore, combination of preservatives with sun drying resulted in variations of microbial levels (i.e. moulds). The standard load of APC and fungi index with total moisture (8.76-13.12%) content at sixty days of storage in this study showed the shelf-life of sundried fillets should be less than three months. This is differed from the findings reported by Jallow (1995). According to Jallow (1995), fish at 10-15% moisture content, reportedly had a shelf life of 3-9 months when stored properly. The differences may be due to the influence of environmental factors.

All the recorded results about total moulds before storage were < 1 $\log_{10}$ cfu/g. The maximum and minimum total moulds of 20 day storage were recorded in untreated sun dried cat fish and garlic treated sundried of the same species with 6.14 and 5.11 $\log_{10}$ cfu/g respectively. Similarly the lowest (5.14) and the highest total moulds (7.11) $\log_{10}$ cfu/g after 40^{th} day storage were recorded in garlic treated oven dried cat fish and untreated sundried tilapia fillets respectively.

By end of 60th day storage the minimum (6.65) and maximum (7.92 log10 cfu/g) total molds were recorded in garlic treated oven dried cat fish and untreated sundried tilapia and cat fish respectively. No significant differences ($P>0.05$) in total mould counts were observed among the untreated sundried fish fillets of the three spp through out of storage periods of 60 days. The observation of large visible mould mass of mycelium from the first twenty days storage under ambient condition obtained in untreated fillets indicated the effectiveness of garlic and ginger as anti-fungal agents which resulted in extended shelf life of treated fillets. Appropriate treatment with garlic and ginger gave lower load of moulds than untreated sundried samples that could extend shelf life of the dried fish. Due to this, the microbial populations (moulds) for all the treatments observed in this study were within the recommended limits for good quality fish product according to ICSMF, (1986). Significant ($P<0.05$) variations in moulds were observed between untreated sundried and the rest dried fillets of experimental fish within 20 days interval until the 60 days storage.

Table 7 : Total count of moulds on dried fillets stored for sixty days

			Total count of moulds(log cfu/g) Storage period(days)			
Method of drying	Treatment	Spp.	0	20th	40th	60th
Sun drying	control	T	<1 $\log_{10}$	6.08±0.05^{e}	7.11±0.01^{h}	7.92±0.01^{f}
		C	<1 $\log_{10}$	6.14±0.03^{e}	7.06±0.02^{h}	7.92±0.04^{f}
		Cr	<1 $\log_{10}$	6.05±0.02^{e}	7.07±0.04^{h}	7.91±0.03^{f}
	Garlic	T	<1 $\log_{10}$	5.23±0.02^{b}	6.08±0.02^{e}	7.03±0.03^{e}
		C	<1 $\log_{10}$	5.11±0.05^{a}	5.96±0.05^{d}	6.46±0.05^{a}
		Cr	<1 $\log_{10}$	5.32±0.06^{cb}	6.17±0.06^{fe}	6.68±0.06^{cb}
	Ginger	T	<1 $\log_{10}$	5.41±0.06^{cd}	6.26±0.06^{fg}	7.01±0.03^{e}
		C	<1 $\log_{10}$	5.32±0.01^{cb}	6.17±0.01^{fe}	6.68±0.01^{de}
		Cr	<1 $\log_{10}$	5.45±0.02^{d}	6.30±0.02^{g}	6.81±0.02^{d}
Oven drying	control	T	<1 $\log_{10}$	<1 $\log_{10}$	5.30±0.03^{c}	6.81±0.03^{d}
		C	<1 $\log_{10}$	<1 $\log_{10}$	5.26±0.06^{bc}	6.77±0.06^{cd}
		Cr	<1 $\log_{10}$	<1 $\log_{10}$	5.23±0.03^{bca}	6.74±0.03^{d}
	Garlic	T	<1 $\log_{10}$	<1 $\log_{10}$	5.18±0.02^{ba}	6.69±0.02^{cb}
		C	<1 $\log_{10}$	<1 $\log_{10}$	5.14±0.05^{a}	6.65±0.05^{b}
		Cr	<1 $\log_{10}$	<1 $\log_{10}$	5.23±0.02^{bca}	6.74±0.02^{cdb}
	Ginger	T	<1 $\log_{10}$	<1 $\log_{10}$	5.22±0.01^{bca}	6.73±0.01^{cb}
		C	<1 $\log_{10}$	<1 $\log_{10}$	5.15±0.05^{a}	6.66±0.05^{b} 6.68±0.06^{cb}
		Cr	<1 $\log_{10}$	<1 $\log_{10}$	5.17±0.06^{ba}	
CV			1.12	1.38	1.13	0.93
LSD			0.09	0.11	0.11	0.11

Where, LSD= list significant difference, CV=coefficient of variation, Spp.=species, T=tilapia, C=cat fish, Cr=common carp and the values are mean ±SE in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

In this study, no or very less (<1 log $_{10}$ cfu/g) number of total moulds were observed in all dried fillets before or zero day storage. These showed that oven drying had a necessary influence on the incidence of total moulds in reducing the moisture level lower than the sun drying. The untreated sun dried fillets attained point of sensory rejection after forty days storage. However, treated fillets were not reached even after sixty days storage periods. This showed effectiveness of the garlic and ginger extracts were antimycotic agents (Magawata and Shina, 2013) with the load of total molds in appropriate suitable range for consumption with 4.57 to 5.23 $\log_{10}$ cfu/g.

IV. Conclusion

The experiment was conducted to assess the effect of drying methods and pre-treatments on shelf-life and microbial quality of dried fish. The experiment was conducted in a factorial arrangement of 2×3×2 with two drying methods (sun and oven drying,) three fish species (tilapia, cat fish and carp) and two preservatives treatment (garlic and ginger juice) laid out in Completely Randomized Design (CRD). Drying reduced the moisture contents making it safe for storage. Fresh fillets were analyzed for their microbiological quality. The dried fillets were stored at ambient condition and the samples were analyzed for microbial status every twenty days starting from the end of drying operation. Fresh fillet and untreated dry fillet were used as control. In the fresh fillets, a high load of aerobic bacteria of 5.11 $\log_{10}$ cfu/g was observed on carp, and *E.coli* was detected in all three species whereas no *Salmonella* spp. was detected at all. Regarding freshly dried fillets, high load of aerobic bacteria (5.82 $\log_{10}$ cfu/g) was observed in untreated tilapia whereas the initial load of moulds was (<1 $\log_{10}$ cfu/g) in all freshly dried fillets. After 60 days of storage, the loads of aerobic bacteria and moulds were 8.03 and 7.92 $\log_{10}$ cfu/g, respectively, in untreated sundried carp, tilapia and cat fish fillets, higher than that in treated samples. Upgrading the traditional fish processing technology and adoption of sun drying with locally available specific antioxidants and appropriate storage were needed in the region to minimize quality defects

related to dried fish. Detection of pathogens and numerated microbial loads were low enough due to drying with garlic and ginger treatments than untreated fillets. Therefore, garlic and ginger which are easily available at the place should be used to extend the shelf life of dried fillets. Moreover, important measures need to be taken to train local consumers in hygienic practices.

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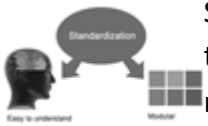

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	A-B	**C-D**	**E-F**
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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with 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
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