International Journal of Food Science and Nutrition Engineering 2018, 8(3): 79-85
DOI: 10.5923/j.food.20180803.04

Effect of Clonal Variation on Quality of *Kocho*, Traditional Fermented Food from *Enset* (*Ensete Ventricosum*), Musaceae

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Abstract *Enset* (*Ensete ventricosum* Welw. Cheesman) is an important multipurpose crop serving for a large part of the Ethiopian population living in the southern and southwestern parts of the country. Survey on indigenous knowledge of farmers on local system of selection and identification of *enset* varieties was carried out in three localities of *Sidama* zone, namely: *Chafee Jebesa* (3 km east of Hawassa), *Tulla* and *Abella* 13 and 16 km, respectively, (south of Hawassa) from November 2011 to July 2011. The main objective of the study was to evaluate the sensory characteristics in relation to a nutritional analysis of selected top ten *enset* varieties. Open – ended and semi-structured purposive questionnaires targeted on best varieties of *enset* commonly used in the above mentioned localities were used for the survey. The sensory characteristics such as appearance, odor, taste, sourness, dryness and texture of *kocho* samples prepared from each selected *enset* variety were evaluated using a sensory panel of judges. Nutritional analysis of the selected varieties was also carried out using Official Methods of Analysis (AOAC, 1984, 1990, 1995). The results of nutritional analysis revealed that there was no significant difference among the selected varieties in terms of their moisture and ash content. The values of moisture content ranged from 59.90 to 63.30% while ash content was between 2.11 to 2.35%. However significant differences have been observed among the selected varieties in terms of their protein (2.93 to 3.51%), fat (0.43 to 1.25%), fiber (3.22 to 4.57%) and carbohydrate (49.21 to 64.15%) content. This is mainly attributed to varietal differences among the selected *enset* plants. In conclusion, varietal variation can affect proximate composition as well as sensory characteristics of the final product. This investigation can be the starting point for the selection of varieties of better nutritional value to reduce possible dietary insufficient uptake particularly of proteins and calories in the area.

Keywords *Enset*, *Kocho*, Proximate analysis, Sensory characteristics, Varieties

1. Introduction

1.1. Background and Justification

Enset (*Ensete ventricosum* (Welw.) Cheesman) is a perennial monocarpic, herbaceous plant belonging to the Musaceae family *(*Ajebu Nurfeta., *et al*., 2008; Welde-Michael., *et al*., 2008). *Enset* traditionally is ranked first in importance as cultivated staple food crop in the highlands of central, south and southwestern Ethiopia (Berhanu Abegaz Gashe, 1987a; Almaz, 2001; Admasu, 2002). *Kocho*, the main food product derived from *enset*, is obtained by fermenting the mixture of the scraped pulp of the pseudostem, pulverized corm and stalks of the inflorescence (Berhanu Abegaz Gashe, 1987a; Pijls *et al*, 1995; Almaz, 2001). Whereas, *bulla* is another product of *enset* made entirely from the internal juice part of the pulp of the pseudostem.

Ensete ventricosum grows at altitudes of about 1500-3100 m above the sea level, an average rainfall of 1100-1500 mm per year and a mean temperature of 16-20℃ with relative humidity of 60-80% (Memarua, 1995; Brandt *et al*, 1997). Some *enset* plants can be found also at lower altitudes (Admasu, 2002).

According to Mehtzun and Yewelsew (1994), *enset* grows as a tree, ranging from 4 to 11 meters in height to the tip of the leaves; its pseudostem (stem part) dilates at the base to a circumference of 1.5-3.0 meters. The dilated base provides the main yield (Mogessie, 2006). According to Mogessie (2006), the length of the pseudostem ranges from 2 to 5 meters depending on the clone and the ecological condition of its cultivation. Leaves are borne on the pseudostem almost from the same point and on short petioles (**Figure 1**), are 5 meters long and 0.75-1.5 meters wide (Brandt *et al*, 1997).

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Published online at http://journal.sapub.org/food

Mehtzun and Yewelsew, (1994), indicated that, the underground portion (corm) of *enset* consists of a corm which is 0.70-1.8 meters long with a circumference of 1.5-2.5 meters at maturity.

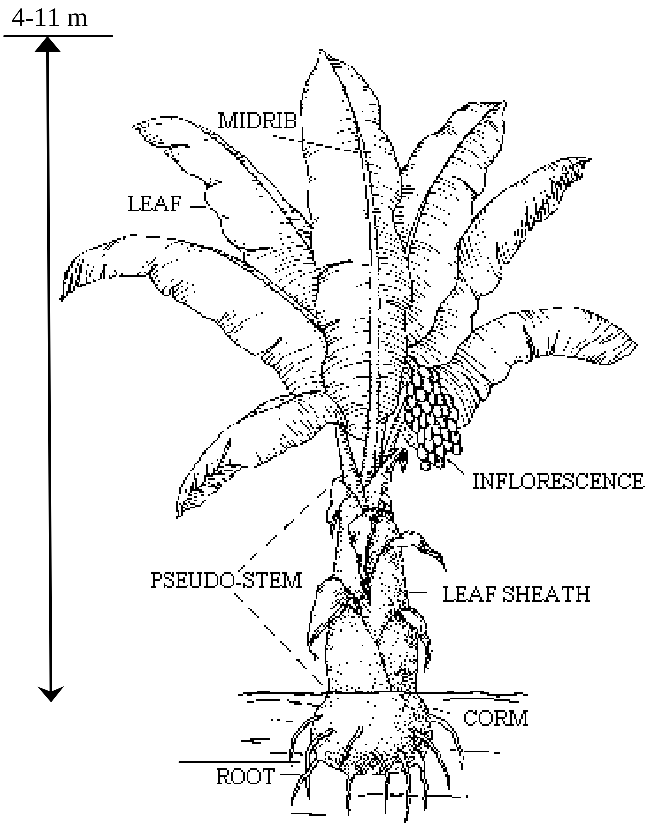

Figure 1. The *enset* plant (adapted from: Brandt *et al*, 1997)

1.2. Varieties of *enset*

Morphological and genetic variability between the individuals of a population represents the main resource for selection, both natural and artificial. Any crop improvement program relies on the existence of sufficient variability in the crop (or population thereof) to be improved. Biologically, enset so called varieties are clones, i.e., vegetatively reproduced assemblages of individuals (Tesfaye Bezuayehu, 2008). In accordance with the International Code of Nomenclature for Cultivated Plants (ICNCP, 2016), the different varieties can be referred to as Clones or cultivars. There are large numbers of *enset* varieties distributed in different regions of Ethiopia (Almaz Negash., *et al*., 2002). According to Tesfaye Bezuayehu (2008), in the Sidama area, around 103 different enset varieties were recognized by the farmers. The report also showed that 79 of these represented actually grown varieties, whereas the rest were reported only verbally. Some enset clones are known by farmers to have medicinal value for both humans and animals (Brandt *et al*, 1997).

Enset production involves transplanting of suckers originating from the mother corm in to field (Admasu, 2002). The report by Admasu (2002) showed that seeds are also used to produce seedlings in some parts of southern Ethiopia. Depending on ecology and variety, *enset* takes nine or more years to produce flowers and set seeds (Tesfaye Bizuayehu, 2008). According to this author, the communities that cultivate and use the crop in Ethiopia recognize and maintain a considerable assemblage of *enset* varieties. Other Studies indicated that, household wealth is also considered related to the number and diversity of *enset* plants in different parts of Ethiopia where *enset* is used as staple food (Almaz, 2001).

Enset can improve food security in *enset* growing areas of Ethiopia and also plays major economic and social roles. This plant is popular as staple food for millions of people in the southern and southwestern parts of the country. In addition, *enset* is a crop with many other uses, as for human food, for livestock feed, for industrial fiber, as binding material in fences and house-building, for mattresses and seats, as packaging material, and as substitute for plates or umbrellas.

The development of improved enset varieties and their dissemination to more enset growing regions is important particularly in relation to improvement of product quality and sustainability. Hence, research on this aspect is required. Although many studies [a shot gun sequence is available in gene bank (L.-F. Li *et al*., 2010)] were conducted on this plant, less information is available on the role of locally maintained varieties contributing to the possible improvement of the quality of the final product. Therefore, this study was aimed at identifying the best enset varieties that mainly contribute for good quality of the final product, particularly in reference to the use as human food, to be recommended and selected as candidate varieties for the improvement of agriculture in selected localities of Sidama region.

2. Materials and Methods

2.1. Description of the Study Area

The study was carried out in the proximity of Hawassa, capital city of the Southern Nations Nationalities and Peoples Regional State (SNNPRS), Ethiopia. It is located 273 km southern from the capital, Addis Ababa. The altitude of the town is 1697 m above the sea level, with mean annual temperature and rainfall of 20.9°C and 997.6 mm, respectively. The selected study localities in the *Sidama* Region were: *Chafee Jebesa* (3 km east of Hawassa), *Tulla* and *Abella* 13 and 16 km, respectively, south of Hawassa, where *enset* is used as staple food.

2.2. Study Subject

Elder farmers and in many cases house wives in each selected locality of *Sidama* region were the main study subjects in this study to collect ethno- botanical data such as local names for the cultivated varieties, methods of varietal differentiation, sensory acceptability of each variety in the order of their importance, and other uses of different *enset* varieties recognized by them. They were also asked to give information on other varieties which are grown in other localities of the *Sidama* region.

2.3. Study Design and Sample Size Determination

Systematic random sampling was carried out on the *enset* growing farmers and their housewives since November 2010 to July 2011 in three localities: *Chafee Jebesa* (3 km east of Hawassa), *Tulla* and *Abella*, respectively 13 and 16 km south of Hawassa. The selection was based on the availability and consumption of *enset* in these localities. All knowledgeable people in each locality were listed first and 30 from each locality were selected based on lottery method for the survey. A survey of the local system for enset varieties naming and selection was carried out using both open – ended and semi-structured purposive questionnaire. The socio-economic factors associated with the naming and selection of varieties for different purposes was also assessed during the survey. The different *enset* varieties were ranked as 1-10 based on their importance and acceptability in each locality. The first ten ranked varieties were considered as the top ten *enset* varieties contributing best to the quality of the final product. During processing of the selected clones, for *Kocho* production, traditional methods practiced by the *Sidama* women were followed throughout the experiment. In addition, the processors were interviewed in *Sidamgna* (local language) for additional information.

2.4. Study Methodology

Both survey and experimental study were conducted in this study. Open – ended and semi-structured purposive questionnaires were used for the survey to obtain first hand information from the selected informants as described above. Experimental studies (sensory evaluation and proximate analysis) were carried out using standard techniques as described below.

2.4.1. *Enset* Sample Collection

A total of 10 *enset* varieties were collected from one of the selected locality of Sidama zone (*Chafee Jebesa*). For each variety, three *enset* plants were used randomly and processed independently following the traditional methods of *kocho* preparation in duplicate experiment. Then each experiment on each *enset* variety was carried out by allowing to ferment for one month using plastic buckets. After completion of the fermentation process, samples from each variety were taken for sensory evaluation and nutritional analysis.

2.4.2. Sensory Evaluation of the Final Baked Product (*kocho*)

Panels of 12 consumer-oriented judges, students and staff members of the University of Hawassa were recruited to evaluate the organoleptic characteristics of baked *kocho* from each *enset* variety. Most of them had participated in a laboratory course on sensory evaluation methods and products of *enset* like *kocho*, *bulla* etc. and were familiar to all of them. The panelists evaluated the different organoleptic characteristics such as; appearance, odor, taste, sourness, dryness and texture (mouth feeling) following standard sample presentation, coding, scoring and data collection (Heymann and Lawless, 1999).

Each baked sample was cut into pieces of similar size corresponding to the number of panelists in three replications. Each piece was presented in identical sample trays coded with 3-digit random numbers in a randomized order within and between the pairs. Finally, the panelists ranked each organoleptic characteristics using a 5-point category scale from 1 to 5 [1 = poor; 2 = fair; 3 = good; 4; very good and 5 = excellent as in Heymann and Lawless (1999)] on the scoring sheet.

2.4.3. Proximate Analysis

2.4.3.1. Moisture Content

The moisture content was determined using triplicate samples in crucibles (as the method described by AOAC (1990). Known quantities of the samples were oven dried at 105°C for 1 h and allowed to cook in desiccators. The weight of the dried samples were recorded and calculated as:

$$\text{Moisture content (\%)} = \frac{(W1 - W2) * 100}{W1}$$

Where W1 = weight of fresh sample; W2 = weight of dried sample.

2.4.3.2 Crude Protein Content

The crude protein content was determined using Micro Kjeldahl method as described by AOAC (1990). 2 g of material were digested by adding 5 ml of concentrated sulfuric acid, in the presence of potassium sulfate catalyst in a Kjeldahl flask. The digested solution was then diluted with 30 ml of distilled water to carry out neutralization. 25 ml of NaOH (40%) was added to the digest in the distillation jacket to neutralize the sulfuric acid. 50 ml of 40% boric acid was measured into two 250 ml conical flasks labeled A and B, respectively, four (4) drops of methyl red indicator was added each. The conical flasks containing the mixture were placed onto the distillation apparatus with the outlet tubes inserted into each conical flask and NH_3 was collected through the condenser. The distillation continued until 25 mL of the distillate were trapped into the boric acid solution and color changes from red to yellow. The distillates were then titrated with 0.02 M HCl and the titre values were recorded. Percentage of crude protein was calculated as total nitrogen.

2.4.3.3. Fat Content

Fat content was determined according to the method described by AOAC (1984). A 3 g dried sample of *kocho* was extracted with 100 ml petroleum ether, for a minimum period of 4 hrs in the soxhlet extractor. The solvent was then evaporated by heating on a steam bath. The flask containing the extracted fat was dried on steam bath to a constant mass.

The total crude fat was calculated as percentage by weight:

$$\text{Crude fat, percent by weight} = \frac{(W2 - W1)}{W} * 100$$

Where, W1 = weight of the extraction flask

W2 = weight of the extraction flask plus the dried crude fat (g)

W = weight of the sample.

2.4.3.4. Fiber Content

Crude fiber was determined using the method described by AOAC (1990). A 2 g *kocho* sample was transferred to 400 ml beaker. It was digested with 1.25% sulfuric acid and washed with distilled water. Then the solution was again digested by 1.25% NaOH, thereafter, the sample was filtered in coarse porosity crucible in apparatus, at a vacuum of about 25 mm Hg. The residue was washed again with 1.25% sulfuric acid. The residue was then dried at 95℃ overnight, cooled in desiccators, and weighed (M1). After mashing for 2 hrs at 500℃, it was cooled in desiccators, and weighed again (M2). The total crude fiber was expressed in percentage as:

$$\text{Total crude fiber (\%)} = \frac{M1 - M2}{M3} * 100$$

Where M_3 is the weight of sample.

2.4.3.5. Ash Content

Ash content was determined using the method described by AOAC (1995). Drying crucibles were oven dried at 120℃ in hot air oven and ignited at 550℃ for about 3 hours in a muffle furnace (MF 120, nuve, Kabul, Turkey). They were allowed to cool in desiccators and weighed using analytical balance. 2 gram of the sample was put and weighed (M2). The sample was dried at 105℃ for 1hr and carbonized by blue flame of Bunsen burner, until the contents turn black. The dish with its contents was transferred to a muffle furnace and ignited at about 550℃, until washing was complete. The residue was weighed (M3). The total ash was expressed as percentage on dry basis as follows:

$$\text{Total Ash (\%)} = \frac{M3 - M1}{M2 - M1} * 100$$

2.4.3.6. Carbohydrate Content

Total carbohydrate content was determined by difference. The sum of the percentage moisture, ash, crude lipid, crude protein and crude fiber was subtracted from 100% Carbohydrate = 100 - (% moisture + % ash + % protein + % lipids + % fiber).

2.5. Data Management and Analysis

The collected data were double entered into the excel spread sheet and verified prior to analysis using STATA version 8:0. The cleaned and verified data were analyzed using STATA version 8 and SPSS version 15. Data analyses were at 95% confidence interval with marginal error of 5%. Tables and proportions were used for result presentation.

3. Results

3.1. Survey in the Study Area

Sidama farmers use phenotypic differences like leaf color, pseudo stem color, midrib color, pseudo stem length, size, fiber quality, time to maturity etc. to differentiate one variety from the other. In this study, a total of 66 locally recognized *enset* varieties were assessed during the survey in three selected localities of the Sidama region: *Chefe Jebesa*, *Tulla* and *Abella*. Among all these varieties, ten were selected based on their acceptance by the farmers as those considered of highest quality as food. These were *Wanikore, Medicha*, *Geena*, *Addo, Dowiramo, Haaho, Sediso, Damala*, *Birra* and *Chacho*. Most of these varieties are common in the three survey sites. We verified that the names of some *enset* varieties were used interchangeably in different localities of *Sidama* region in reference to a single *enset* variety. E.g. *Medicha* is known as *Genticha* in *Tulla* and in *Abella*. Previous reports also indicated that, exchange of clones among farmers has not been restricted to single zones or similar environmental conditions or geographical distances. The abundance and distribution of varieties differs from household to household and from locality to locality.

3.2. Descriptive Sensory Analysis

The mean scores given by the panelists to each of the attributes evaluated in different *enset* varieties are shown in table 1 A comparison of the sensory taste characteristics of the varieties revealed significant differences ($P \leq 0.05$) between them for most of the evaluated sensory attributes (appearance, odor, and taste). The variety, *Wanikore* accounted for the highest scores for the attributes appearance, odor, taste, sourness, dryness and texture compared to the remaining varieties (**Table 1**). The scores for sourness, dryness and texture did not differ significantly ($p \geq 0.05$) among all *enset* varieties (**Table 1**).

3.3. Proximate Composition Analysis

Proximate (nutrient content) analysis in the finding of this study indicated that, there was no significant difference in moisture ash content among the varieties (**Table 2**). Proximate compositions of protein, fat, fiber, and carbohydrate contents revealed significant differences among the varieties. The highest values of most of the proximate compositions were obtained from *kocho* sample taken from *Wanikore* variety, while the lowest values were recorded from *kocho* sample taken from *Chancho* variety. Similarly the respondents during survey responded that is *Wanikore* known for its good quality of the final fermented product.

Table 1. The mean scores* (± SE) of the sensory attributes of each *enset* variety

Name of varieties	Sensory attributes					
	Appearance	Odor	Taste	Sourness	Dryness	Texture
Wanikore	3.71 (0.00)^{a}	3.43 (0.06)^{a}	3.56 (0.19)^{a}	2.14 (0.22)^{a}	2.10 (0.14)^{a}	3.82 (0.17)^{a}
Medicha	3.42 (0.32)^{a}	3.37 (0.02)^{a}	3.37 (0.11)^{a}	2.42 (0.32)^{a}	2.63 (0.21)^{a}	3.68 (0.12)^{a}
Geena	3.56 (0.40)^{a}	3.36 (0.07)^{a}	3.03 (0.12)^{b}	2.50 (0.12)^{a}	2.44 (0.11)^{a}	3.56 (0.11)^{a}
Addo	3.11 (0.01)^{b}	3.19 (0.06)^{a}	2.99 (0.31)^{b}	2.34 (0.01)^{a}	2.31 (0.01)^{a}	3.52 (0.16)^{a}
Dowiramo	3.33 (0.13)^{b}	3.32 (0.09)^{a}	2.96 (0.23)^{b}	2.25 (0.00)^{a}	2.10 (0.01)^{a}	3.43 (0.04)^{a}
Haaho	3.17 (0.15)^{b}	3.10 (0.03)^{ab}	2.91 (0.01)^{b}	2.94 (0.00)^{a}	2.66 (0.13)^{a}	3.33 (0.11)^{a}
Sediso	3.32 (0.07)^{b}	2.96 (0.13)^{b}	2.84 (0.15)^{bd}	2.60 (0.12)^{a}	2.13 (0.15)^{a}	2.99 (0.02)^{a}
Damala	2.51 (0.32)^{c}	3.07 (0.01)^{a}	2.43 (0.20)^{cd}	2.75 (0.04)^{a}	2.89 (0.04)^{a}	3.09 (0.22)^{a}
Birra	2.94 (0.27)^{bc}	2.81 (0.30)^{b}	2.50 (0.33)^{c}	2.80 (0.11)^{a}	3.10 (0.71)^{a}	2.87 (0.25)^{a}
Chacho	2.70 (0.21)^{c}	2.83 (0.15)^{b}	2.54 (0.01)^{c}	2.16 (0.03)^{a}	2.82 (0.31)^{a}	2.96 (0.14)^{a}

*, a 5 – point category scale (5 = the best; 1= the lowest score = 1)
a–d, different superscripts within columns indicate significant differences ($P \leq 0.05$).
SE = standard error of the mean.

Table 2. Mean Values (± SE) of proximate composition of selected *enset* varieties (dry weight basis)

Name of varieties	Proximate Compositions					
	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Carbohydrate (%)
Wanikore	60.82 (0.17)^{a}	3.51 (0.00)^{a}	1.08 (0.01)a	3.22 (0.02)^{a}	2.34 (0.02)^{a}	54.30 (0.04)^{a}
Medicha	61.46 (0.03)^{a}	3.46 (0.02)^{a}	0.79 (0.21)b	3.31 (0.05)^{a}	2.23 (0.11)^{a}	49.21 (0.12)^{b}
Geena	60.53 (0.26)^{a}	3.43 (0.05)^{a}	1.10 (0.02)a	3.83 (0.11)^{a}	2.33 (0.03)^{a}	53.50 (0.19)^{ab}
Addo	60.26 (0.30)^{a}	3.48 (0.02)^{a}	0.67 (0.05)b	3.75 (0.31)^{a}	2.19 (0.10)^{a}	57.20 (0.71)^{c}
Dowiramo	62.41 (0.22)^{a}	3.48 (0.04)^{a}	1.25 (0.00)a	3.62 (0.08)^{a}	2.35 (0.35)^{a}	51.61 (0.00)^{ab}
Haaho	60.00 (0.13)^{a}	3.13 (0.01)^{b}	0.91 (0.12)ab	4.51 (0.10)^{b}	2.15 (0.18)^{a}	64.15 (0.11)^{d}
Sediso	63.30 (0.11)^{a}	3.15 (0.08)^{bc}	0.46 (0.07)c	4.35 (0.20)^{b}	2.11 (0.15)^{a}	57.17 (0.05)^{c}
Damala	60.52 (0.48)^{a}	2.93 (0.03)^{c}	0.44 (0.04)c	3.48 (0.13)^{a}	2.26 (0.12)^{a}	62.20 (0.33)^{d}
Birra	59.90 (0.74)^{a}	3.37 (0.05)^{a}	0.46 (0.04)c	4.43 (0.30)^{b}	2.18 (0.11)^{a}	58.64 (0.04)^{c}
Chacho	61.06 (0.50)^{a}	2.98 (0.13)^{bc}	0.43 (0.13)b	4.57 (0.01)^{b}	2.17 (0.20)^{a}	59.18 (0.04)^{c}

Values are means ± SE of triplicate determinations.
a–d, different superscripts within columns indicate significant differences ($P \leq 0.05$).
SE = standard error of the mean.

4. Discussion

The survey of this study has shown that there is diversity of *enset* varieties known by farmers in *Sidama*. This reveals that there is existence of variation among varieties in terms of their phenotypic as well as genotypic characteristics. Farmers use phenotypic differences like leaf color, pseudo stem color, midrib color, pseudo stem length, size, fiber quality, time to maturity etc. to differentiate one variety from the other. This phenotypic selection results in the increased chance of adopting genetic selection among different *enset* varieties for improving yield in specific aspects (for instance, protein content). Genetic variation has been studied using AFLP analysis (Almaz *et al*., 2002). Farmers and household women traditionally rank the different *enset* varieties based on their contribution to the quality of the final fermented product. This was now confirmed in this study using proximate analysis procedure and the nutritional components of each selected varieties were compared.

Sensory evaluation data (Table 1) indicated that there is a significant difference in appearance, odor and taste among *kocho* samples prepared from the selected *enset* varieties. This could be attributed to the existence of genetic variation among the varieties and also maturity stages might affect the nutritional contents of the processed varieties. The slight variation with respect to agro ecological conditions of the three localities might also affect the contents of each variety. In addition, according to Ajebu Nurfeta, et *al*. (2008), varietal diversity *enset* affects chemical composition. The highest score was given to the variety *wanikore* for most of sensory attributes evaluated. This is most likely attributed to the high content of proximate compositions. The survey also confirmed that the variety *wanikore* is ranked first by the consumers in terms of its acceptability. The scores for sourness, dryness and texture did not show significant difference among the selected *enset* varieties. This is most likely due to the fact that all the selected varieties were processed the same day, and fermented for equal duration of time and baked and presented to the panelists at the same time. Therefore, a significant difference of the sensory attributes: sourness, dryness and texture could not be expected.

The results of proximate analysis (Table 2) indicated that, there was no significant variation among varieties on moisture content of *kocho* samples taken from each selected variety. This is possibly due to equal amount of initial moisture content, since all the selected varieties are processed at the same time with a similar method of processing and allowed to ferment for the same duration of time. The ash content, which is a subset of the mineral elements in the sample did not also differ significantly among the samples taken from each selected *enset* variety. This is attributed to similar fermentation time. Since fermentation influences the solubility of mineral elements and of the organic constituents, it directly contributes to the ash composition and quantity of *kocho*. This is in agreement with studies made on different varieties of cassava (Eleazu, 2012; Kenneth, 2013; Carola *et al*., 2007; Sarkiyayi and Agar, 2010).

The protein content of *kocho* samples taken from each variety, varied significantly. This could be possibly due to varietal differences among the selected *enset* plants. This is in agreement with studies carried out on cassava varieties by Carola *et al*., (2007). In addition to varietal differences, Apea-Bah *et al.*, (2011) also reported that age of the plant significantly affected ($p<0.05$) crude protein content i.e. the younger plants contain more crude protein than the older ones. This report indicated that this may be due to differing rates of nitrogen metabolism in the growing plants resulting in differing amount in crude protein content at the time of harvest.

Crude fat content of each sample has also shown significant variation among the selected *enset* varieties. This could be attributed to genetic diversity among the selected *enset* varieties. Generally, *enset* plat has lower fat content as compared to other proximate analysis studied in this experiment. In previous studies (Akpabio *et al*., 2012) a lower amount of fat content has been reported in a similar plant (cassava). Some of the samples also showed variation on crude fiber content. The observed differences may be related to genetic differences among the selected *enset* varieties. The samples taken of each variety showed high values of carbohydrate content. This confirmed that *enset* products are a good source of energy for human as well as animal food. The variation in the carbohydrate content might be attributed to varietal differences. This could confirm the works of other researchers who carried out proximate analysis of other tubers like cassava in comparison to *enset* (Sarkiyayi and Agar, 2010; Akpabio *et al*., 2012; Chukwuneke *et al*., 2013, Kenneth, 2013).

5. Conclusions and Recommendations

This study has shown that noteworthy variation at the level of cultivated varieties of enset can affect some sensory characteristics such as appearance, odor and taste as well as proximate compositions such as protein, fat, fiber and carbohydrate content of the derived *kocho* prepared from each selected *enset* variety. It may be concluded that selection of appropriate varieties could contribute to the overall quality of food products prepared from *enset* plants. The low protein content of all varieties suggests dietary supplementation with foods with higher protein content. Additional research is also necessary, to distinguish between the effect of genetic variation and that of other factors, such as climate, altitude, soil composition and water availability. An important aim is to select the best *enset* varieties to conserve them as germplam for feasible production of *enset* products also in the future. In addition, further focus is needed to collect and evaluate the sensory and nutritional analysis of other *enset* varieties. This will help to ensure food security as well as development of better *enset* varieties to improve the nutritional content of the final products.

ACKNOWLEDGEMENTS

The financial support of Hawassa University, Research and Development Directorate is gratefully acknowledged. The kind assistance of my colleague, Ato Bishaw Tadele during survey was also of great importance.

REFERENCES

[1] Adamsu Tsegaye. 2002. On indigenous production, genetic diversity and crop ecology of *enset* (*Enset ventricosum*). PhD Thesis, Wageningen University, The Netherlands. 198p.

[2] Ajebu N., Lars O.E., Adugna T., and Frik S. 2008. Chemical composition and *in sacco* dry matter degradability of different morphological fractions of 10 enset (*Ensete ventricosum*) varieties. *Animal Feed Science and Technology* 146: 55-73.

[3] Akpabio U. D., Akpakpan A. E., Udo I. E. , Nwokocha G. C. Comparative Study on the Physicochemical Properties of Two Varieties of Cassava Peels (*Manihot utilissima* Pohl). *Int. J. Environ. Bioener* 2(1): 19-32.

[4] Almaz Negash. 2001. Diversity and conservation of *enset* (*Ensete ventricosum*) and its relation to house holds food and livelihood security in southwestern Ethiopia. PhD Thesis, Wageningen University, The Netherlands. 247p.

[5] Almaz N., Admasu T., Rob van T., and Bert V. 2002. AFLP Analysis of Enset Clonal Diversity in South and Southwestern Ethiopia for Conservation. *Crop Sci*. 42: 1105-1111.

[6] Apea-Bah, F.B., Oduro I., Ellis W.O., and Safo- Kantanka O. 2011. Factor analysis and age at harvest effect on the quality of flour from four cassava varieties. *World J. Dairy Food Sci.*, 6: 43-54.

[7] Association of Official Analytical Chemists (AOAC). 1984. Official Methods of Analysis. 16th ed. Gaithersburg,

Maryland, U.S.A.

[8] Association of Official Analytical Chemists (AOAC). 1990. Official Methods of Analysis. 16th ed. Gaithersburg, Maryland, U.S.A.

[9] Association of Official Analytical Chemists (AOAC). 1995. Official Methods of Analysis. 16th ed. Gaithersburg, Maryland, U.S.A.

[10] Ayele Nigatu and Berhanu Abegaz Gashe. 1994b. Survival and growth of selected pathogens in fermented *kocho* (*Ensete ventricosum*). *East Africa Medical Journal* 71: 514-518.

[11] Ayele Nigatu, Berhanu Abegaz Gashe and Tarekegn Ayele. 1997. *Basillus* spp. From fermented *tef* dough and *kocho*: identity and role in the two Ethiopian fermented foods. *SINET: Ethiopian Journal of Science* 20 (1): 101-114.

[12] Berhanu Abegaz Gashe.1987a. *Kocho* fermentation. *Journal of Applied Bacteriol*ogy 62, 473-477.

[13] Bizuayehu Tesfaye and Peter Ludders. 2003. Diversity and distribution patterns of *enset* landraces in Sidama, Southern Ethiopia. *Genetic Resources and Crop Evolution* 50: 359–371.

[14] Brandt, S.A., Endale T., Gebre Y., Gizachew W., Hiebsch, C., McCabe, J.T., Mulugeta D., Shiferaw T., and Shigeta, M. 1997. The "Tree Against Hunger". *Enset*- based agricultural systems in Ethiopia. American association for the advancement of science with Awassa Agricultural Research Center, Kyoto University Center for African Area Studies and University of Florida, Washington, DC,USA, 66p.

[15] Carola R., Baboo N., Adelina H., and Björn B. 2007. Proximal composition and mineral contents of six Varieties of cassava (*mannihot esculenta,* crantz), from bolivia. *BolivianJournalOfChemistry* 24:70-76.

[16] Chukwuneke J.L., Achebe C.H., Okolie P.C., and Okafor E.A. 2013. The Effect of Variety and Drying On the Engineering Properties of Fermented Ground Cassava. *International Journal of Scientific Knowledge* 1:13-27.

[17] Drake, M.A. 2007. Sensory analysis of dairy foods. *Journal of dairy science* 90: 4925-4937.

[18] Eleazu C.O. 2012. eDetermination of the Proximate Composition, Total Carotenoid, Reducing Sugars and Residual Cyanide Levels of Flours of 6 Elite Yellow and White Cassava Varieties. *International Journal of Toxicological and Pharmacological Research* 4(4): 71-76.

[19] Heintz, C.M. and Kader, A. A. 1983. Procedures for the sensory evaluation of horticultural crops. *Horticultural science* 18 (1): 18-22.

[20] Heymann. H. and Lawless. H.T. 1999. Sensory evaluation of food: principles and practices. New York. pp 208-216.

[21] Jacob, G. 2004. Enset - The 'False Banana' as Food Security, http://fex.ennonline.net/22/enset.aspx. (Accessed on 22 July 2004).

[22] Janz, J. 2003. The ABC's of Sensory Evaluation and Consumer Testing. CMSA news (Canadian meat science association). 1-5pp.

[23] Kelbessa Urga, Alemu Fite and Eskindr Biratu. 1997a. Natural fermentation of *enset* (*Ensete ventricosum*) for the production of *kocho*. *Ethiopian journal of Health Development* 11:75-81.

[24] Kenneth V.A., 2013. Quality characteristics, root yield and nutrient Composition of six cassava (*manihot esculenta* crantz) varieties. Gladstone Road Agricultural Centre Department of Agriculture Nassau, Bahamas.

[25] Koeferli, C.S. Schwegler., P.P. and Hong-Chen, D. 1998. Application of Classical and Novel Sensory Techniques in Product Optimization. *Lebensm.-Wiss. u.-Technol* 31: 407-417.

[26] Lazim, M.A. and Suriani, M. 2009. Sensory Evaluation of the Selected Coffee Products Using Fuzzy Approach. *World Academy of Science, Engineering and Technology* 50: 717-720.

[27] Meaza Girma and Berhanu Abegaz Gashe. 1985. Studies on the microbial flora of *kocho* and *bulla* purchased from markets in Addis Ababa. *SINET: Ethiopian journal of science* 8:29-36.

[28] Mehtzun Tedla and Yewelsew Abebe. 1994. Study of *enset* processing and development of *enset* processing tools in the southern region of Ethiopia (Monograph). ACA/ NORAGRIC research project. Awassa College of Agriculture, Addis Ababa University, Ethiopia. 66p.

[29] Memarua Abesha. 1995. Traditionally fermented products of *enset* (*Ensete ventricosum*) microbial and nutritional qualities of *kocho* and *bulla*. M.Sc Thesis, Agricultural University of Norway, Norway. 58p.

[30] Mogessie Ashenafi. 2006. A review on the microbiology of indigenous fermented foods and beverages of Ethiopia. *Ethiopian journal of biological science* 5 (2): 189-245.

[31] Pijls, L.T.J., Timmer, A.A.M., Wolde-Gebriel, Z. and West, C.E. 1995. Cultivation, preparation, and consumption of *enset* (*Ensete ventricosum*) in Ethiopia. *Journal of science food agriculture* 67: 1-11.

[32] Sarkiyayi S., and. Agar T.M. 2010. Comparative Analysis on the Nutritional and Anti-Nutritional Contents of the Sweet and Bitter Cassava Varieties. *Advance Journal of Food Science and Technology* 2(6): 328-334.

[33] Tesfaye B. 2008. On Sidama folk identification, naming, and classification of cultivated enset (Ensete ventricosum) varieties. *Genet Resour Crop Evol* 55:1359–1370.

[34] Welde-Michael. G, Bobosha. K., Blomme. G., Addis. T., Mengesha. T., and Mekonnen. S. 2008. Evaluation of *Enset* Clones against *Enset* Bacterial Wilt. *African Crop Science Journal* 16: 89-95.