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Assessment of enset (*Enseteventricosum)* (Welw) Cheesman) processing and it's postharvest: Constraints in post-harvest handling and farmer's preferences

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Abstract
Enset, grown worldwide despite purposive production and consumption, is only in Ethiopia where it supports as staple and co-staple food for about 20% of Ethiopia people mostly in south and southwestern parts. The study aimed on enset processing and post-harvest techniques in enset producing areas covering Jimma and Keffa zones and Yem special districts which has participated about 128 farmers. In the area, participants portrayed before harvesting matured enset identified using different criteria such as pseudostem size, leaf and leaf sheath color change, year counting from the start of transplanting to harvesting, flowering and expose of corm stated by majority of respondents (43.75%). Additionally, all respondents (100%) responded the traditional enset harvesting/processing method is tiresome and cumbersome. The processed enset is stored for fermentation either in pit lined with leaf and leaf sheath (87.20%) or above ground in wrapped leaf and leaf sheath (12.80%) depending on harvesting season. The respondents also added traditional fermentation enhancer to hasten fermentation and shorten time of fermentation. From the study, the critical problem identified for this indigenous crop upon which people depended was the non-modified processing technique which is time consuming, tiresome why new generation neglecting enset production despite its multi-merit calling for multidisciplinary and integration research to find consistent solution.

Keywords: Enset, processing method, traditional fermentation enhancer

Introduction
Enset *(E. ventricosum* (Welw*)* is one of the most important crops grown in East, and horn of, Africa. The crop is important for food and nutritional securities, income source, combined with its socio-cultural importance and make it one of the most important food and livelihood security crops in Ethiopia (Hunduma and Ashenafi, 2011) [4]. The plant is also known by its versatility and resilience habit to combat harsh environmental conditions where other plants cannot exist.

Enset supports more than 20% of Ethiopian people, predominantly societies found in South and Southwestern part (Semman *et al*., 2017) [6]. All plant parts are valuable as a source of food, feed, fiber, soil fertility protection and even moderating micro-climate of the area. Besides, its production is firmly related with culture, social expression and economic status of the community (Kefelegn *et al*., 2014) [5]. The crop has existed several hundred years ago in south and southwestern part mainly in Sidama, Dawro, Kefa, Sheka, Yem, Gedio, Gurage and in the rest of the zones; and contributed to food and nutritional security (Dejene and Yemataw, 2018) [1]. Furthermore, the crop is also used as a source of fuel wood, construction materials, containers and as shade effect for intercropping. The major products derived from enset are kocho (processed and fermented enset product), Bulla (sediment obtained from the squeezed scraped and pulverized leaf sheath and corm), amicho (that is, cooked corm, the below ground plant part). These products are made through traditional processing methods (selection of matured enset plant, preparation of fermentation pit and by clearer processing spot, decortications of the above ground plant parts by using traditional tools and finally pulverization process); and it varies from one region to another (Hunduma and Ashenafi, 2011) [4]. All of these processes are old techniques and not supported by scientific research to get quality products. In this regard, little effort so far has been done to improve the traditional enset processing materials and methods in Ethiopia, which hinders the wider utilization (such as food, industry and medicine) of the crop.

Further, the methods hardly fully cover the whole yields, and the products are not assessed

for quality as currently obtained from enset. Thus, comprehensive assessment of enset processing methods and materials with quality products is required to boost enset production in the country. Cognizant of these facts, the present study was designed to assess the conventional enset harvesting practices, post-harvest handling and its drawbacks in major enset growing areas of southwest Ethiopia and to collect information for future scientific intervention.

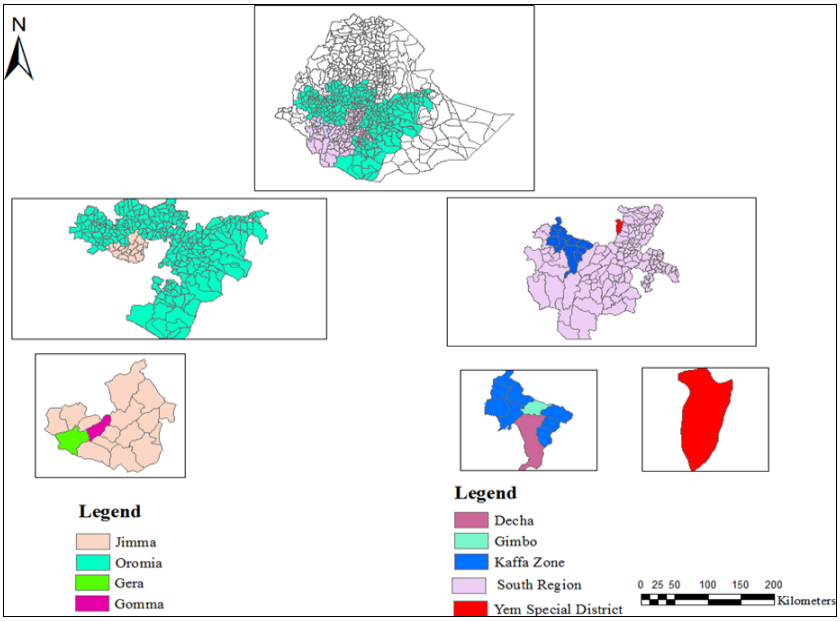

Fig 1: Map of the study areas

Materials and Methods

Description of study areas

A total of five districts from two zones (Jimma and Kafa) and one special district (Yem) was assessed for this study from mid of October to January 2018 (Figure 1). These areas were selected for study based on strong tradition in cultivating and domesticating various enset clones with wide genetic base (Neim *et al*., 2019) [7], high production potential and long history on production and management system of enset with farmers' traditional knowledge. From each district (that is, Gomma and Gera of Jimma zone Oromia, Decha and Gimbo Kaffa zone South Nation Nationality Regional State (SNNRS) and Yem special districts) an average of 30 farmers, 15 to 20 enset producers, 5 key informants and five DAs were sampled from different social groups for individual interviews, and group and key informants' discussions. The key informants were selected in order to conduct in-depth interviews and discussion sessions. They were selected from household heads of both sexes and different age groups based on their availability, willingness and practical knowledge about enset in the areas. The local administrators and agricultural extension workers helped during identifying the names of the focus groups. Field visits (home gardens, cultivated fields) were conducted to observe some of the species under cultivation. The household characteristics of the surveyed districts are presented in Table 1.

Table 1: Household characteristics of the surveyed districts.

District	No. of farmers	Religion			Sex		Mean age of farmers	Mean family size	Mean farm size(ha)
		Ortho	Mus	Prot	Male	Female			
Gomma	20.0	2.0	18.0	-	18.0	2.0	40.08	5.00	1.63
Gera	15.0	0.0	13.0	2.0	14.0	1.0	45.83	4.19	0.86
Gimbo	32.0	9.0	22.0	4.0	25.0	7.0	47.46	6.08	1.00
Decha	30.0	10.0	3.0	17.0	27.0	3.0	51.67	6.80	1.50
Yem	31.0	19.0	7.0	5.0	23.0	8.0	52.35	6.90	0.80

Ortho = Orthodox, Mus = Muslims, Prot = Protestant.

Sampling methods and data collection

For this study, purposive and stratified random sampling methods were followed to describe the sampling units. Two zones and one special district were selected purposively and the district was stratified first based on elevation and agro-ecology to obtain an appropriate ecological range of enset; and kebeles were selected and judged as main enset growing areas. The present study was conducted in 25 Kebeles belonging to five administrative districts from Jimma, Kafa and Yem zones and special district from April mid of October to January, 2018. Five Kebeles were selected from each district based on consultation with district agricultural experts on the basis of enset growing potential and agro-ecological variation (Table 1).

To undertake an exhaustive enset postharvest inventory, a total of 120 households were selected using a sample size determination method revised by Glen (2003) [3]. The representative households were selected from each district based on the farmers' owning larger farm size of enset and their growing diversified species by consulting Kebele leaders and key informants that are knowledgeable about the crop.

Data were collected from different sites through the application of participatory research appraisal tools and techniques, such as individual household interviews, direct observation, and field visits, group discussion and key informant interviews using a well- prepared questionnaire and checklists. On average twenty four individuals were randomly selected from each district for individual interviews with the help of local translators. Besides, about 15 to 20 enset producers of different social groups were identified and assembled with the help of key informants involved in the study to facilitate the group meetings and data collection. Through discussions, detailed information of the agronomic practices, gender, maturity time, postharvest handling and culinary characteristics that existed were identified and documented.

Data analysis

The collected data were analyzed through descriptive statistics (frequencies, percentages, means, etc.) to generate summaries and tables at different (Kebeles and districts) level using SPSS (1996) version 16 (Statistical Packages for Social Sciences).

Results and Discussion

Maturity determination, harvesting and post-harvest problems

The result showed that enset harvest age maturity varied from person to person. Accordingly, a majority of the respondents (43.75%) of the study area responded that they determined enset maturity for harvesting based on pseudostem size, leaf and leaf sheath color change, year counting from the start of transplanting to harvesting, flowering, and sprouting or exposure of the corm. About 37.5% respondents used flowering and size of the plant to begin the harvest or to decide maturity of their enset (Figure 2). Fewer respondents, about 3.125%, stated counting years, and size of the plant or pseudostem size, were used as maturity determination criteria. Different enset clones have different maturity periods (Figure 2). Based on these scenarios, farmers classified enset as male and female in which the female enset have smaller size, early flowering up to 3 years, which means early mature types; whereas the male enset have opposite characters. That is why the majority of other attributes are considered by farmers besides size and year count. This result was in line with the reports of Hunduma and Ashenafi (2011) [4]; Semman *et al*. (2017) [6] who stated mature enset was identified by locally-established maturity signs, such as size of central shoot, appearance of inflorescence and exposure of the corm (Figure 2).

Concerning about enset harvesting, all sampled respondents used traditional enset harvesting methods (Table 2). This traditional harvest process has its own steps, such as identifying mature enset, preparing pit and lining with leaf and leaf sheath, removing external leaf sheath, decorticating and pulverizing of the inner leaf sheath using traditional processing (harvesting) tools called Mato, Maro and Mukatupho (Figure 3). This was in parity with the report of Hunduma and Ashenafi, (2011) [4], except naming the materials differ based on local language. As far as harvesting season is concerned, the majority of farmers (56%) in the study area harvested their enset during the rainy season, which means at a time of food shortage and directly related to a time given for fermentation of processed kocho. In this strategy, about 73.44% of farmers in study areas wait for 15-30 days for fermentation from the time of harvesting to consumption. They stated that the time for keeping fermented kocho in the hole and harvesting season depend on the economic status of the household. The surveyed community stated that farmers who have sufficient food sources harvest their enset at any season of the year and store for more than a month. The more stored in the hole the kocho quality become (Figure 4).

There were a few storage problems mentioned during the survey work, which affect quality and quantity of kocho in the pit. Of these problems, 21.09% of respondents said that pigs were the main factor that reduced kocho quality and quantity; whereas, 2.34% of farmers underlined improper pit lining and covering the piled kocho, which allowed air penetration thereby leading to development of worm growth, which deteriorates kocho quality. But a majority of respondents (75.78%) stated there were no storage problems if the pit and kocho covering was properly done (Figure 5). They reported that aeration causes blackening of kocho, development of a repugnant smell, and worm development, thus consequently losing quality.

Table 2: Summary of enset processing and storage techniques

Method of harvesting technique		
(i) Traditional Harvested enset/ kocho/ storage places	124	100
(ii) In hole lined with leaf and leaf sheath	109	87.20
(iii) Above ground prepared from wrapped leaf and leaf sheath	16	12.80

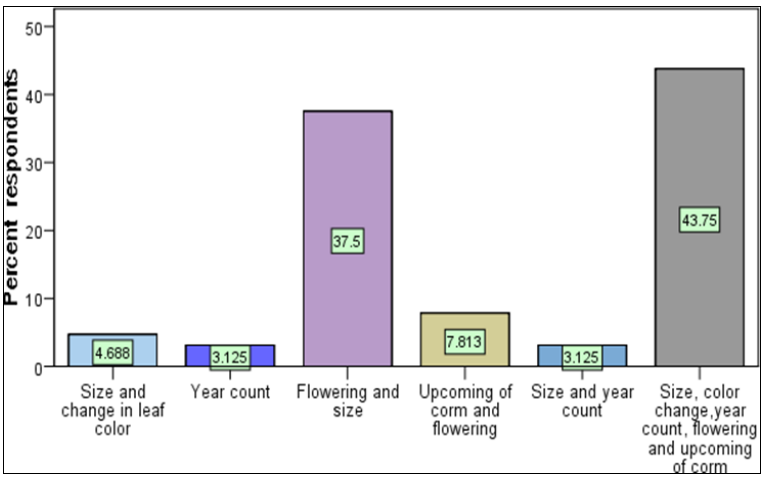

Fig 2: Summary of maturity determination methods.

Enset processing and its storage

In the study community, there were two harvested enset storage techniques in the study districts. About 109 (87.20%) of respondents stored the harvested enset in pit/hole lined with leaf and leaf sheath; and 16 (12.80%) of respondents used above ground storage prepared from wrapped leaf and leaf sheath (Table 2). The former method was mostly applied during dry season or around the pit curved trench for drainage is prepared to prevent flood penetration to the pit. According to respondents, this method was preferred for long period storage. But the later storage method was preferred during rainy season which can overcome moderate flood damage but easily destroyed by other external environment like animals and not appropriate for long storage period. Based on storage methods, altitude of the area (temperature of the area), accession used and economic status of farmers, waiting of fermentation period (storing period) from the time of processing to consumption varied. Thus, 73.44% of respondents kept their kocho in the pit for 15-30 days (Figure 6). The rest 15.63% and 10.94% of surveyed farmers allow fermentation period for more than a month and less than 15 days, respectively (Figure 6). This result agrees with the findings of Fikadu *et al*. (2016) [2].

Women in the surveyed area reported that a traditional starter culture (fermentation enhancer) was used to hasten fermentation and to shorten the time taken from harvesting to consumption as well as quality improvement. However, this contradicts the results of Fikadu *et al*. (2016) [2] who indicated a fermentation starter was not being used in Gamo Gofa and that the time from harvesting to the first consumption took more than a month.

Fig 3: Enset harvesting equipment: (a) Mato, (b) Maro, (c) Mukatupho.

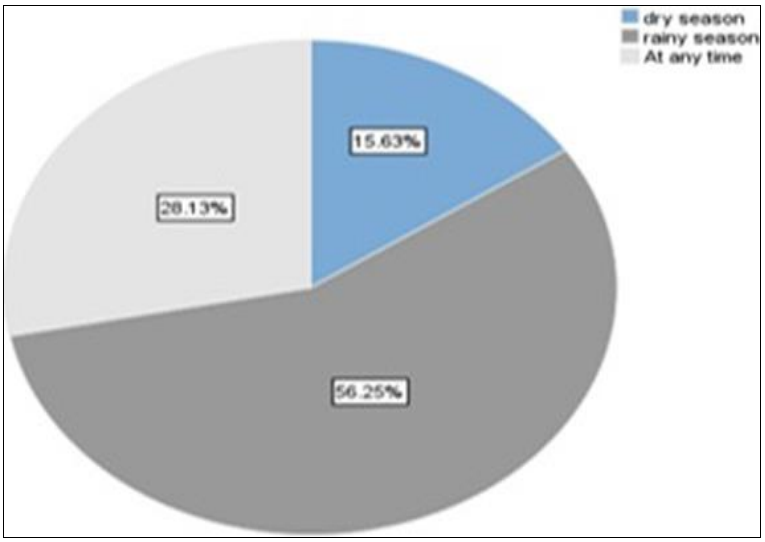

Fig 4: Percent Share of respondents to harvesting season

Conclusion and Recommendations

Most producers harvest their enset using traditional methods when there is a shortage of other cereal crops, and store it either in the pit or above ground using prepared storage composed of wrapped leaf and leaf sheath depending on season and duration of storage. Additionally, due to long term experiences, the farmers identify matured enset and harvest at its proper maturity period. Using traditional harvesting equipment and cultural harvesting methods; they harvest, process and use kocho products which is heavy work and cumbersome. Generally, there were no scientifically modified harvesting and storage methods of enset in the study area; and intervention of government and non- governmental organization is paramount in modifying traditional processing through mechanization. Additionally, the role of addition of fermentation starter or fermentation enhancer on shortening of fermentation period and increasing kocho quality requires scientific investigation.

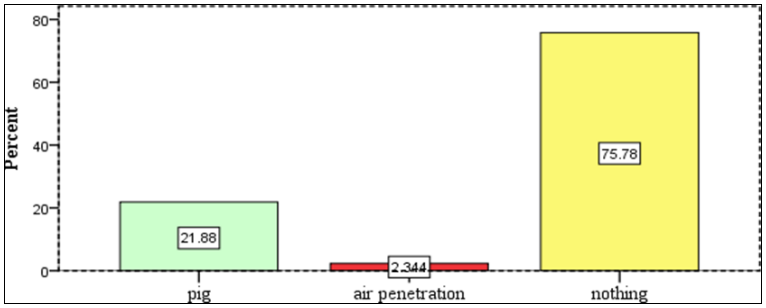

Figure 5. Storage problems and their percent share

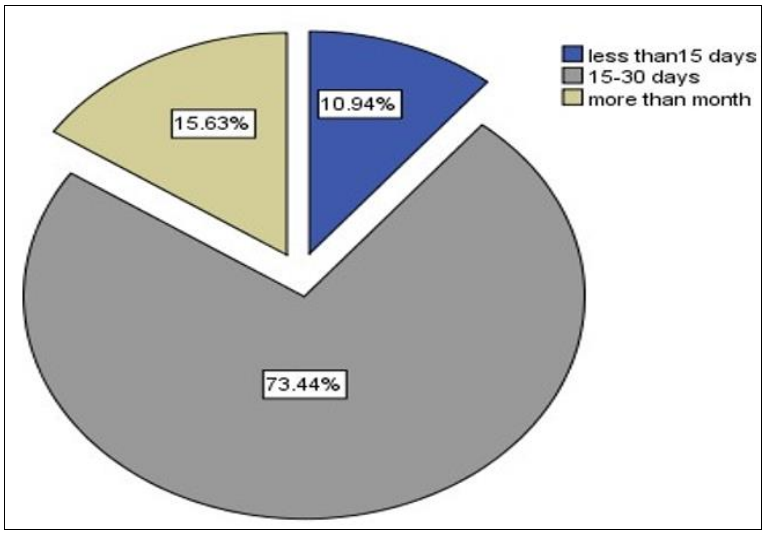

Fig 6: Fermentation period of processed enset from time of processing to consumption

Conflict of interests

The authors have not any conflict of interests and the paper belongs to the listed authors.

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