Wolkite University

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College of Engineering and Technology

Food Process Engineering Department

Title: ***Study on functional and Physico-chemical characteristics of Bulla, Enset (*Ensete *Ventricosum) Product.***

Theis Proposal Submitted to: - Department of Food Process Engineering in Partial Fulfilment of the Degree of Bachelor (BSc) Of Food Process Engineering

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Wolkite University, Ethiopia

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List of Abbreviations and Acronym

AARC .....Areka Agricultural Research Centre

AHI ……African Highlands Initiative

ANOVA .....Analysis of Variances

AOAC..... Association of Official Analytic Chemists

CRD ……. Completely Randomized Design

DC……Discreet of Colombia

FAO ……Food and Agricultural Organization

FCES …..... French Centre of Ethiopian Study

FDRE …… ……. Federal Democratic Republic Of Ethiopia

IBC …….. Institute Of Biodiversity Conservation

LSD …….. Least Significant Difference

OAC ……. Oil Absorption Capacity

Rpm.....Revolution per Minutes

Sp …….. Swelling Power

SZC-D…….Least Significance Difference

TSS.....Total Soluble Solid

USA…….United States of America

WAC…… Water Absorption Capacity

WKU …… Wolkite University

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CHAPTER ONE

1. INTRODUCTION

1.1. Background

Enset is one of the potential indigenous crops for food, and the Enset cultivation system is economically viable, and is one of the few successful indigenous and sustainable agricultural systems. It is sustainable because it has been providing food for humans for generations from the same plot, and maintains the quality of life of the people. It grows in a wide range of environmental conditions. Even though it grown in many wide areas, the dwellers of the central and southern parts of Ethiopia are, the only people that use Enset as a staple and co-staple crop. It is a multipurpose plant with a range of utilities including food, feed, construction and medicinal uses (Annual report, 2013). Moreover, enset cultivation improves soil by permanent soil tillage due to its high demands to soil fertility and soil structure (Zippel and Karina, 2002).

Root and tuber crops are widely cultivated in southern Ethiopia, and support a considerable portion of the country's population as source of food. Prominent among these are: sweet potato (Ipomoea batatas L.), enset (Ensete ventricosum (Welw), Cheesman), godere (Colacasia esculanta L.), yams (Dioscorea spp.), Ethiopian dinch (Coleus parviflorus). Among these, enset and, some yams are endemic to Ethiopia (Aregahegn *et al*., 2013).

The crop known for its tolerance to transient drought, high productivity and environmental sustainability (Annual report, 2013). Research suggests, that populations depending on enset have never suffered from famine, even during Ethiopia's tragic drought and famine prone decades of the 1970s and 1980s" (Macentee *et al.*, 2013). Kocho, bulla and amicho are primary enset products. Kocho and bulla are obtained after processing, whereas the Amicho or corm is a cooking type boiled and eaten directly without any processing (Olango *et al.*, 2014 and Forsido *et al.*, 2013). Kocho and bulla foods are extremely popular at restaurants that serve the Ethiopian delicacy of Kitfo (raw minced beef mixed with butter and spice) (Brand *et al.*, 1997 and Forsido et al., 2013).

The length of fermentation time varies from weeks to several months, depending on ambient temperatures of incubation. In the cooler regions, it kept in a pit for years, and the quality said to

increase with increasing fermentation time. In warmer regions, fermentation is rapid and is therefore, terminated within 3 to 6 months. However, during the bridging period or otherwise in difficult situation, fermentation cannot afford to wait more than a month, even fifteen days, for fermentation (Hiwot, 2015). After the fermentation is completed, a portion is removed from the pit and the liquid is squeezed out, it resulting in a moist fibrous Kocho (Yirmaga, 2013). Roots and tubers generally are processed into various foods before consumption. Processing makes them digestible and palatable, extends the shelf-life and reduces post-harvest losses (Ugwu, 2009).

Bulla is one of the major products of enset "the best part" obtained from the transformation process of enset into Kocho. The internal part of the pseudo stem scraped with a piece of split bamboo in order to separate the starch from the fiber. This pulp is then pressed with the feet to collect the juice, which is then left to decant. This decantation produces the bulla, which then left to ferment for several weeks, which is highly starchy food and best quality of food. It consumed on specific occasions (religious, traditional feasts) or in the honour of guests (FCES, 2005). But the nutritive value of starchy foods depends mainly on their nutrient content, physicochemical properties of their starches and the existence of antinutritional factors and toxic substances (Atlabachew, 2007).

All the roots including enset exhibit a very low lipid (0.12-2.7%) content and may affect the palatability of the crops (Ugwu, 2009). The protein content is low in almost all root crop, Sulphur-containing amino-acids are limiting in the proteins as in legume proteins and no vitamin at all (Atlabachew, 2007 and Ugwu, 2009).

Geographically distributed as a wild species in many parts of Sub-Saharan Africa and Asia and other parts of the world.

1.2. Nutritional and Mineral composition of kocho and bulla

1.2.1. Nutritional composition of Bulla and Kocho

The main feature of enset foods is their high energy, derived almost entirely from carbohydrate. Carbohydrates are the main sources of nutritive energy, the principal constituent of edible carbohydrate is starch together with some sugars, the proportion depending on the root crop. All the roots contain a very low lipid (Ugwu, 2009) and also protein content is low in almost all root crop, Sulphur-containing amino-acids are limiting in the

proteins as in legume proteins. Most root crops contain a reasonable amount of lysine though less than in legumes (Atlabachew, 2007 and Ugwu, 2009). The corm contained 17 of 20 amino acids, in concentrations from 1.2 to 8.7 g per 100 g dry protein and from 25.6 to 186.6 mg per 100 g fresh corm. The amino acids not present in enset corm were asparagine, glutamine and tryptophan (Mohammed *et al.*, 2013). Atlabachew, 2007 done study on the nutritional composition of bulla and kocho and obtain the following results.

Table 2. 1. Nutritional Composition of bulla and Kocho

Parameters	**Dry Kocho/100 g**	**Dry Bulla/100g**
energy value	1410–1950 KJ	1580–1850 KJ
Carbohydrate	95–98 g	93–98 g
Protein	1.1–2.8 g	0.4–0.8 g
Fat	0.2–0.5 g	0.2–0.4 g
Ash	1.7 g	0.2 g
Fiber	-	0.6– 0.8 g
Moisture/fresh based	47–62 g	44–55 g

Source Atlabachew, 2007

1.2.2. Mineral composition of kocho and bulla

Kocho and Bulla are free of heavy metals (Cadmium and lead) contaminations. (Atlabachew, 2007). Enset products provide more calcium and iron than most cereals, tubers and root crops (Mulualem and kifle, 2014). Atlabachew, 2007 done study on the mineral content of bulla and kocho on dry weight basis of bulla and kocho and obtain the following results.

Table 2. 2. Mineral composition of bulla and kocho on dry weight basis

Types of mineral	Kocho (µg/g)	Bulla (µg/g)
Potassium	2753 – 4380	708 – 875
Sodium	462 – 688	402 – 442
Calcium	498 – 584	385 – 446
Magnesium	180 – 290	58.4 - 89.5
Iron	92.5 -135	36.5 - 59.8
Zinc	31 - 32.08	22- 44.3
Copper	3.4 – 4.3	2.01 - 3.53
Manganese	8.58 -10.13	1.0 - 4.98
Nickel	≤ 5.61	<4.0
Chromium	5.96 - 6.42	≤ 5.38
Cobalt	5.5 - 6.1	5.0 - 5.01

Source Atlabachew, 2007

1.3. Statement of the problem

There is a growing interest in the role that enset currently plays in regions of high consumption but it remains an understudied crop in relation to exploring its challenges and development potential (Macentee *et al.*, 2013). In previous studies the samples of enset (bulla and kocho) were taken either from communities (who consume enset as staple food) or from the market, but major drawback of commercially available enset, it is a mixture of different variety of enset. Therefore there may be few work on the nutritional composition, physicochemical and other characteristics of bulla.

Obviously the Ensete product are less in quality because all the process are exposed to environment and no suitable material that designed especially for that purpose, so there will be unwanted contamination and there are too much of wastage due to lack of scientific knowledge of processing.

On other point of view, the packaging material that used traditionally have large effect on product of Ensete. Hence, this study introduces a new knowledge in this idea.

1.4. Objectives

1.4.1. General objective

The general objective of this study is to assess the functional and physicochemical characteristics of bulla.

1.4.2. Specific objectives

- To evaluate physicochemical characteristics of bulla obtained from the enset
- To assess the functional properties of bulla obtained from of enset in order to select bulla with better nutrient for human consumption.
- To analyze sensorial properties of the Ensete product (*bulla*)

1.5. Significance of the study

Roots and tubers generally are one of the cheapest sources of dietary energy in the form of carbohydrates in developing countries. Therefore, there has been a tremendous increase in consumption of these roots and tubers over years as food for adults and young children (Ugwu, 2009). Since enset products such as Bulla and Kocho serve as the staple and co-staple food for many peoples of Ethiopia, knowledge towards its overall application is minimal. Thus, this study contributes:-

- To increase understanding of the available food composition data among indigenous and newly released varieties of enset product (bulla).
- To provide information on health benefits or risks of consuming of bulla.
- Help to indicate nutrient that lacks in enset (bulla) that may suggest fortification opportunities to improve its nutritive value.
- This indigenous crop some lesser known than others that deserve wider attention, thus one of the importance of this research is to increase people attention.
- It will further prove whether the raw or the fermented bulla has provided better nutrition to improve the quality of bulla for human consumption.
- This paper will provide information for future researchers, students, consumers, producers, who are interested to work on bulla /enset.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Root and tubers crop

According to FAO estimates, the 5 major food and agricultural commodities produced in Ethiopia in 2004 were roots and tubers, maize, sorghum and other cereals and cow milk. All these productions were mainly for local human consumption. (FAO, 2008). Root crops are the edible energy-rich underground plant structures developed from modified roots while tuber crops are those crops in which the edible carbohydrate-rich storage organs develop wholly or partly from underground stems (Iyagba, 2010). There are several indigenous cultivated or semi-cultivated root and tuber crops in Ethiopia. These crops have an important place in the diet of the population (IBC, 2007). Enset /Ensete ventricosum/ is one of the common staple plants categorized under root and tubers (Aregahegn *et al.*, 2013).

2.2. Taxonomy and classification of Enset (Ensete ventricosum)

Ensete ventricosum (Welw.) is an indigenous, perennial, herbaceous, monocarpic crop belonging to the family Musaceae (Annual Report, 2013). Morphologically it resembles a banana plant but bananas belong to the related genus Musa. Both Enset and Musa have a large underground corm, a bundle of leaf sheaths (pseudo stem), and large paddle-shaped leaves. It reaches 4-8 meter or even up to 11 meter in height (Atlabachew, 2007) and one meter in diameter (Stone *et al.*, 2011). Although further research still need to be done on the taxonomy and distribution of enset species, current data reveal six species of genus Ensete. Enset (Ensete ventricosum) is one of the six commonly recognized species of the genus Ensete (Hiwot, 2015).

Ensete ventricosum (Welw.) is endemic to Ethiopia and occurs throughout the country both cultivated and wild. It is an important staple to a large number of people in the south and southwest of the country. Although the plant is propagated vegetatively, there is tremendous variation in several characters, including colour of pseudo stem and leaf midribs, earliness, disease resistance and product quality (IBC, 2007). Even though, the production is high, the utilization of Enset plant is insignificant. The main problem is the inability to produce at a commercial scale and the loss of its product during harvesting, processing and the improper storage of the final product

before consumption and lack of knowledge about nutrition. Even though there is enough food, the people are not accustomed to vary their meal to fulfil the nutritional requirement. This is due to the lack of knowledge of the people on the balanced diet, the lack of income to purchase foods, and to use different raw materials as a source of food (Ayele and Sahu, 2014). It grows in house yards and consumed predominantly in the south and southwest regions of Ethiopia (Macentee *et al.*, 2013). Although the exact age of Enset domestication is not yet established, it was practiced in Ethiopian highlands between 5000 and 10000 years ago (Amedea and Dirob ,2005). It is cultivated in areas extending from 1700 to 3300 meter altitude with annual average temperatures between 8°C and 22°C and annual precipitation between 900 and 1500 mm (Zippel and Karina, 2002).

Enset ranges from being a staple to secondary food crop in different regions of the country and in 1991, the Ethiopian government declared enset a national crop. It plays an important role in national food security (Macentee *et al.*, 2013). It has probably given rise to better intensification of production systems involving year round cultivation of the land, with emphasis on root crops and close integration between livestock and crop production units. One plant of 5 years old. Enset could produce up to 21 kg of local food (Kocho, Bulla and Amcho) (Amedea and Dirob, 2005). Enset in the sub-system fulfils both production and protective functions (Hiwot, 2015).

Figure 2. 1. Matured Enset plant which grows around house yard

2.3. Origin of Enset

Ethiopia is a centre of origin for many cultivated plants such as Teff (Eragrostis teff), noug (Guizotia abyssinica), Ethiopian mustard (Brassica carinata), enset (Ensete ventricosum), anchote (Coccinia abyssinica) and coffee (Coffee arabica) (FDRE, 2014). Even though, enset originated in Ethiopia it is geographically distributed as a wild species in many parts of Sub-Saharan Africa and Asia (Olango *et al.*, 2014). Enset ventricosum grows wild also in a number of countries in central and eastern Africa including Congo, Mozambique, Uganda, Tanzania, and Zambia (Debebe, 2006). It grows in a wide range of environmental conditions. Even though it grows in many administrative regions, the dwellers of the central and south western parts of Ethiopia are the only people that use enset as a staple and co staple crop. The majority of enset production is confined to Sidamo, Shoa, Keffa, Gamo Goffa and Illubabor administrative regions (Atlabachew, 2007).

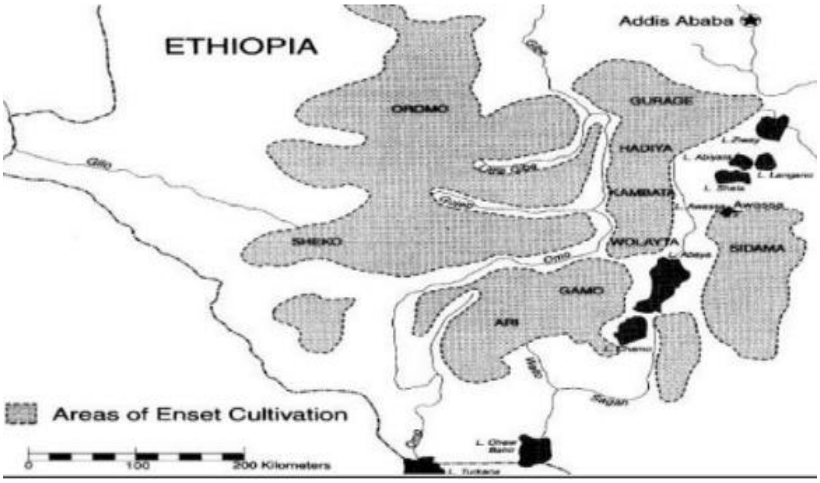

Figure 2. 2. Major Enset growing areas in southern Ethiopia and ethnic group (*Source Hiwot, 2015*)

2.4. Indigenous uses of Enset in Ethiopia

Cultural identity crop: - The enset plant and its cultivation have special cultural meaning and value. The cultivation of enset also bears a cultural symbol for the communities and it is an expression of their identity. Enset being highly valued as a status symbol, people appreciate

a hamlet by enset around it and give special respect and name for a man (Allawa) owing a large number of vigorously growing enset plants (Alla) in his home garden.

Staple and cultural food crop: - Enset food served as staple daily diet as well as in occasions of cultural festivals; hence enset foods have both nutritional and cultural values for the society (Olango *et al*., 2014).

Multipurpose material culture crop: - Every part of enset plant has some sort of use in material culture of the Wolaita. The green enset leaf, yeecha, is used as traditional plate to serve food, or as wrapping material for different products and baking breads, but it can be used also as an umbrella during the rainy seasons. Dried leaves and other pseudostem parts are also collected for making traditional seats (shill'a) and mattress (konashia hitta). Any dried part of the enset plant, mostly the dried lamina (gombila) and petiole, is used as a firewood. Susa, the dried and semi-dried long lamina, is used for fastening harvests of grasses, crops, and firewood. For construction of fences and traditional houses only dried, water-soaked and relatively strong lamina is used. The fiber of enset, gola, produced as side product during food processing kocho is a very strong and high quality fiber. It used for making ropes, strings, baskets, sacks, house floor carpets, filters, utensils' cleansers and many traditional house decors. In addition, the fiber used for fencing and construction of houses.

Medicinal plant:- It contribute to indigenous ethno-medicinal values traditional enset medicines include:

(i) Porridge made of bulla from Agino and Gefetanuwa landraces, for strengthening women after delivery, and healing bone fractures in humans respectively;

(ii) Very highly fermented kocho from Maziya and Halla landraces, for curing stomach cramps; and

(iii) Boiled corm of Lochingia, for birth control and abortion in humans, and to feed cows to facilitate placental expulsion (Olango *et al*.,2014).

Health benefit of enset/bulla: - As the principles of good nutrition, people are encouraged to eat more starches, especially those high in fiber, vitamins, and minerals. Fiber in foods may help to lower blood-glucose and blood-fat levels. Most people should increase the amount of carbohydrate and fiber they eat. This can be done by eating more bulla (swamp taro), giant taro, yams, sweet

potato, cassava, bananas, dried beans, and peas; more whole grain breads, cereals, and crackers; and more fruit and vegetables (Olango *et al*., 2014).

Other uses: - As described by the community, enset agriculture fulfils an ecological role, because it is an organic farming systems using only farmyard manures, with no external chemical fertilizers, herbicides and insecticides. Enset considered a safety-shield cattle feed because it is available during the drought prevalent seasons of the year. The enset plantation in home gardens serves also as a windbreak for enset and other crop nurseries. Enset farming also fulfils an aesthetic requirement for the home garden through colourful ornamental landraces (Olango *et al*., 2014).

2.5. Major Enset Based Foods

2.5.1. Kocho

Kocho is the bulk of the fermented starch obtained from the mixture of the decorticated (scarped) leaf sheaths and the grated corm (underground stem base). Kocho needs a lengthy period of processing and preparation, which carried out by women. The first stage involves removing the leaf stalks and grading of the corm. Then the fibers separated and the pulp crushed to extract the starch. This is put in a pit about 1.5 m deep and 1 m diameter, wrapped air tight with enset leaves before being weighed down with stones (Atlabachew, 2007).

It then allowed fermenting which requires weeks to months (Nigatu and Gashe, 1998), which may last from 4 months to three years. The pit opened at intervals to allow aeration, and the enset leaves replaced. This repeated until the desired fermentation quality reached or the food needed. Finally, the fermented starch is dried and treated as flour. This can be used to prepare a pancake − like bread, which is eaten with milk and cabbage. Kocho is increasingly exported to urban markets, Kocho can be stored for a long period of time without spoiling. The quality of Kocho depends on the age of the harvested enset plant, the type of clone (variety), and harvesting season. Moreover, within one plant, the quality is influenced by the part of leaf sheath and corm processed (Atlabachew, 2007).

2.5.2. Amicho

Amicho is the fleshy inner portion of the enset corm, which may be cooked and eaten separately, tasting similar to potato (Atlabachew, 2007), often served with other root crops and vegetables (Olango *et al*., 2014). Corm also used as a source of kocho and it acts as a fermenting

agent or starter (Yeshitila and Yemataw, 2010). Enset mostly consumed in the form of kocho and bulla. However, the roots of enset (amicho) may consumed separately, without being transformed or fermented before. It may also consumed during the bridging period, from February to May. The families having an enset plantation smaller than 0.25 hectare consume an important quantity of boiled roots during the bridging period (Hiwot, 2015).

2.5.3. Bulla

Bulla is the small amount of water-insoluble starchy product that may be separated from kocho during processing by squeezing and decanting the liquid. After decanting, the bulla left to dry or fermented in a way similar to Kocho. However, mostly, instead of being fermented, it dehydrated to make a flour that can be stored for extended periods of time (Stone A. *et al*., 2011) or can be directly cooked without fermentation. (Atlabachew, 2007).

Figure 2. 3. Final bulla flour (*Source Hiwot, 2015*)

2.6. Determination of functional property of bulla flours

Functional properties are the fundamental physicochemical properties that reflect the Complex interaction between the composition, structure, molecular conformation and physicochemical properties of food components together with the nature of environment in which these are associated and measured. Functional characteristics are required to evaluate and possibly help to predict how new proteins, fat, fiber and carbohydrates may behave in specific systems as well as

demonstrate whether or not such protein can be used to stimulate or replace conventional protein (Chandra and Samsher, 2013). A functional property of food is determined by physical, chemical, and/or organoleptic properties of a food. **Example** of functional properties may include-

- ✓ ***Bulk density***
- ✓ ***Swelling power,***
- ✓ ***Oil absorption capacity,***
- ✓ ***Water absorption capacity,***
- ✓ ***Solubility,***
- ✓ ***Water retention,***
- ✓ ***Frothing ability,***
- ✓ ***Elasticity and absorptive capacity*** for fat and foreign particulars.

Typical functional properties include emulsification, hydration (water binding), viscosity, foaming, solubility, gelation, cohesion and adhesion. Knowledge of the functional properties will provided useful information to industry purpose and other alike on the subsequent incorporation of the different flours to produce natural, cheap and acceptable functional foods (Chandra and Samsher, 2013).

2.7. Process flow diagram for bulla production

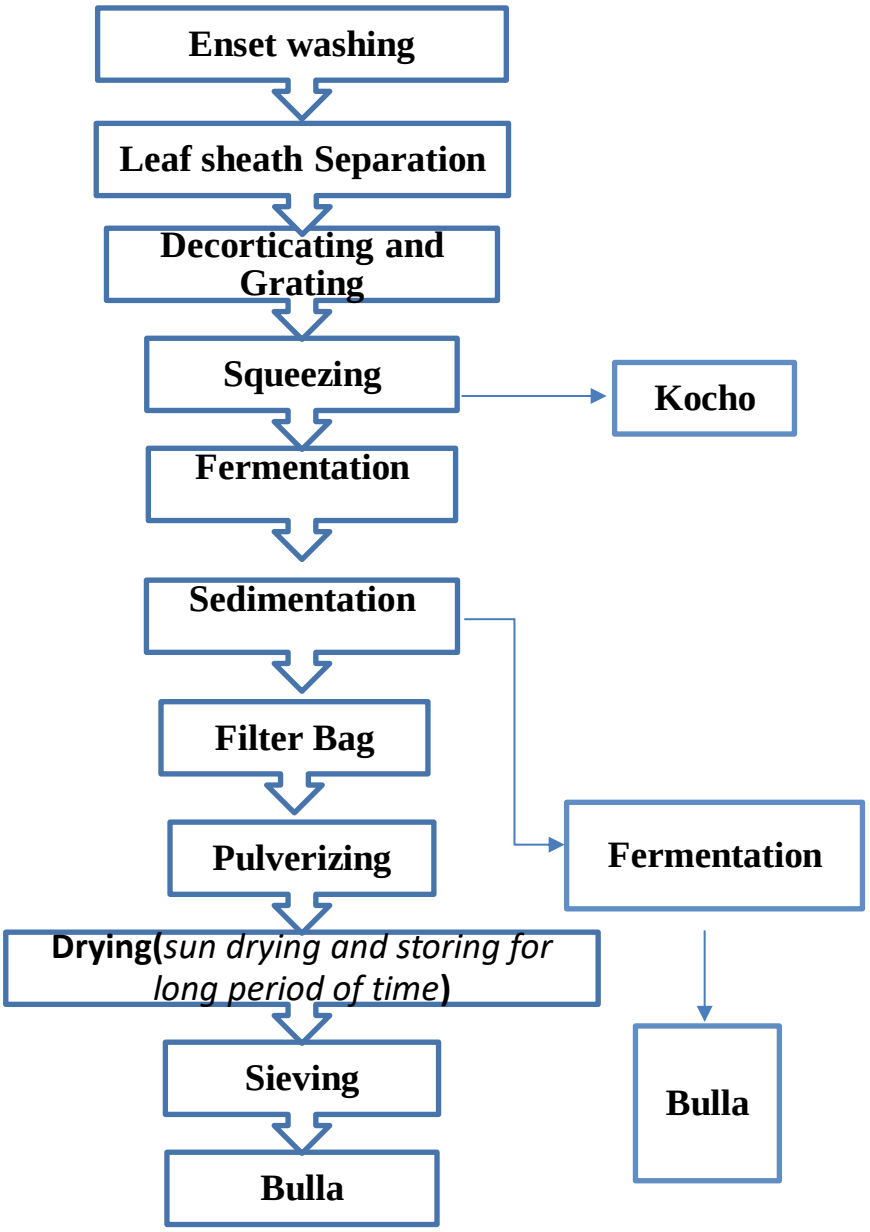

Figure 2. 4. Flow diagram of bulla processing

1. **Harvesting and transportation: -** Enset is usually harvested just before flowering, the preferred harvesting time is just when the plant flowers. The time duration required to flower depends upon climatic conditions, clone type, and management. Hence, the flowering time varies from 3 to 15 years but is optimally around 6 or 7 years.

2. **Raw material storage: -** This helps to fasten the processing eliminating transportation delay and efficient use of employer's energy without time wastage by waiting raw material and also to control deterioration of the raw material by storing for long time. It stored at room temperature.
3. **Enset washing: -** The enset washed to remove the soils, insects, dusts and any unwanted impurities, which may decrease the quality of the product.
4. **Leaf sheath Separation: -** After harvesting leaves and older leaf, sheaths first removed from the designated plants. The internal leaf sheaths (commonly up to two meters in length) are separated from the pseudostem down to the true stem, which is about a 20 centimeter section between corm and pseudostem. Then the true stem separated or stumped from the underground corm. The concave side of the leaf sheath is peeled and cut into pieces of about one meter length and split lengthwise in order to shorten the leaf sheath to a workable size.
5. **Decorticating and Grating: -** Then the leaf sheath is decorticated using a decorticating machine which helps to reduce the size. There is variation in the way that the corm grated in different places. One practice is to uproot the corm and remove any soil from its surface.at this stage the pseudostem and corm reduced to small pieces and ready for squeezing.
6. **Squeezing: -** Squeezer is used to separate Kocho and bulla from decorticated and chopped Enset by adding water, which added to aid the extraction of bulla, with the application of some force using presser. Then the Kocho is send to the fermenter and Bulla collected in received tank.
7. **Fermentation: -** After the completion of decorticating and grating, the leaf sheath pulp is spread on fresh enset leaves covering the tank in the ground, after which the grated corm is spread on the processed pulp. A starter added to aid in fermentation. This starter consists either of already fermented Kocho to which various spices and herbs added or fermenting agents are prepared from the inner portion of the corm and then mixed with the decorticated pulp and grated corm after some weeks. Turning, mixing, rinsing, and chopping continue over a period of time until the mixture partially ferments, when it is then referred to as Kocho. The total time for this fermentation to occur ranges from 15 to 20 days. Then the fermented Kocho is stored in fermenter tank that placed in the

ground. The Kocho must left in a storage tank for a minimum of a month, but it can be stored for many months and even for several years. The fermenter tank opened at intervals to allow aeration. This repeated until the desired fermentation quality reached or the food needed.

8. **Sedimentation: -**helps to separate bulla from impurities before it left for fermentation and drying.by density difference the water becomes at the top and bulla settles down. The bulla easily collected at the cone shape of the cylinder and the water left either for further process or for drainage system.
9. **Filter Bag: -** It used to remove fine fibres and other impurities by filtering Kocho to get Purified product and increasing the efficiency of the dryer by removing some water.
10. **Drying; -** The moisture contained in bulla and Kocho is removed by using drying process. The either drying performed by in open air (sun drying) or using industrial drying equipment like that of rotary drum dryer in order to conduct the process in short period of time.
11. **Pulverizing: -** It used for cutting to reduce the size of dried Kocho and bulla prepared for sieving of flavored product in the standard size.
12. **Sieving: -** This separates big size products from specified sizes. The oversize left at the top and the size that we need to use only left at end of the sieve passing through series of sieves of different size, finally the products stored in the form of flour (Ayele, and Sahu, 2014).

CHAPTER THREE

3. MATERIALS AND METHOD

3.1. Experimental Design and Data Analysis

Data obtained from experimental tests were examined and required information extracted for analysis and interpretation with regard to moisture content, total ash and other remaining parameters. Data collection from sensory evaluation regarding color, flavor, odor, and overall acceptability examined. All data were analyses using single factor analysis of variance (ANOVA). Mean value were considered at 5% significance level ($p<0.05$).the statistical analysis of the data were conducted using statistical analysis software.

3.2. Experimental Site

The experiments would conducted at Wolkite University (WKU) centre for Food Process Engineering department Laboratory. The sample site must be located where enough amount of raw material obtained. The sample of the raw material also has a crucial effect on the profitability of a project because its availability. The various principal factors that must considered while selecting a suitable sample site such as; availability of suitable source of raw material should considered. For this reason, we selected our sample site around gubre local area and transported to Wolkite university food process engineering laboratory.

3.3. Sample collection and transportation

5 kilograms of fresh bulla was collected purposively from the nearest market. The samples packed in polyethylene bags, kept in an icebox in order to prevent moisture loss and fermentation, and transported to the centre for Food Process Engineering Laboratory of the Wolkite University.

3.4. Material and equipment

3.4.1 Materials

Bulla, Distilled water, refined oil, Diethyl ether, NaOH, Table salt, cooking oil, Fiber Tec and Celite sand

3.4.2 Equipment's

The equipment's that are to be used during experiments are, oven drier, drying dish, desiccator, analytical balance, muffle furnace, cylinder, graduated cylinder, centrifuge, evaporating can, water bath, tapping material, magnetic stirrer, crucible, muffle furnace, pH meter and refracto meter.

3.5. Physicochemical Analysis

3.5.1. Determination of moisture content

Moisture content of the sample were analyzed by drying air oven (DHG 9055A) method according to the official method 925.09 of the AOAC (2000). A drying dish dried in an oven at 105°C for 1 hr. and placed in desiccator. The weight of the drying dish (W1) was determined. 5 g of bulla samples weighed in the dry dish (W2), oven dried at 105°C for 3 hrs. In addition, after cooling in a desiccators to room temperature, it was again weighed (W3). Moreover, brought to a constant weight by put it again in an oven for extra one hour.

$$\boldsymbol{moisture\ conent}(\%) = \frac{\boldsymbol{W_2 - W_3}}{\boldsymbol{W_2 - W_1}} \times \mathbf{100}$$

3.5.2. Determination of ash

The ash content was measured according to dry ashing procedure using official method 923.03 of the AOAC (2000). Clean drying dish dried at 105°C in hot air oven, cooled in a desiccator and weighed using analytical balance (W1). Then, 2.5 gram of bulla powder sample put and weighed (W2). The sample charred on a hot plate until the contents turn black. The dish with its contents was transferred to a muffle furnace (S30 2RR England) and ignited at 550°C for 5 hrs. Finally, the residue will weighed (W3) and the total ash will expressed as percentage on dry basis as follow:

$$\boldsymbol{Total\ Ash}\ (\%) = \frac{\boldsymbol{W_3 - W_1}}{\boldsymbol{W_2 - W_1}} \times \mathbf{100}$$

3.5.3. Determination of crude fat

Crude fat test were carried out on soxhlet extraction (SZC-D fat determination meter YLC 2000) method utilizing Diethyl ether according to official method 920.39 of the AOAC (2000). A 2 g dried sample (W3) of bulla extracted with 50 ml diethyl ether for about hrs. in the soxhlet extractor. The cylinder containing the extracted fat was dried in an oven until constant mass was obtained. The total crude fat calculated as percentage by weight: -

$$(\%)\boldsymbol{crud\ fat} = \frac{\boldsymbol{w_2 - w_1}}{\boldsymbol{w_3}} \times \mathbf{100}$$

Where, W1= weight of the extraction flask

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

W3= weight of the sample

3.5.4. Total soluble solids

The total soluble solids (TSS) level of the bulla powder will be determined according to AOAC method by using hand refractor meter, at room temperature (range from 18 to 23°C).

3.5.5. PH value

The pH of the sample measured by dipping the electrode of a digital Lab PH meter (MP 511) in to the sample after a proper calibration of the meter with buffer solution. The pH of bulla Sample were determined from 1/10 dilution of sample by glass electrode attached to digital PH meter before and after fermentation time. 10 g of bulla sample mixed with 90 ml of Distilled water. After calibrating the pH meter at 7.00, 4.00 and 9.2 with buffer solution, the PH sample measured.

3.6. Preparation of Genfo

Genfo (stiff porridge): - The dried and milled bulla flour used for the preparation of genfo, while mixing the flour in boiling water and cooked until it retains the right Consistency and flavour.

3.7. Sensory analysis

The sensory analysis conducted on enset product of bulla in order to evaluate nutritional value and its quality. The experiments performed in Wolkite University experimental kitchen. Bulla porridge which prepared by adding some amount of salt (half tea spoon), presented to 10 trained panelists to evaluate the taste, colour, appearance, flavour, and overall acceptability, the panelist were assigned to score their preference for the various attributes using nine (9) hedonic scale. With nine being like extremely and one, dislike extremely (Hiwot, 2015).

3.8. Determination of Functional Properties bulk density

3.8.1. Determination bulk density

The flour sample will filled to 5 ml into an already weighed measuring graduated cylinder (W1). For the packed bulk density determination, the flour sample was gently tapped to eliminate spaces between the flour and the level noted to be the volume of the sample (V) and then weighed (W2). No tapping was made in the case of loosed bulk density and the level is also noted to be the volume of the sample and then weighed.

$$\textbf{Bulk density}\frac{g}{cm^3} = \frac{w_2 - w_1}{v}$$

3.8.2. Determination of water absorption capacity (WAC)

WAC was determined with the method reported by (*Hiwot, 2015*). 25 ml of distilled water was added to a sample of 3g flour (W1) in a weighed centrifuge tube (W2) and stirred six times for 1 minutes at 10 minutes intervals. The mixture centrifuged at 3000 rpm for 25 minutes and the clear supernatant decanted and discarded. Pellets were dried at 50℃ for 25 minutes and the adhered drops of water removed and reweighed (W3). The amount of water retained in the sample recorded as weight gain and taken as water absorbed. Water absorbed capacity expressed as the weight of water bounded by 100g dried flour.

$$\textbf{WAC}\frac{g}{100g} = \frac{w_3 - (w_2 + w_1)}{w_1} \times 100$$

3.8.3. Oil absorption capacity (OAC)

10 mL of refined corn oil with the density of 0.92 g/cm3 added to 1.0 g of the sample in a 25ml of centrifuge tube. The suspension stirred using a magnetic stirrer (Model MS-12B, MS-17B, and MS- 22B) for 5 min. The suspension obtained was centrifuged at 3555 rpm for 30 min and the supernatant was measured in a 10 ml of graduated cylinder. Oil absorbed calculated as the difference between the initial volume of oil added to the sample and the volume of the supernatant (Ocloo1 *et al.*, 2010).

3.8.4. Swelling power and solubility

Swelling power and solubility determination were carried in the temperature range of 60-90oc (using the method of Leach et al., 1959). About 1g of bulla flour sample was accurately weighed and transferred in a clear dried test tube and weighed (w1). About 10 ml of distilled water added and mixed gently at low speed for 5 minutes. The slurry was heated in a thermos stated water bath (YCW-0125) at 80oc for 30 minutes and was stirred gently to prevent lumps forming in the flour. Then the cooled test tube (20oc) centrifuged at

2200rpm for 15 minutes. The supernatant decanted immediately after centrifuging into a pre weighed evaporating can and at 100oc to a constant weight approximately for four hrs. The weight of the sediment taken and recorded as (W2) or the swollen.

$$\textbf{Swelling power} = \frac{w_t\ of\ sedment}{sample\ w_t - w_t\ of\ soluble}$$

CHAPTER FOUR

4. WORK PLAN

Table 4. 1. Schedule for research time and plan of action

Actions to be done	Months in 2011 and sectioned into weeks (w)											
	April				May				June			
	W 1	W 2	W 3	W 4	W 1	W 2	W 3	W 4	W 1	W 2	W 3	W 4
Collection of necessary data and prepare proposal.	?	?										
Arrange equipment and purchasing of the raw material.		?	?									
preparing of all the purchased raw materials and equipment				?								
conduct the experiment by using our materials and equipment				?	?	?						
Evaluation of functional and physicochemical properties						?	?	?				
Analysis Physico-chemical, and other parameters						?	?	?				
Writing of all the experimentally recorded data and discussion.								?	?	?		
Finishing of writing of documentation and showing the document to advisor for giving any progress**.**										?	?	
Improving of the document (which directed by advisor).											?	
Submitting of final document**.**											?	
To be ready for Presentation of final research.												?

CHAPTER FIVE

5. ANTICIPATED OUTCOME

What we expecting from of this study is, achieving the targeted value in which is closed to the previously conducted result of experimental value of each parameters that conducted through the experiment all physicochemical and functional characteristics that obtained during experimentation and comparing the observed result with respect to previously obtained value of the same works. In addition, we expect to realize the bulla quality regarding sensorial characteristics.

CHAPTER SIX

6. BUDGET

Table 6. 1. Total budget needed to accomplish the research

No.	Item	Unit measured	Quantity	Unit price in birr	Total price in birr
1	Bulla	Use as raw material for processing	5kg	50	250
2	Print	To submit document for department	50-60page	2	120
3	Pen	Use to write data	3	5	15
4	Pepare	Used to record data	30	0.5	15
Total			_	_	450
Contingency (20%)				20%	90

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