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Enset (*Ensete Ventricosum*) Production in Ethiopia: Its Nutritional and Socio-Cultural Values

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Abstract

Enset is a perennial root crop indigenous to Ethiopia cultivated dominantly in the south and southwestern highlands. There are several enset varieties or clones mainly produced for their starch from the pseudostem while some are exclusively cultivated for their corm. *Kocho*, *bulla*, and corm (*amicho*) are the main food products of enset. We studied the nutritional, socio-economic, and cultural values of this crop. The corm (Neqaqa) was found to be more nutritious than *bulla* (Gena) except in starch and zinc contents. Enset is rich in starch but low in protein composition hence, dietary protein source is mandatory. It plays great role in the food security of the country and a staple food for significant Ethiopian population. It has several environmental, nutritional, and socio-cultural importance however its cultivation is under disease challenges. Continuous research effort is required to improve the production of enset and its food products and fiber processing.

Keywords: Bulla, Corm, Enset, Nutritional value, Socio-culture, Variety.

Contents

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1. Introduction

Enset *(Enset ventricosum)* is a genus of banana family and termed as false banana. It is a gigantic leafy monocarpic evergreen perennial root crop and main food source mostly for the southwestern part of Ethiopian highlands. Biogeographers and agronomists have considered the center of origin for enset agriculture to be the Ethiopian highlands [1, 2]. Other scholars have also presumed enset domestication in Ethiopia to 10,000 years ago [3]. The representative enset growing areas of southwest highlands Ethiopia are shown in Fig. 1. This does not mean that enset is cultivated and used only in these regions as food. It is customary food in the southwest, central, towns, and cities with the Ethiopian delicious food, *kitfo*. Depending on the climate and agro-ecology, the main food crops and diet vary from region to region in the country. Thus, cautious interpretation is required on general statements of Ethiopian diet. More than one sixth of Ethiopian population (nearly 15 million people) depends on enset [4].

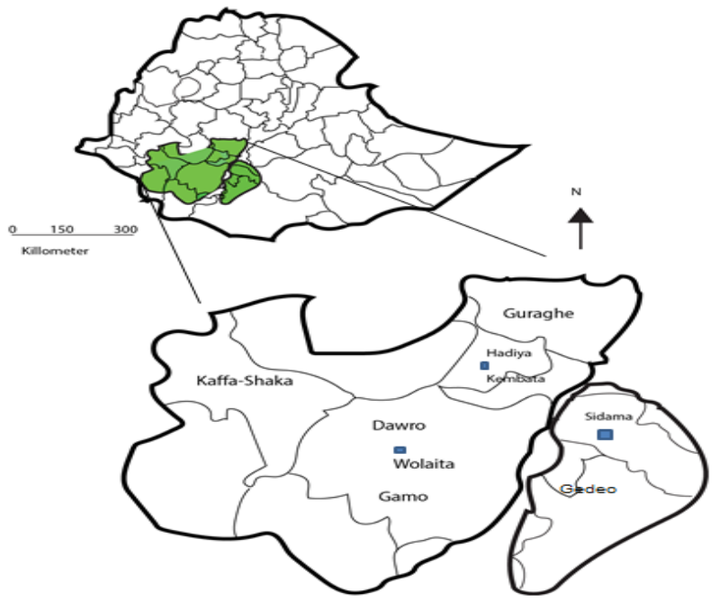

Fig-1. Map of Ethiopia showing the major enset growing geographical areas of the southwestern part.
Source: Tsegaye and Struik [5].

Enset is a classic multipurpose crop that every botanical part is used for numerous material cultures. Enset is a large banana like plant [3] and its all botanical parts are shown in Fig. 2. The leaves and pseudostems are utilized for wrapping, sheeting to sit, thatching, making containers, shading from sunshine and protecting from rain [6]. The sheaths, fiber, and leaf of the plant are used for house construction, food wrapping, cattle feed, and ropes [7]. It is also used for various socio-economic and cultural values in the enset growing areas. Some varieties are needed for certain ritual activities in big ceremonies and funerals.

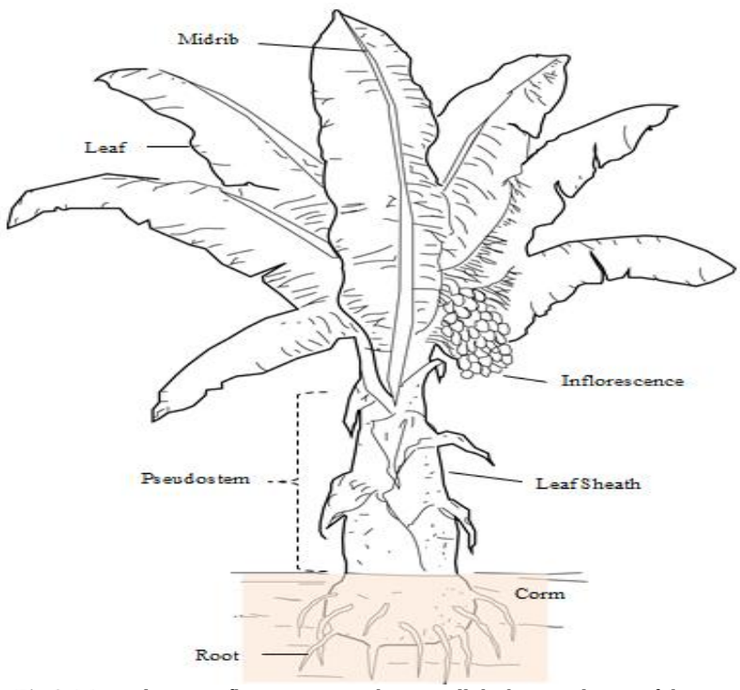

Fig-2. Matured enset at flowering stage showing all the botanical parts of the crop.
Source: Brandt, et al. [3]

The edible parts of enset vary from place to place. In general, the pulp of the pseudostem, the young shoots, and the corm are eaten. The processed pseudostem usually undergoes fermentation, which becomes flour and ultimately the basic ingredient of bread and porridge upon drying. In some parts of the country the pseudostem pulp, together

with the young shoots are boiled and eaten as a vegetable that tastes like Irish potatoes when fresh [8]. Seldom, the mealy substance of the seeds and the pith of the inflorescence stalk are boiled and eaten [9, 10] though the three most common enset derived foods are *kocho, bulla,* and *amicho* (corm). The plant is cut before flowering the pseudostem and leaf midribs are scraped (Fig. 3), fermented for 10-20 days and becomes ready for various foods preparation. The juice of squeezed and dehydrated parenchymatic scrapings of the pseudostem gives a high-grade product. This product is called *bulla,* which is tightly packed in enset leaves and fermented in a silo [10]. The low-protein enset products are staple or co-staple foods without the required protein supplement for people [7].

Fig-3. Various enset varieties and enset processing. The *Kocho* or *Bulla* type on the left and the corm type on the right (A). Processing enset samples used for nutritional analysis around Areka Agricultural Research Center (AARC) (B).

The processed enset (*kocho, bulla,* and corm) are rich in carbohydrate and good sources of minerals. However, the starch yield and nutrient compositions vary among enset clones or varieties. According to AARC, more than 265 enset clones were identified and characterized. Enset varieties are categorized to two main groups namely the *kocho* or psuedostem types and the corm types. There happen variations in the qualities (color, texture, aroma, etc.) of the final enset products, which are affected mainly by enset variety and processing skills. Enset varieties that yield the whitest *kocho* and *bulla* color are considered to be the best quality while yield is very important trait for a family food according to farmers. The majority of enset varieties are produced mainly for processing to starch through fermentation, *kocho* or *bulla* while some other are produced entirely for their corm. Detail nutritional studies of the identified varieties were not undertaken so far except little information on either general or undefined enset varieties. Therefore, two best enset varieties supposed to be the representatives of the *kocho* type (Gena) and corm type (Neqaqa) were considered for their nutritional composition study. The nutritional, socio-cultural, and the opportunities and challenges of enset cultivation in the country are also described in this study.

2. Research Methodology

The *bulla,* corm samples, and various information were obtained mainly from Areka Agricultural Research Center (AARC), which is the center of excellence for research on enset nationally. Some preliminary information was also obtained from Holetta Agricultural Research Center (HARC), Root Crops and Temperate Fruits research program. The social aspects, agronomic, and pertinent issues related to enset were studied. Two enset varieties, one from the *kocho* type namely Gena and the other from the corm type, Neqaqa were processed with the help of AARC research staff in December 2014. The air dried *bulla* of Gena and ground corm of Naqaqa were brought to Japan for their detail nutritional composition analysis. The samples were analyzed at Japan Food Research Laboratory (JFRL). Various literatures and previous studies on different aspects of the crop were reviewed in addition to information from farmers and research institutions.

3. Results and Discussions

3.1. Enset Cultivation in Ethiopia

Based on the review of previous studies, enset plantation in Ethiopia as a food crop has long history. Many scientists of different disciplines have developed theories that assume enset domestication in Ethiopia to 10,000 years ago [3]. Early scholars considered the indigenous hunter/gatherers of southern Ethiopia may be the first ones to cultivate enset [8]. It was suggested in Westphal [8] that the high land of Kefa, which is the humid corner of southwest Ethiopia, is the natural center of distribution of enset. Others also proposed that the Ethiopian highlands as the primary center of origin for enset cultivation [1, 2, 11]. It is an indigenous crop to Ethiopia, where primarily cultivated as a staple food though wild enset varieties were reported to be found in other African and Asian countries.

Further research is required on the taxonomy and distribution of enset however four wild species found in sub-Saharan Africa and Madagascar and other two wild enset species distributed over Asia [12, 13].

In the late 19th century, Stigand [14] designated enset as "groves of what appeared to be bananas" in his first impression in the Baka chief's area of Ari area. Based on Sidamo area field study and comprehensive literatures survey, the Finnish-Scandinavian geographical expedition in 1953-54 described the enset cultivation in Ethiopia [9]. Cushitic-speaking people later introduced enset agriculture to the northern Ethiopian highlands and then replaced by crops like wheat, barley, and teff following the migration of Semitic-speaking groups into northern Ethiopia [8]. He also reported the early cultivation of enset in the northern part of the Abyssinian highland in the course of his survey on the source of the Nile. Enset domestication was brought to southwestern Ethiopia sometime in prehistory of Sidamo tribes [15]. Later the Agaw, central Cushitic-speaking peoples of northern Ethiopia, began to grow enset and other crops like wheat, barley, and cattle like goats and sheep into their economy [3].

The multipurpose use and propagation method of enset are mostly shared by the Ethiopian agriculturalists that are classified as Omotic and Cushitic with one exception of Semitic people, Gurage [6]. In the mid to highlands of Southern Peoples Nations Nationalities Regional State (SPNNRS), western Arsi-Bale, and western Oromia, enset is widely cultivated [7]. According to Straube, the Amarro people harvest enset when they are needed since they do not ferment its starch as cited in Westphal [8]. In Jima area, it is used during the rainy season when cereals are scanty otherwise, it is not so important like maize [8]. The aforementioned studies show the early domestication of enset in Ethiopia and their gradual distribution pattern across the country and its importance as a staple and semi-staple food in various parts of the country.

3.2. Agronomy and Enset Varieities

Enset (*Ensete ventricosum*) belongs to order *Schistaminae* and family *Musaceae*. The *Musaceae* family has two genera, Musa and Ensete [16]. Farmers categorize enset and name based on several features that differentiate one from another and there are several cultivars in different agro-ecologies. The phenotype and utilization values are the basis for the naming of enset landrace accessions by farmers [17]. Though scattered plants can be seen at lower altitudes, enset mainly cultivated at high elevations from 1,200 to 3,100 masl [18] with the optimum altitudes between 2,000 and 2,750 masl [19].

The existence of several different enset varieties is ascribed to the use of enset and its products for diverse purposes [20]. According to AARC, some enset cultivars like Gena, Merza, Kucha, and Silkente are preferred for their processed starch, *kocho* quality and productivity. Others such as Naqaqa, Arke, and sweete are cultivated exclusively for their corm. According to AARC, the average maturity of Gena is 5.07 years and that of Neqaqa is 3.78 years and the origin of both varieties is Walaita. The productivities of Gena and Neqaqa are 21.24 and 14.91 ton/hectare/year. However, the corms of the *kocho* type varieties are also edible in most cases. Under the production of five out of seven zones, Gena is the most broadly disseminated enset clone Yemataw, et al. [21]. Taboje [22] reported that Gena provides up to 16.9 ha^{-1} $year^{-1}$ of *kocho* and it is one of the high yielding clones. At AARC, 279 accessions of enset were evaluated [23].

According to Negash and Niehof [24] twelve distinguishing features to categorize enset accessions that are grouped into three clusters are: (1) phenotypic characteristics: pseudostem, midrib, leaf, and petiole colors, (2) agronomic characteristics: disease resistance (susceptible, intermediate, tolerant); maturity (early, intermediate, late); plant vigor (poor, medium, high), and (3) use-value characteristics: *bulla* quality (not good, good); corm use (not used, used); *kocho* yield (low, medium, high); medicinal value (not used, used); fiber quality (low, medium, high).

Farmers have conventionally established sophisticated way of enset propagation. It commences with cutting pseudostem of 2-3 years old from the underground corm and cover with soil when rainy season begins. Up to 100 suckers emerge from one corm mother and they are separated from the corm and planted individually after maximum of 2 years. The farmers transplant them after few years in to the final pit prepared usually by removing the secondary roots from the corm and adding manure. The plants can be transplanted only once or up to four times with wider spacing. Totally it takes 4-6 years for an enset to mature and get ready to be processed [3]. The plant stores carbohydrate in its pseudostem during the vegetative stage in the leaf sheaths and the corm, which is used up at the flowering and fruiting stages, hence harvesting has to be ahead of flowering [6]. The seeds can stay viable for more than 25 years [13].

The enset product yields of different clones evaluated at AARC differ greatly [21]. The sampled enset varieties in this study from AARC were of the high performing clones. Shank and Ertiro [7] studied the product yield and plant size and modeled yield estimation derivatives. Individual plant yields vary from 114.7 kg (303 cm high plant x 298 cm circumference) to 3 kg (93 cm x 58 cm plant). They reported that the yield has a correlation of 87% with circumference and 83% with the pseudostem height. The resultant model plant yield = -36.5 + 0.23 x circumference + 0.19 x height in cm accounted for 82% of the observed variation in plant yield [7].

3.3. The Nutritional Qualities of Enset

Significant Ethiopian population relay on enset for their major daily diet. However, it is limiting in protein and some mineral compositions. There are differences in the nutritive values among enset cultivars and different botanical parts used as food. Gena and Neqaqa, which were considered to represent the *kocho*/*bulla* and corm types, respectively, were analyzed for their nutritive values (Table 1). *Bulla* is supposed to be the best quality product obtained from the juice of decorticated leaf sheath or pseudostem. However, the corm was found to contain better nutrients except potassium, in which *bulla* is better as shown in Table 1.

The dry matter (DM) content of the air dried enset flour samples were 92% in bulla (Gena) and 94% in corm (Neqaqa), and the organic matter fraction on DM basis is around 99% (Table 1). As fractions of DM, the crude protein contents are 0.7% in bulla and 8.8% in corm. The corm has better composition of other nutrients though *Bulla* has higher carbohydrate. Both the corm and *bulla* were found to contain most of the essential amino acids however *bulla* contains very small amounts of these nutrients. Glutamine, tryptophan, and asparagine are amino

acids that are not found in corm Mohammed, et al. [25]. Hirose, et al. [26] examined the behavior of starch and storage in the enset tissues. They reported the similarities and differences of enset starch among the well utilized starches of potato, corn, and sago. They suggested the better possible use of enset starch as a binder for compressed tablets because of its better binding stability than that of potato starch.

Table-1. Comparative nutrient compositions of enset varieties (*Bulla* and corm).

	Nutrient	**Gena (*Bulla*)**	**Neqaqa (corm)**
Proximate (g/100 g)	Water	7.8	5.7
	Protein	0.6	8.3
	Fat	0.1	0.6
	Ash	1.0	3.2
	Carbohydrate	89.6	64.8
	Fiber	1.0	17.4
	Energy	363 kcal/100 g	333 kcal/100 g
Minerals (mg/100 g)	Sodium	3.7	5.2
	Phosphorous	30.1	80.4
	Iron	6.99	12.3
	Calcium	58.7	99.7
	Potassium	357	1.24
	Magnesium	11.9	59.6
	Copper	0.02	0.70
	Zinc	0.20	22.3
	Manganese	0.67	5.84
Essential Amino acids (mg/100 g)	Lysine	23	212
	Histidine	9	124
	Phenylalanine	21	238
	Leucine	33	334
	Isoleucine	18	170
	Methionine	8	73
	Valine	22	223
	Threonine	15	133
Vitamins (mg/100 g)	Thiamine (B1)	0.02	0.28
	Riboflavin (B2)	0.01	0.05

Note: This composition is not on DM basis, it is on the basis of air dried sample flours.

The starch yield varies greatly with variety, management practices, and harvesting stage. Shank and Ertiro [7] stated that variations in the spacing and frequency of transplanting, agro-ecology, harvesting age, and variety make the assessment of enset yield difficult. About 47.0 kg of edible portion can be obtained from one mature enset and one meal of *washi*, food from fermented pseudostem starch, for instance is cooked for about five people on average with the share of about 600 to 800 g per person [6]. From 100 g fermented enset starch, a total of 186 ± 28 kcal energy is obtained [27]. However, 100 g of *bulla* and corm contain 363 and 333 kcal, respectively (Table 3). Hence, one person can get 2,541 kcal from *bulla and* 2,331 kcal from corm of roughly 700 g. This is nearly enough daily maintenance energy during low working activity but cannot be assumed out of 700 g *washi* for it contains a lot of moisture. One person requires roughly 8 enset plants per year based on 500 g per day [6]. The enset *kocho* yield ranges from 3 to 12 ton DM/ha depending on the variety and the age at which it is harvested [28].

In terms of protein, a person can get only 4.2 g from *bulla* and 58.1 g from corm considering 700 g air dried as an average daily intake. This shows that for an average person of 65 kg farmer gets only 8% from *bulla* and 112% from corm, respectively. It should be noted that protein is not enough if they live on enset food (*kocho/bulla*) alone. One hundred grams of *washi* normally contains only 0.9 g of protein [29] which means that only 6.3 g of protein can be obtained from 700 g in a day. Corm (Neqaqa) contains substantial amount of protein (9%) on DM basis (Table 2) and provides excess of daily required protein in quantity. The names of the varieties are referred in the parentheses in this paper to explain that the nutritional composition differences may arise from the varieties not only of the botanical parts. The leaves had markedly higher protein content than that of the pseudostem and corm of the same plant [30, 31] which is in agreement with the general fact that more proteins are found in the leaves than in the stems or roots of plants. The protein content of 118 different landraces from different places in Ethiopia enset leaves ranged from 10 to 23% that can be good dry season protein source for livestock [32].

The proximate and mineral contents of enset were compared with other common root and cereal crops (Table 2). The corm type contains significantly higher compositions of minerals than the *bulla* type. The iron and calcium composition of the corm are higher than potato and its zinc content is much higher than even teff. The starch fraction of enset pseudostem was reported to be comparable to sorghum [33]. The nutrient contents of *kocho* and *bulla* is sufficient to human requirement similar in extent to cereal flours [34]. On the other hand, Abebe, et al. [35] reported that the protein content and the amino acid composition of enset are relatively low. This makes legumes recommendable in a *kocho*-based diet, especially in cases where little animal products are consumed [25]. The facts of enset being low in protein composition and necessity of protein supplementation are in agreement with our current study shown in Table 2 and 3.

On the other hand, bulla contains higher carbohydrate and hence, energy than the corm. In other proximate compositions, the corm type is entirely superior. It was found to be better only in potassium among macro minerals. The corm contains more than twice of most minerals and many times higher of some minerals like zinc, magnesium, copper, and manganese. However, this variation may be attributed to the enset varieties/cultivars or botanical parts (the pseudostem and corm). *Bulla* is known to be the best quality product from the pseudostem part. Therefore, kocho is supposed to compose less of the analyzed nutrients than *bulla* and obviously than the corm. In order to

precisely evaluate the nutrient qualities of the botanical parts of enset, the samples ought to have been taken from the same plant. However, Mohammed, et al. [25] have compared the compositions of the corm, above ground, and pseudostem of the same enset. In their study, the corm is higher in starch content and the above ground is better in fiber and the leaf was the best in protein content.

Table-2. Proximate and mineral comparisons of enset with potato and teff (on DM basis)

Parameter	**Bulla (Gena) (*Ensete ventricoum*)**	**Corm (Neqaqa) (*Ensete ventricoum*)**	**Potato (*Solanum tuberosum*)***	**Teff (*Eragrostis teff*)****
Proximate	**g/100 g**			
Moisture	7.8	5.7	75.17	12.2
Protein	0.65	8.80	6.44	14.58
Fat	0.11	0.64	2.01	3.53
Ash	1.08	3.39	3.34	2.16
Carbohydrate	97.18	68.72	86.47	70.67
Fiber	1.08	18.45	1.73	9.05
Energy	393.71	353.13	-	391.24
Minerals	**(mg/100 g)**			
Sodium	4.01	5.51	99.36	1.88
Phosphorous	32.65	85.26	197.22	319.40
Iron	7.58	13.04	7.09	22.37
Calcium	63.67	105.73	67.14	146.26
Potassium	387.20	1.31	1743.86	479.12
Magnesium	12.91	63.20	139.63	178.82
Copper	0.02	0.74	-	1.21
Zinc	0.22	23.65	-	4.74
Manganese	0.73	6.19	-	19.24

Note: *Elfaki and Abbsher [36] * * Average compositions of kuncho and key-tef on DM basis

Potato is the common root crop and teff is the dominant cereal crop and daily food source for Ethiopians. This was the point of comparing enset with these crops. In Table 3, we indicated that the corm is more nutritious than *bulla* in terms of essential amino acids composition. The amino acid content of *kocho* is similar to sweet potato and potato [35-37]. These food sources need to be supplemented in order to provide enough protein in general and specifically the deficient amino acids in *Kocho* and the root crops. Various beans are cultivated in Ethiopia and common bean (*Phaseolus vulgaris*) is commonly grown around home gardens [38] this practice must be encouraged in enset-based farming system. The clonal differences used by farmers, variation in the places of growth in different environments and soil qualities, and harvesting time differences unsurprisingly affect the nutrient qualities of enset [25].

There were no enough studies and the nutritional research on enset and its dietary analysis has so far been challenged Ethiopian Nutrition Institute (ENI) [29]. Argen and Gibson [27] described the nutritional composition of several enset dishes and indicated the necessity of additional protein source for an enset to be a staple food. Enset fractions are good sources of some minerals like potassium, phosphorous, calcium (except corm), and magnesium [39]. In all these minerals, the corm was found to be much better than *bulla* except it contains much higher concentration of potassium than corm in our current study (Tabe 1). Most enset fractions except leaf lamina are deficient in copper but rich in iron and manganese [31]. However, all these minerals were found to be limiting both in bulla and corm (Table 1 and 2). The macro and trace mineral content differences because of enset varieties can help in strategic supplementation of mineral deficiencies [31].

Enset food products are usually used after fermentation. Fermentation normally enhances the nutritive value of foods but similar result was not obtained in *kocho*, possibly because of water soluble nutrients leaching through the long incubation [40, 41]. The nutritive value of enset was compared with other common root crop, potato and Ethiopian popular cereal, teff (Table 2 and 3). Most of the proximate composition of enset is lower than both potato and teff except the carbohydrate content of *bulla* (Gena) is much higher than both crops and the total energy content is equivalent to teff. The corm is the highest in fiber composition. Teff is superior in the total protein and fat contents than both enset and potato. In terms of mineral contents, teff comes first followed by potato and then by the corm. In this study, the corm was better in lysine content than *bulla* but much lower than that of potato and teff (Table 3). On the contrary, Steinkraus [40] and Gashe [41] reported that enset contains high lysine and low methionine.

Generally, enset is poor in protein composition and particularly *bulla* (Gena) contains extremely low. The essential amino acid content of the corm (Neqaqa) is remarkably higher than that of bulla (Gena). However, teff is the best followed by potato (Table 4). In essential amino acids, the daily recommended intake (DRI) is not fulfilled by depending on enset as a sole daily diet. In this case, 700 g of enset was considered for an average daily intake from Shigeta [6] and Brandt, et al. [3]. Only phenylalanine, histidine, and threonine daily requirements are attained from corm (Neqaqa) while none is fulfilled from *bulla*. This shows that foods from enset should necessarily be supplemented with protein rich foods as recommended also by many others. In Ethiopia usually, stews are made of mainly bean powders however vegetables are used in some cases. Unless the nutritional conditions are improved, basing solely on enset leads to protein deficiencies that entails poor growth and weakened immune systems.

Table-3. Comparison of amino acids (mg/100g protein) of enset with other crops on DM basis.

Amino acids	*Bulla* (Gena)	Corm (Neqaqa)	Teff* *(Eragrostis teff)*	Potato (*Solanum tuberosum*)**	ADA 65 kg (mg)**	Available in 500 g Enset (mg)	
						bulla	Corm
Lysine	24.95	224.81	378.68	227.10	1950	175	1574
Histidine	9.76	131.50	319.40	129.88	650	68	921
Phenylalanine	22.78	252.39	741.52	459.12	(Phe+Tyr) 1625	281	3199
Leucine	35.79	354.19	1063.46	500.32	2535	251	2479
Isoleucine	19.52	180.28	498.09	318.16	1300	137	1262
Methionine	8.68	77.41	522.22	91.34	(Met+Cys) 975	61	542
Valine	23.86	236.48	689.49	724.93	1690	167	1655
Threonine	16.27	141.04	559.84	253.32	975	114	987

Note: *Average composition of Kuncho and Key-tef on DM basis ** Elfaki and Abbsher [36]
*** FAO/WHO/UNU [42]

3.4. Socio-Economic and Cultural Values of Enset

Enset is a perennial evergreen crop with many aesthetic values and multipurpose in the south and southwestern Ethiopia. It has many material uses and socio-cultural values. A large number of enset plants around houses provide comfort, shading for people and some crops such as coffee which need only moderate sunshine [6]. The use of enset and its products for different purposes such as food (*amicho* (corm), *bulla*, and *kocho*), medicine, rituals, and construction purposes could attributed to the existence of various enset varieties [20].

Enset garden is sometimes an indicator of the economic status of farmers; many varieties more mature and large number of enset plants are found in the gardens of wealthier households [24]. Gurage people depend much on enset socially and economically to obtain their essential needs [8]. Once it reaches certain stage of growth, cultivated enset can be utilized for several purposes throughout a year [8]. Most botanical parts of enset are good fodder for livestock. It is drought resistant because it contains a lot of water in pseudostem and used for cattle stall feeding especially in the dry season when grass is scarce. It provides good fiber, a by-product obtained from decorticating the leaf sheaths and the dried fibers are strong enough to make high quality ropes.

The pseudostem yields very strong fibers, even the unprocessed leaf sheaths is used for tying livestock, bundling harvests from fields, and fencing. According to Brandt, et al. [3] the fiber has excellent structure and its strength is equivalent to the fiber of abaca, a world-class fiber crop. In rural areas the fiber is used to make sacks, bags, ropes, cordage, mats, construction materials, and sieves. About 600 tons of enset fiber per year is sent to factories for processing [3]. Fresh enset leaves are used for wrapping foods, serving plates, and pit linings to store *kocho* for fermentation. Men sometimes make cap from enset and the fresh leaves are used as clothes for women skirts and often worn in the markets and ceremonies [6]. The dried petioles and midribs are used as firewood, to make mats, and tying materials for house construction. For cleaning rags, brushes, baby cushions, pot stands, as wrappers for butter, *kocho*, and other items to transport to local market [3]. Particular varieties and enset parts are used medicinally for both human and livestock for problems like diarrhea, birth control (as an abortifacient), and assisting to discharge placenta [3].

Enset has cultural values during wedding and funeral ceremonies. During wedding, enset leaves can be used on tables for serving food and as skirts for women in some cases in addition to being the major food for the ceremony. Shigeta [6] elucidated that at funeral ceremony, people beat the psuedostems of enset laid on the ground in circle like drums and they also go with enset leaves on their hands. The members of the lineage cut all the enset plants when the head of the household dies, to express their sorrow and desperation [6]. The enset plant can also be sold in some cases and the processed products like *kocho* and *bulla* are sold anytime in the rural markets and towns. Therefore, it is an immediate cash income source for a family to buy their daily needs.

3.5. Some Health Benefits of Enset

Some enset varieties are believed to have medicinal value and used by the enset growing community. For example in Areka area, a variety called sweete is strongly recommended for treating a person with bone problem. This may be because it contains high calcium and phosphorous. Even in the central highlands and cities where enset is not a staple, *bulla* is fed to a mother who gave birth for strengthening and fast recovery. They also make *atmit* (gruel) and given to a person caught cold. Different enset varieties were reported to have medicinal and religious (ritual) significances for prevention, healing, and other therapeutic purposes. According to Tsehaye and Kebebew [20] Tayo is a variety with a light red pseudostem and midrib with deep green leaf. The boiled corm and starchy powder *bulla* of this variety is eaten with milk to cure ailments such as joint displacement and swelling, broken bone fractures, and used to cure similar disorders in domestic animals, especifically it is fed with salt to dairy cows. Some enset clones like Astara and Tayo are believed to have medicinal values and are used to treat human and livestock [43]. The corm of enset is fed to stimulate placental discharge and reduce delivery-associated stomachache and eaten with cheese, butter, and milk. *Officho*, a dehydrated starch suspension and *bulla* are used together with milk for bone related problems [20].

Furthermore, some clones are used for abortion or to reduce fertility. The following are some of the enset clones that are claimed to have medicinal and ritual values by farmers in Kaffa Sheka zone [43]:

- Choro is fed to a woman immediately after baby delivery in order to stimulate the discharge of placenta. In terms of ritual significance, planting this clone in their backyard deters away the devil or evil spirits by Kaffa farmers.
- The *bulla* or corm of Tayo are consumed for bone fractures, backache, and swelling displacement of joints treatment.

- Shasi wagi (Wagi beli) is recommended for a woman to prevent uterus contraction and relive stomachache after baby delivery.
- The corm of Ariko is boiled and fed when a person catches flu. In addition, children eat its uncooked stem to keep healthy and gain weight.

However, the scientific clinical studies of these enset medical uses were not reported. In fact, its potential use as glucose source is suggested because of its rich carbohydrate content. Focusing mostly on the corm (*amicho*) by the farmers signifies their appropriate traditional knowledge of its better nutrient composition based on our study.

3.6. Opportunities and Challenges of Enset Cultivation

Having a field that encompasses the homestead is considered aesthetically desirable by enset-based societies, enset beautifies the landscape by its green foliage. It also affects the macro-environment of an area in a positive manner [3]. The native soils are altered positively through the long-term application of manure in areas where enset is grown for many years. Enset's perennial leaves canopy and the abundant accumulation of litter also reduces soil erosion and organic matter depletion. It plays the same role as trees in protecting people, other plants, and animals from wind and sun. Plant species like enset possessing deep roots and leaf canopies of long duration improve the hydrological dynamics of an area. They improve water in the soil and aquifers through increasing water infiltration and reducing surface runoff. As a result, this increases water availability and discharge to springs and decreasing the effective dry season length [3]. Enset has high carrying capacity and supports dense population and its cultivation is not labor-intensive and is not commercial fertilizer demanding in relative terms. It also has many non-food values as mentioned in the previous sections.

Collectively, the severe problems facing enset cultivation are diseases. They include sheath, corm, and dead heart leaf rots caused by an unknown bacterial pathogen and fungus as well as viral diseases, lesions, nematodes, and root-knot [3]. The knowledge limitation in the implementation of preventing strategies contributed to the severity of enset plant diseases. They are caused by several organisms. Bacterial wilt, caused by the bacteria *Xanthomonas campestris* pv musacearum, is the worst to the enset farming system [3]. It attacks the plant at any stages even after full maturity. It is a serious loss for the farmers when a disease kills an enset plant late in its life cycle as they have already invested labor, land, and resources for several years. In some cases, such situations lead farmers to replace enset farming with annual crops abandoning their land. The other shortcoming of this crop is it being poor in nutrient composition particularly protein and minerals. Hence, appropriate nutritional strategies need to be studied and designed to promote the processing of ense food at industrial level.

4. Summary

Enset is a multipurpose evergreen tree crop staple food for significant Ethiopian population. It is indigenous to Ethiopia and believed to be originated in the southwestern part of the country. It has several socio-economic and cultural values developed by the society for many years. Enset has limitations in nutritional adequacy particularly in essential amino acids and important minerals. Therefore, supplementary food sources of protein and minerals are highly recommended for people who entirely depend on especially *bulla*/*kocho*. In addition, nutritious varieties need to be selected and promoted. In order to sustain and improve enset cultivation, serious and continuous work is required to control diseases, improving its productivity, and nutritional schemes. Furthermore, its products need to be processed in factories with better quality and high market values.

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