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Effect of Fermentation and Boiling on Functional and Physico Chemical Properties of Yam and Cassava Flours

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Abstract

Cassava and yam are a source of food security, not only because it can be grown on less productive land, but because it is a source of income for producers and generally a low cost source of food. Hence, the present tubers were cultivated new region of Ethiopia which is not cultivated yet. This work aims at examining the physical, chemical and functional properties of flour produced from cassava and yam tubers collected from Shewa Robit integrated research and development site of Debre Berhan University, North Shewa Administrative Zone, Shewarobit, Ethiopia. The flours were produced using fermentation and boiling processing methods. Flours produces were subjected to physio-chemical and functional properties analyses. The tubers were washed, sorted, peeled and sliced. The sliced tubers were divided into two portions. One portion was fermented for 72 hr. The other portion was boiled for about 45 minutes. Both prepared samples were dried using sun. The moisture contents of the samples were 9.51% for cassava and 12.46% for yam for raw samples. Based on dry weight basis, the ash, crude fat, protein and crude fiber were 2.47, 1.12, 1.02 and 4.09%, respectively, for the raw sample of cassava and 3.81, 0.69, 6.98, and 3.77% for the raw sample of yam. The mineral contents of the samples were 734.88, 639.71 mg/kg Ca, 30.38, 51.52 mg/kg Fe, and 4.7, 15.93 mg/kg Zn content in raw cassava and yam samples, respectively. Among the anti-nutritional factors analyzed, the level of cyanide, phytate and oxalate were determined to be 36.2, 809.48 and 2.32 mg/1000 g in raw cassava sample respectively and the level of tannin and oxalate 1036.0 and 14.03 mg/kg in raw yam sample respectively. Both cyanide and phytate were not detected in raw yam samples and also in raw cassava tannin is not detected. A reduction of 98.23%, 37.4% and 4.31% in the level of cyanide, phytate, and oxalate was achieved by boiling process respectively and fermentation brought about 100%, 48.5% and 31.9%, in the level of cyanide, phytate and oxalates in cassava samples. Tannin and oxalate were reduced by 69.2% and 30.8% by boiling and 70.7% and 69.13% reduction was achieved by fermentation for yam samples. The bulk density, water absorption capacity, oil absorption capacity, foaming capacity and foam stability were within the range of 0.65-0.86 g/ml, 0.65-0.86 ml/g, 0.8-1.24 ml/g, 2.55-3.25% and 2.25-2.56% for cassava flour and 0.64-0.97 g/ml, 0.64 to 1.12 ml/g, 0.55-0.87 ml/g, 3.26-3.56% and 0.87-2.45% for yam flour samples, respectively. Natural fermentation has resulted in reduction in all types of anti-nutrients for both cassava and yam samples, particularly, cyanide. Fermented cassava and yam flours will have a good potential for product development.

Keywords: Anti-nutrients; Chemical; Functional and physical properties; Tuber flours

Introduction

Although Ethiopia has made significant progress in improving health, nutrition, education, and other human development indicators; yet for millions of Ethiopians, poverty, vulnerability and food insecurity remain, and are exacerbated by climate change and other shocks and stresses. Hence, food security remains the main challenge in Ethiopia. High prices of available staple foods and policy constraints on food imports are also contributing factors that have been worsening the food situation in developing countries. Also contributing to this problem is the underutilization of most of the crops found in this part of the world. Hereafter it is mandatory searching other crops in order to alleviate food security problem [1].

Roots and tubers generally serve as a major source of carbohydrate or energy and provide minor amounts of proteins, fats and oils, minerals and vitamins. Hence, these crops can be blended with cereals and possible to improve the nutritional quality. But the major drawbacks of the cassava and yam crops are rapid tuber perishability following harvest, and high content of anti-nutritional factors like the cyanogenic-glucosides:linamarin and lotaustralin (methyl-linamarin) which is the main toxic substance in cassava and some other anti-nutritional factors such as tannin, phytate and oxalates in very small proportion as compared to cyanide and reduce the bioavailability of very essential nutrients. For this reason, all cassava and yam products should pass through different effective processing methods to suppress adverse health effects that arise from cyanide anti-nutritional toxicity as a result of consumption of these products and also to improve the nutritional profile and reduce the anti-nutritional factors that hinder normal absorption of nutrients. Other factors favoring the processing of cassava and yam crops are that the processed products are easier to store than raw products, they need less storage space and they can be stored for longer periods. Processing is therefore undertaken primarily to prolong the shelf life, detoxify the tuber-based product i.e., reduction/elimination of toxic substances, to improve its palatability and nutritional value and to convert it to a storable form [2].

Debre Berhan University is trying to adapt diverse root and tuber crops at its Shewa robit integrated development project. Among those crops Taro, Yam and Cassava have been cultivated. Even though those crops are adapted very well in the study site, their utilization the community is almost none. Therefore, the level of anti-nutritional factors, mineral content, proximate composition and others has to be determined under different processing conditions in order to popularize the tuber by producing different value-added food products through blending with other crops. Therefore, this study was provided proximate composition, anti-nutritional contents and functional properties of the processed tuber flours in order to select good quality cassava and yam flours.

Materials and Methods

Description of the area

The study samples were collected from shewarobit integrated research and development site of Debre Berhan University, north Shewa administrative zone, Shewarobit, Ethiopia. Shewarobit is located at about 225 km north east of Addis Ababa. It is located at 11°55' N latitude and 37°20' E longitude at an altitude of 1380 m.a.s.l. The area has an average annual rainfall of 1007 mm, with short rain between March and April and long rain between June and September, and annual mean minimum and maximum temperatures of 16.5°C and 31°C, respectively.

Processing methods

Slicing: All samples were washed with clean water to remove adhering soil and other undesirable materials. The samples were sorted and hand-peeled using kitchen knives and then sliced in to sizes of 2 to 2.5 cm in thickness. The sliced samples were used for the preparation of raw, boiled and fermented flours as shown in Figure 1.

Soaking of slices: The sliced samples were soaked using tap water for 72 hours at room temperature.

Natural fermentation: The sliced samples were mixed with water for the natural fermentation in 1:3 ratios (w/v) of the slice to water using sterile distilled water for 72 hours where the microorganisms (fermenter organisms) are introduced by chance from the environment. After 72 hours, the fermented slices were sun dried to less than 12% moisture content (db) using the procedure of Gomez. The dried fermented slice was ground in to flour to prepare it for further analysis.

Boling of the slices: The sliced samples were boiled using boiling dish at the Chemical Engineering Laboratory of Debre Berhan University for about 45 minutes. The slices were sun dried to less than 12% moisture content (db) using the procedure of Gomez. Finally, the dried boiled slices were grounded in medium sized blender to produce flour in order to make it suitable for various analyses (Figure 1).

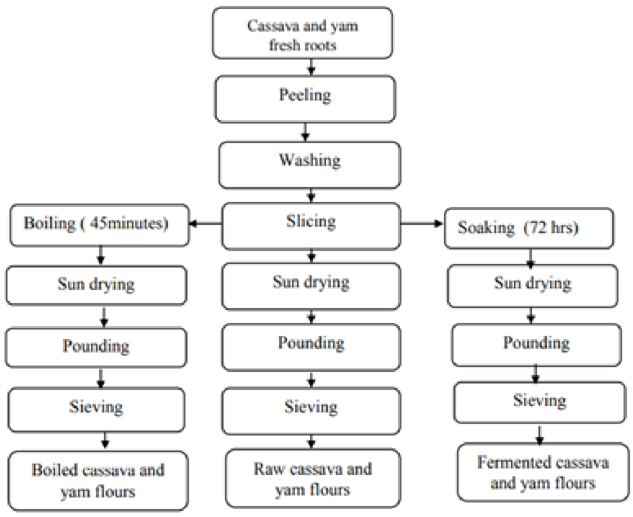

Figure 1: Flow chart for production of root crop flours.

Analytical determination

The raw and processed samples were used for anti-nutrients, physicochemical, functional properties and proximate composition analyses. Analytical grade reagents and chemicals were used for the analyses. Physiochemical and functional properties were done at the Chemical Engineering Laboratory of Debre Berhan University. Proximate composition including mineral values and anti-nutritional factors were conducted at JIJE Analytical Testing Service Laboratory and Ethiopian Public Health Institute.

Proximate composition: Moisture content, total ash, crude protein, crude fiber, and crude fat of the raw, boiled and fermented taro flours were determined using the methods developed by the Association of Official Analytical Chemists AOAC. The methods, respectively, were 925.05, 941.12, 979.09, 920.169, and 4.5.01 in which triplicate analysis was conducted in all cases.

Mineral analysis: Upon ashing for the determination of the total ash content 3 drops of 1 M HNO_3 acid was added to the sample in each of the crucibles. The ash was digested by using 6 N HCl acid. The digested sample was filtered in to sample bottles each using the Whatmann filter paper size 42 prior to analysis. The iron (Fe), zinc (Zn) and calcium (Ca) contents in the samples were determined using atomic absorption spectrophotometer (AAS) at 248.3 nm, 213.9 nm, 422.7 nm wavelengths, respectively.

Anti-nutritional factors: The cyanide content of the fresh, boiled and fermented tubers was determined by AOAC Phytate content of the prepared flour [3]. Tannin content of the prepared flour samples [4]. Oxalate content was determined using the method originally employed by Ukpabi and Ejidoh.

Functional and physico-chemical properties: Water and oil absorption capacity of the raw and processed flour samples [5]. Bulk density was determined using the method of AOAC. Foaming capacity and stability was determined by the method developed by Coffman and Gracia [6]. The pH of the flour samples were determined by the method of Egan and titratable acidity was determined by the method of AOAC.

Statistical analysis

The data obtained from the experiment were subjected to appropriate statistical tools of SPSS version 16.1.

Results and Discussion

Effect of processing on proximate composition the flours

The proximate composition of raw boiled and fermented both cassava and yam flours samples subjected to different processing methods and are presented on Table 1. The low moisture content was observed for the raw and boiled cassava flours are a good indicator of their potential to have longer shelf life. It is believed that materials such as flour and starch containing more than 12% moisture have less storage stability than those with lower moisture content. For this reason, a water content of 10% is generally specified for flours and other related products.

The lower level of fat in the raw cassava samples and all yam flour samples range from 0.3-1.12%, this gives a higher probability of a longer shelf life in terms of the onset of rancidity. The crude fiber content was high (5.29%) in the fermented yam flour and also the raw cassava flour (4.09%) while the protein contents in boiled both yam and cassava flour samples that were subjected to natural fermentation were decreased.

Flours	%				
	Moisture	Crude fat	Crude fiber	Protein	Ash
Raw Cassava Flour	9.51	1.12	4.09	1.02	2.47
Boiled Cassava Flour	11.62	2.11	2.49	0.97	1.13
Fermented Cassava Flour	12.58	1.94	3.55	0.71	0.99
Raw Yam Flour	12.46	0.69	3.77	6.98	3.81
Boiled Yam Flour	12.2	0.3	3.42	7.2	2.7
Fermented Yam Flour	13.1	0.69	5.29	5.85	1.65

Table 1: Proximate composition of processed flours.

As compare to processed flours, yam flours have higher protein content. Boiled yam flour sample recorded the highest crude protein (7.2%) followed by raw yam flour (6.98%) and fermented yam flours (5.85%) while the processed cassava flours including the raw cassava flour have small protein content.

Effect of processing on anti-nutritional factors

The anti-nutrients quality of raw, boiled and fermented cassava and yam tubers were shown in Table 2.

Cyanide: The efficiencies of two different processing methods (boiling and fermentation) in reducing cyanide levels in cassava tubers were compared. Of the tuber samples analyzed, cyanide level was the highest in raw samples and lowest in sample of fermented samples. The cyanide reduction rate is 98.23% by boiling and 100% by fermentation for cassava flour samples. For raw yam flour samples, it is not detected.

The concentration of cyanide level in the present study as compared to the cyanide level which ranges from 36.67 to 16.17 mg. HCN/100 g of raw and fermented cassava flour, the cyanide level in the present study is very less [7]. The considerable reduction in total HCN content of the cassava flour recorded in this experiment might be explained as a result of enhanced hydrolysis process of cyanogenic glucosides by the enzyme linamarase. The significant contribution of soaking of cassava slices in water for 24 hours was apparent to induce hydrolysis.

The effect of traditional processing techniques such as boiling in reducing the cyanide levels has been studied by several workers and it is indicated from the result that, boiling which is a common traditional method of processing cassava roots for consumption in addition to drying, steaming and frying has reduced the cyanide content in cassava flour samples equivalently with fermentation from 16.43 mg HCN/100 g to 9.26 mg, HCN/100 g [2].

Generally, the cyanide range of 0.064 to 3.62 mg HCN/100 g obtained in the case of cassava flour samples by the three days fermentation experiments are close to the reported values of 0.84 and 2.12 mg HCN/100 g and 0.00 and 3.20 mg HCN/100 g in fermented cassava flour [2,8]. From the results investigated in the present study, fermentation of cassava flour, for detoxification purpose which is common in many of the African countries is another good choice of cassava processing for the community. The removal efficiency of the processing methods described here agrees with the results reported in different papers [9,10]. Solar drying and fermentation were found to be the best methods in removing cyanide content and detoxifying cassava-based foods.

Phytate: The phytate contents obtained in the cassava and yam are indicated in Table 2. The levels of phytate in cassava flour ranged from 416.86 mg/100 g to 809.48 mg/100 g and for yam flours totally not detected. Fermentation shows 48.5% reduction and boiling 37.4% reduction for cassava flours. The decrease in phytate content during fermentation and boiling may be partly due either to the formation of insoluble complexes between phytate and other components, such as phytate-protein and phytate protein-mineral complexes or to the inositol hexaphosphate hydrolyzed to penta-tetraphosphates and leached out with boiling and fermentation water [11]. The decrease in phytate level by fermentation and boiling has been reported to lower the phytate levels in several plant food stuffs.

The phytate contents of cassava flour samples presented in this study for raw cassava samples are found to be greater than the phytate content of cassava which ranges from 253 to 400 mg/100 g [12].

Flours	Phytate (mg/kg)	Oxalate (mg/kg)	Tannin (mg/100 g)	Cyanide (mg/100 g)
Raw Cassava Flour	809.48	2.32	BDL	3.62

Boiled Cassava Flour	506.34	2.22	BDL	0.064
Fermented Cassava Flour	416.86	1.58	BDL	ND
Raw Yam Flour	ND	14.03	103.06	ND
Boiled Yam Flour	ND	9.98	31.72	ND
Fermented Yam Flour	ND	4.33	30.18	ND

Table 2: Anti-nutritional factors of processed flours.

Phytic acid is a common storage form of phosphorus in seeds and in a few tubers and fruits. However, it is also considered an anti-nutritional factor. The complexing of phytate with nutritionally essential elements and the possibility of interference with proteolytic digestion have been suggested as responsible for anti-nutritional activity. The unfermented cassava and yam flour from both cassava tubers had higher phytate content than those which are boiled and fermented in both yam and cassava flour samples.

Tannins: Tannins affect nutritive value of food by forming a complex with protein (both substrate and enzyme) thereby inhibiting digestion and absorption [13]. They also impart dull color on cassava products, and this affect the acceptance of the products.

Table 2 shows the result of tannin determination in the two cassava and yam flour samples. The levels of tannins for raw, boiled and fermented yam flour samples are given to be 103.06 mg/100 g, 31.72 mg/100 g and 30.18 mg/100 g, respectively. Fermentation shows 70.7% reduction while boiling shows 69.22% reduction in tannin contents whereas for cassava flour samples for raw and processed flour samples is below detection limit.

Oxalates: Oxalate contents of raw, boiled and fermented cassava and yam flour samples are shown in Table 2. The levels oxalate shows a decrement trend in both cassava and yam tubers. Fermentation for cassava flour had 31.9% and for yam flour samples 69.13% reduction was recorded. Boiling and fermentation treatments were found effective measure to reduce the oxalate content in both cassava and yam flour samples. Decrease in the oxalate content was highest in yam flour samples upon fermentation compared to boiling. Oxalate in cassava flour comprises soluble and insoluble fraction [14]. Fermentation and boiling may cause considerable cell rupture and facilitate the leakage of soluble oxalate into fermenting and cooking water [15]. This may be the possible reason to observed high reduction in oxalate level upon both fermentation and boiling.

To keep oxalate intake as low as possible one should choose among the different food processing methods. Oxalate can have deleterious effects on human nutrition and health, particularly by decreasing calcium absorption and aiding the formation of kidney stones. Therefore, the reduced oxalate content by boiling and fermentation could have positive impact on the health of consumers, particularly as the reduction of oxalate levels on boiling and fermentation is expected to enhance the bioavailability of essential dietary minerals of the cassava food products, as well as reduce the risk of kidney stones occurring among consumers.

When the two processing methods are compared in terms of anti-nutrients reduction, natural fermentation was observed to be very effective processing method both for optimum anti-nutrients reduction and nutrients enrichment.

Effect of processing on mineral content of the flours

Table 3 shows the mineral contents of the flour samples. Yam processed flours have a higher mineral content than the other flours. The Ca content for raw, boiled and fermented yam flour samples were 639.71, 558.09 and 1127.73 mg/kg, respectively. Similarly, the Ca content of raw, boiled and fermented cassava flour samples is 734.88, 554.42, and 480.44 mg/kg content in the given order.

In all the cases, the Fe content of both raw and processed cassava flour samples in the present study is less than the Fe content of cassava stated in the Food Composition Table of Ethiopia which was stated to be 4.50 mg/100 g. Among yam flour samples boiled yam flours had a higher Fe content than both raw and fermented yam flour samples.

Flours	mg/kg		
	Ca	Fe	Zn
Raw Cassava Flour	734.88	30.38	4.7
Boiled Cassava Flour	554.42	30.59	4.53
Fermented Cassava Flour	480.44	22.34	3.43
Raw Yam Flour	639.71	51.52	15.95
Boiled Yam Flour	558.09	80.73	19.99
Fermented Yam Flour	1127.73	46.66	14.77

Table 3: Mineral content of processed flours.

In the present study Zn content in raw cassava flour and boiled yam flour had a higher content. The content of Zn stated in the Food Composition Table of Ethiopia for cassava to be 0.20 mg/100 g is different from the result of the present study. In the present study recorded the higher Zn content than the report. This due to mineral composition of a food crop is directly related to its genetic origin, geographical source and soil conditions.

It was observed that both boiling and fermentation resulted in marginal increases in the level of Fe in cassava and yam flour and Zn content for boiled yam flour samples. In both cases, this could be due to the absorption of minerals derived from the boiling and fermenting medium or the absorption of minute quantities of minerals from the water used and also from enrichment of Fe from knife used for slicing in the case of boiled samples. For boiling, the loss of soluble minerals like sodium (Na) and potassium (K) contributes for the corresponding increase in the fraction of other insoluble minerals such as Fe proportionally. The increase in Fe content of cassava by enrichments stated above might be suggested as a means of food fortification with minerals. Similarly, there is a higher increment in Ca content (1127.73 mg/kg) during fermentation.

Physico-chemical property

PH of the flours: Table 4 shows the Chemical characteristics (pH and TTA) of the processed cassava and yam flour. The pH value for prepared cassava flours ranged from 3.7 to 6.48, where the maximum pH belongs to raw yam flour and the minimum pH value belongs to fermented yam flour. The pH values obtained for both prepared cassava flour samples are in agreement which ranges from 3.8 to 7.2 and pH value of cassava flour to vary from 4.6 to 7.2 [16].

Flour Types	PH values	Titratable acidity
Raw Cassava Flour	6.48	0.36
Boiled Cassava Flour	5.29	0.45
Fermented Cassava Flour	3.37	0.88
Raw Yam Flour	6.69	0.25
Boiled Yam Flour	5.44	0.28
Fermented Yam Flour	3.54	1.04

Table 4: Chemical properties of the flours.

Titratable Acidity (TTA): The titratable acidity is given in Table 4 for both cassava and yam flour samples. Titratable acidity is the highest for fermented flour samples. Processing methods have an impact of increasing the TTA of boiling and fermentation of cassava and yam flour samples.

The pH is decreased and the titratable acidity increased after processing; the intensity of acidification was greater for fermented cassava flour with the pH value of 3.37. The lower pH value is due to during fermentation days that results in generation of organic acids such as lactic acid [17]. The trend of increasing in the titratible acidity for processed cassava flours is close to the finding in Nigerian cassava flour and the pH of lafun flour in Benninese which was 4.5 after fermentation [18].

The fermentation processes were characterized by increased acid production (increase in TTA and decrease in pH) for both processed cassava and yam flour samples. Acid production during cassava fermentation might be attributed to the activities of the lactic acid bacteria on the carbohydrates of the cassava root that results in the formation of lactic acid and formic acid where the formation of these acids in turn increases the rate of acid tolerant microorganisms such as *Geotriccum candida* that converts lactic acid in to aldehydes and eaters developing a product of good aroma and flavor due to the formation of these organic compounds.

Effect of processing on functional properties

The functional properties of yam and cassava flour samples are as shown in Table 5. These are bulk density, water and oil absorption capacity, foaming capacity and foaming stability.

Bulk density: The bulk densities of cassava and yam flours are presented in Table 5. The result revealed that the bulk the density of raw, boiled and fermented cassava flour is 0.65, 0.86, and 0.75 in g/ml. For yam flour, it ranges from 0.97 to 0.65 in g/ml for boiled and fermented yam flours, respectively.

As compared to the bulk density of cassava flour which ranges from 0.64 to 0.76 g/ml, the value obtained in the present study is somehow larger and therefore can be chosen as good quality flour as high bulk density increases the rate of dispersion of the flour which is important in the reconstitution of cassava flours in hot water to produce dough [19]. Bulk density gives an indication of the relative volume of packaging material required. Generally, higher bulk density is desirable for the greater ease of dispersibility and reduction of dough thickness which is an important factor in convalescent child feeding [20].

Water and oil absorption capacity: Water absorption capacity (WAC) gives an indication of the amount of water available for gelatinization and the ability of flour to absorb water, depends on the availability of hydrophilic groups which bind water molecules. Oil absorption capacity (OAC) is attributed to physical entrapment of oil and is important for flavor retention and mouth feel of foods. It is a critical assessment of flavor retention and increases the palatability of foods.

The WAC and OAC of the processed cassava and yam flour samples are presented in Table 5. The WAC of cassava flour samples ranges 0.65 to 0.86 ml/g which belongs to fermented and boiled flour, respectively. As compared to the value reported by Odoemelam for boiled and fermented cassava flour, the values obtained in this study are larger than the previously reported value which ranged from 1.37 and 1.26 ml/g. Water absorption capacity describes flour-water association ability under limited water supply.

Fermentation decreased WAC of cassava flour while boiling increased it. The most probable reason behind this pattern of change may be the difference in the fat content of the two samples as fat is hydrophobic. Water absorption capacity is a useful indication of whether flour can be incorporated into aqueous food formulations especially those involving dough handling [21]. The less water absorption capacity results obtained suggest that cassava flours may not be comparable with others which have high WAC in food systems such as bakery products which require hydration to improve handling characteristics. The water absorption capacity of flour has been observed to be dependent on the starch and protein concentration in the material coupled with the size of the particles. Generally, the water absorption characteristics of the root flour is very important depending on the ultimate product to which the flour is intended to be converted which may include snack foods, extruded foods, and in bakery products.

Oil absorption capacity is the ability of the flour protein to physically bind fat by capillary attraction and it is of great importance, since fat acts as flavor retainer and also increases the mouth feel of foods, especially bread and other baked foods. Variation in water and oil absorption capacity of flour samples may be due to different protein concentration, their degree of interaction with water and oil and possibly their conformational characteristics. The lower water absorption capacity of flour samples is due to less availability of polar amino acids and low-fat absorption may be due to the presence of large proportion of hydrophilic groups and polar amino acids on the surface of the protein molecules.

The OAC of processed cassava flours had 0.8 ml/g and 1.24 ml/g belongs to boiled and fermented flours, respectively. The OAC of yam flour samples ranges from 0.55-0.87 mg/l. Fermented yam flour shows the highest oil absorption capacity.

Flour Types	BD (g/ml)	WAC (ml/g)	OAC (ml/g)	FC (%)	FS (%)
Raw Cassava Flour	0.65	0.76	1.15	2.88	2.28
Boiled Cassava Flour	0.86	0.87	0.8	2.55	2.25
Fermented Cassava Flour	0.75	0.65	1.24	3.25	2.56
Raw Yam Flour	0.64	0.87	0.64	3.26	1.18
Boiled Yam Flour	0.97	1.12	0.55	3.32	0.87
Fermented Yam Flour	0.65	0.64	0.87	3.56	2.45

Table 5: Effect of processing on functional properties.

It is presented in Table 5 that processing of cassava flour has resulted change in OAC i.e., boiling has decreased the OAC and fermentation has increased the oil absorption of the flour. The same trend of decreasing in oil absorption capacity was observed for yam flour due to boiling and fermentation. The OAC value of cassava flour determined in this study is less than the value which ranges from 1.07 to 1.13 ml/g [16]. The lower oil absorption capacity of cassava flour in this study might be due to low hydrophobic proteins which show superior binding of lipids [19].

Foam capacity and stability: The foaming capacities and stability of the processed cassava and yam flour samples in raw, boiled and fermented form are presented in Table 5. For cassava flour the foaming capacity varies from 2.55% to 3.25% representing the foaming capacity of boiled cassava flour and fermented cassava flour, respectively. The foaming capacity for yam flour samples ranges from 3.26 to 3.56%, which are the minimum and maximum values correspond to boiled yam flour and fermented yam flour, respectively.

Boiling has reduced the foaming capacity of cassava flour. During boiling, proteins will be denatured irreversibly by heat treatment and result in reduction of protein content of the flour. Therefore, the result of foaming capacity of cassava flour for boiled sample obtained in this study is agreement with this fact. Foaming of the flour is the manifestation of protein content. The decrease in protein content of boiled sample is the may cause reduction in the foaming capacity of the flour. Fermentation on the other hand has increased the foaming capacity of the flour. The most probable reason for an increase in the foaming capacity of flour is due to an increase in the percentage of protein content by fermentation process. The low foam capacity may be attributed to the low protein content of the flour since foam ability is related to the amount of solubilized protein and the amount of polar and non-polar lipids in a sample.

From the result of foaming stability (Table 5), it shows that fermentation has increased and boiling reduced the foaming stability in cassava flour samples. Similarly, for yam flour samples boiling reduced foam stability and fermentation increase foam capacity flour samples.

Conclusion

From the result of this study can be concluded that fermentation produce a good quality flours which have better phsico-chemical and functional properties. Fermented root crops flour like cassava and yam has a great potential to be used for preparation of value added products through substitution of the community common cereal crops like wheat, teff and sorghum. This will not only be helpful to minimized import of wheat flour in Ethiopia but also ensure producing nutritional value added food products by introducing root crops supplemented products. Therefore, the community can use these new tubers through natural fermentation and sun drying without any problem for consumption. Moreover, the outcomes derived from present investigation would be supportive for the researchers and stakeholders dealing with food for better understanding of the compositional, nutritional value of root crops.

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Conflict of Interest

The author has no any conflict interest between regarding to this paper publication. Therefore, all the members of the authors of this paper agree to publish the paper based on the existing arrangement.

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