Journal of Food and Nutrition Sciences
2017; 5(1): 16-22
http://www.sciencepublishinggroup.com/j/jfns
doi: 10.11648/j.jfns.20170501.13
ISSN: 2330-7285 (Print); ISSN: 2330-7293 (Online)

Effect of Processing on Proximate and Mineral Composition of Hepho, a Black Climbing Bean (*Lablab purpureus* L.) Flour

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To cite this article:
Mengistu Tadesse Mosisa, Diriba Chewaka Tura. Effect of Processing on Proximate and Mineral Composition of Hepho, a Black Climbing Bean (*Lablab purpureus* L.) Flour. *Journal of Food and Nutrition Sciences.* Vol. 5, No. 1, 2017, pp. 16-22. doi: 10.11648/j.jfns.20170501.13

Received: January 12, 2017; **Accepted**: January 29, 2017; **Published**: March 2, 2017

Abstract: Legumes represent major sources of nutrients and their nutritive value depends upon the processing methods applied. The objective of this study was to determine the effect processing on proximate and mineral compositions of ‘hepho’ (*Lablab purpureus L.*). Hepho is the Afan Oromo name for black climbing bean *Lablab purpureus L.* which is an indigenous legume in Ethiopia. The processing techniques employed were traditional cooking (TC) and pressure cooking (PC) of the dehulled and undehulled hepho bean while the raw sample was served as a control. The protein content was retained in all the processing methods while other proximate compositions showed deviations from the raw. Both PC and TC caused a significant ($p < 0.05$) difference in carbohydrate, fat, fiber, ash and energy content. The results also showed that the processing methods caused a significant ($p < 0.05$) difference in all the minerals (Ca, P and Zn) except the iron (Fe) content that was retained during all the processing employed. This legume was reach in minerals and proximate compositions and after processing the protein and iron content were determined to be stable. The high amount of iron in lablab beans and its retention during processing was noteworthy as diets in many developing countries are iron deficient. Hence, hepho or lablab can be an alternative and cheaper source of supplemental protein and other nutrients to solve protein energy malnutrition which is a prevalent problem in developing countries like Ethiopia.

Keywords: Hepho (*Lablab purpureus* L.), Processing Methods, Proximate Composition, Mineral Content

1. Introduction

Protein-calorie deficiency is now viewed as the major nutritional problem in most developing countries including Ethiopia. Due to the high price of animal proteins, much importance is now placed on plant foods as a source of proteins in all developing countries [1]. The dearth in food supply especially of protein source is so enormous that, the developing nations have to depend on cereals, grains, starch roots and tubers for energy and protein need [2, 3].

Therefore it is essential to produce or introduce new foods that have high nutritional quality, easy for people with a low income to purchase and being suitable to the environment having desirable agronomic features to be cultivated. Legumes which refer to the seeds of leguminosae include: peas, beans and pulses are considered as “poor man’s meat” due to their high protein content (up to 50%) and low costs [4, 5]. They are good sources of cheap and widely available proteins, carbohydrates, vitamins and minerals for human consumption [6]. Legumes are generally consumed after various processes like soaking, dehulling, cooking, milling, roasting, puffing, and germinating [7]. It has been recognized for many years that the nutritive value and digestibility of legumes are very poor unless subjected to some processing techniques [8]. A legume to be used as food is suggested to have proximate contents which comprises of 15 to 25% proteins, 50 to 75% carbohydrates mostly starch and about 1 to 3% fat, 2.9 to 4.2% ash and 3.5 to 6.5% crude fiber [9].

Beans are an excellent source of vegetable protein, starch, soluble and insoluble fibers. Further, they contain considerable amounts of vitamins (especially B group), minerals particularly potassium, iron, zinc, magnesium and phosphorus and nutritionally useful quantities of many essential amino acids [10, 11].

Indigenous legumes are an important source of affordable alternative protein to poor resource people in many tropical countries especially in Africa and Asia where they are predominantly consumed (http/p:www.intechopen.com**)**. Hepho is the Afan Oromo name for black climbing bean (*Lablab purpureus* L.) which is a common bean belonging to the Leguminosae (Fabaceae) family [12]. It is an indigenous, less popular and one of the principal food and cash crop legumes grown in both lowland and medium altitude areas of Ethiopia [13]. 'Hepho' or lablab is well known in the North-West parts and Wollega Zones (Western and Eastern Wollega Zones of Oromia region and Bennishangul-Gumuz region) in Ethiopia [9].

Hepho or lablab is cultivated on a limited scale by intercropping with maize and under fence (supportive) around home [12]. Its seed usually reach a harvestable stage within five to six months from planting depending on the environment and the plant dies after the seeds have matured [14]. In addition to its consumption, the growing women sell this crop and generate their own money. It is consumed in different forms; such as sauce or 'Wett' prepared from both dehulled and undehulled seeds with addition of salts, pepper and butter. It can also be prepared in the form of 'Nifiro' by boiling hepho bean together with maize. Though it is consumed in various forms, this legume is less known and its nutritional potential was unknown to the growing communities and others. Therefore, this study was aimed to determine the proximate and mineral composition of hepho (*Lablab purpureus* L.) and evaluate the effect of different processing techniques on hepho compositions with a view of providing information about the nutritional potentialof this legume.

2. Materials and Methods

2.1. Sample Collection

Mature seeds of *Lablab purpureus* L., 'hepho' beans were collected from growers in Bandira, Kubena Hambelta and Horo Hambelta districts of Ethiopia and authenticated by a botanist of the department of Botany, Addis Ababa University, Ethiopia. The samples were packed in polyethylene bags, kept in an ice-box to prevent moisture loss and taken to laboratories for experimentation.

2.2. Samples Preparation

The seeds were thoroughly cleaned and sorted to remove stones and injured seeds. It was then divided into three portions and treated as follows. The first portion was treated as raw and served as a control. The second portion was manually dehulled after boiling in water for 30 minutes followed by hand-rubbing to separate the seeds from the seed coat. The dehulled seeds were then dried in oven-drier (Gallenkamp Hotbox Oven, size 2, Gallenkamp, UK) at 60°C for 8 hours. The third portion was properly cleaned and treated as undehulled. The raw was milled into fine powder using electric grinder (NIMA-8300 Burman, Germany) until to pass through 0.425 mm sieve mesh size and the dehulled and undehulled portions were subjected to the processing methods.

(Source: A photo by Researchers)

Figure 1. *Undehulled Hepho bean.*

(Source: A photo by Researchers)

Figure 2. *Dehulled Hepho bean seeds.*

2.3. Traditional Cooking

The dehulled and undehulled 'hepho' or lablab seeds were traditionally cooked separately in distilled water in the ratio 1:10 (w/v) for 1 to 2hrs until they became soft when felt between the fingers following the method justified by the local women. The cooking water was drained off and the seeds were sun dried and ground into fine powder by using an electric mill (NIMA-8300 Burman, Germany) until to pass through 0.425 mm sieve mesh size. Samples were preserved in air-tight bottles in the refrigerator for analysis.

2.4. Pressure Cooking

The dehulled and undehulled seeds of 'hepho' or lablab were pressure cooked separately in pressure cooker at 101.31 Kpa (15 psi), 121°C in distilled water (1:5 w/v) for 15 min. The cooking water was drained off and the seeds were sun dried and ground into fine powder by using an electric mill (NIMA-8300 Burman, Germany) until it pass through 0.425 mm sieve mesh size. Samples were preserved in air-tight bottles in the refrigerator for analysis.

2.5. Proximate Analysis

The proximate analysis of the flour samples for moisture, protein, fat, fiber, carbohydrate, ash and energy were determined in triplicate according to methods of the Association of Official Analytical Chemists [15]. Nitrogen was determined by micro-Kjeldahl method and the percentage nitrogen was converted into crude protein by multiplying by 6.25. The total carbohydrate content was determined by difference [15]. All the chemicals used were of Analytical grade.

2.6. Mineral Analysis

Minerals were determined after wet-ashing by concentrated nitric acid and perchloric acid (1:1, v/v). Calcium, iron and zinc were determined by Atomic Absorption Spectrophotometer (Buck Scientific's 210VGP, USA). Phosphorus was determined by Vanadomolybdate colorimetric method [16]. All determinations were done in duplicate and the minerals were reported in mg 100 g-1 sample.

2.7. Statistical Analysis

The results obtained from the various analyses were subjected to Analysis of Variance (ANOVA) using SPSS version 16.0 (SPSS Inc., Chicago IL, USA). Significant differences were determined at $p < 0.05$ level.

3. Results and Discussions

Table 1 shows the proximate composition of raw and processed 'hepho' or lablab bean flour. The moisture, crude protein, crude fat, crude fiber, carbohydrates and ash values were reported in percentage of dry weight.

3.1. Moisture

The moisture content of raw 'hepho' or lablab flour was determined to be 7.14% and in all the treatments, the moisture content was increased except in dehulld TC and the higher moisture content was recorded for dehulled PC (Table 1). These findings agreed with the report of Audu and Aremu [17] that the moisture content of red kidney bean showed increment by similar treatments. The different processing techniques employed in this study increased the moisture content in this order: DTC < Raw < UTC < UPC < DPC. The increased moisture content might be due to water absorption by fibers and other natural chemical components during heat treatment [6, 18, 19].

3.2. Crude Protein

The crude protein content of whole raw 'hepho' flour (24.63g/100gm), Table 1 was found to be comparable with some previous reports like Akinjayeju and Ajayi [20] for *P. vulgaris* (23.50 gm/100gm) and it was in the protein range for lentil seeds 17-30g/100gm (Davis, 1981). But it was lower than the results of selected beans such as winged bean 30 to 40%, soybean 33 to 41% and pigeon pea 28 to 29% [22] (Table 2). Lower value was reported for red kidney bean (15.3 g/100g) [17]. In this study, protein was retained among the processing methods applied, no significance difference ($p > 0.05$). The result showed that hepho bean had contained adequate amount of protein to satisfy the calorie and protein needs of the consuming populations and it was not affected by the common processing methods, traditional cooking and pressure cooking.

Table 1. *Proximate composition (g /100 g dry weight) of raw and processed Hepho bean seeds (Lablab purpureus L.).*

Treatment	Moisture	protein	fat	fiber	CHO	energy	Ash
Raw	7.14±0.03^{a}	24.63±0.23^{a}	0.90±0.03^{ba}	4.63±0.02^{a}	65.85±0.36^{bc}	369.89±0.26^{cb}	3.99±0.09^{b}
DTC	7.13±0.03^{a}	24.81±0.04^{a}	0.83±0.04^{b}	4.11±0.02^{dc}	64.29±1.43^{d}	378.24±12.78^{a}	2.61+0.07^{d}
	(-0.1%)	(+0.73%)	(-8%)	(-11%)	(-2%)	(+2%)	(-35%)
UTC	7.37±0.03^{a}	24.67±0.24^{a}	0.92±0.00^{a}	4.38±0.07^{d}	67.22±0.23^{a}	375.82±0.12^{a}	3.14±0.31^{c}
	(+3%)	(+0.16%)	(+2%)	(-5.4%)	(+2%)	(+2%)	(-21%)
DPC	8.67±0.13^{a}	24.68±0.10^{a}	0.97± 0.10^{a}	4.13±0.22^{c}	65.12±0.17^{dc}	367.87±0.45^{c}	4.31±0.04^{a}
	(+21%)	(+0.20%)	(+8%)	(-10.8%)	(-1%)	(-1%)	(+8%)
UPC	8.24±0.03^{a}	24.46±0.42^{a}	0.91±0.02^{ba}	4.44±0.84^{b}	66.57±0.04^{ba}	372.23±0.24^{b}	3.99±0.20^{b}
	(+15%)	(-0.69%)	(+1%)	(-4%)	(+1%)	(+1%)	(0%)

Each value represents the mean +standard deviation of three triplicate determinations. Carbohydrate% calculated as the (100-total of other components). Energy% calculated kJ/100g (protein ×17+fat ×37 + CHO ×17). NB: DTC stands for De-hulled Traditionally Cooked, UTC for Undehulled Traditionally Cooked, DPC for Dehulled Pressure Cooked, and UPC for Undehulled Pressure Cooked." "(+) and (-) indicate increased and decreased from raw mean" Means in the same column with different superscript letters are significantly ($p < 0.05$) different.

3.3. Crude Fat

The crude fat content of whole raw 'hepho' flour (0.90 g/100g), (Table 1) was lower than past reports by Aremu [23] for cowpea (3.1 g/100g) and Mubark [18] for mung bean seed (1.85 g/100g). The undehulled TC and PC hepho seeds increased the crude fat content (Table 1). This result was in agreement with the work of Akinjayeju and Ajayi [20] that cooking enhanced crude fat content of black bean seeds and African oil bean. The dehulled TC reduced the crude fat content by 8% and this reduction of crude fat could be due to the leaching of the fat into the cooking water [17, 18).

3.4. Crude Fiber

Crude fiber content (4.63 gm/100gm) (Table 1) of raw 'hepho' bean was within the expected values of most beans (Table 2). This result was also comparable with the finding of Mubarak (2005) for mung bean seeds (4.63 g/100g) and Akinjayeju and Ajayi [20] for black bean (4.18 g/100g) but it was higher than the report of Audu and Aremu [17] for red kidney bean (3.6 g/100g). There was a significant ($p < 0.05$) reduction in the mean crude fiber content among all the processing methods of 'hepho' bean as compared to the raw but the reduction in the dehulled TC and dehulledPC was higher than the undehulled treatments. The higher reduction in crude fiber contents in the dehulled treatments can be attributed to removal of the bean coat and loss of water soluble fractions of fiber during the cooking process (21, 24). This finding was agreed with the report of Abiodun and Adepeju [24] where the cooking of red and white kidney beans caused reduction of crude fiber and Mugendi [25] reported crude fiber reduction in dehulled mucuna bean. This finding suggests that 'hepho' had appreciable amount of crude fiber and is important for health in maintaining the gastrointestinal tract by absorbing foreign substances [26].

3.5. Carbohydrate

Carbohydrate as Nitrogen Free Extract (NFE) calculated by difference for whole raw hepho flour (65.85 g/100g) (Table 1) was well comparable with the range values of 60-65 g/100g for cowpea and common bean [22] 65-70 g/100g for Pigeon pea as reported by Duhan [27]. The result was higher than for haricot beans ranged from 56.66 to 61.63 g/100g reported by Derese [9], soybean (30-40 g/100g) by Fasoyiro [22] and lentil (34-65) by Davis [21] but it was lower than for lima bean (66.9) [17]. The result showed that 'hepho' bean contained high amount of carbohydrate as other dry beans and is a good source of carbohydrate energy. The undehulled TC and undehulled PC methods increased the total carbohydrate content as compared to the raw. This agreed with past works that pressure cooking and convectional cooking increased the carbohydrate content of Jack bean [25]. Both the dehulled treatments slightly decreased the carbohydrate content.

3.6. Gross Energy

The gross energy value of whole raw 'hepho' flour was calculated to be 369.98 Kcal/100g (Table 1). In all the processing methods, the gross energy values were increased compared to the raw except in the dehulled pressure cooking. Changes in gross energy values of both raw and processed 'hepho' bean reflect the changes in the observed values of other proximate composition discussed earlier.

Table 2. *Proximate compositions (g/100g) of some common grain legumes seed and black climbing* 'Hepho' or *Lablab bean.*

Legumes	Protein	Fat	Carbohydrate	Ash	Fibre
'Hepho' bean	24.63	0.90	65.85	3.99	4.63
Common bean	20-27	1-2	60-65	4-5	4-5
Lima bean	19-25	1-2	70-75	4-6	3-5
Winged bean	30-40	15-20	35-45	6-7	3-5
Cowpea	22-26	1-2	60-65	4-5	3-4
Soybean	37-41	18-21	30-40	4-6	4-5
Hyacinth bean	24-28	1-2	65-70	7-9	4-5
Pigeon pea	25-29	15-20	35-45	35-45	

(Source: [30].

3.7. Total Ash

The ash content of whole raw 'hepho' flour (3.99%) (Table 1) determined was moderate and comparable with previous studies on legumes range from 3.0-5.8% for Red kidney bean [17], 3.78% for mung bean [18]. The result was also fairly comparable with average ash content (4.2%) of soybean which occupies a unique position among leguminous crops [28]. The result was higher (3.5%) for mucunabean reported by Mugandi [25], barabam nut (3.26g/100g) reported by Abiodun and Adepeju [24] and for red kidney bean (2.34 g/100g) reported by Eijigui [6]. Since 'hepho' contained moderately high ash content, it may indicate that the legume could provide essential and useful minerals needed for good body development. Significant reduction ($P<0.05$) in ash content was observed by traditional cooking methods while the undehulled pressure cooking had shown no effect at all on the ash content. This finding was similar to the works of Mittal [19] and Mubarak [18] that conventional cooking decreased ash content of kidney bean and Mung bean. As ash content is directly proportional to inorganic elements, the reduction in ash might be due to the leaching out of both macro and micro elements into the cooking water.

3.8. Minerals

Mineral contents of raw and processed 'hepho' beans were presented in Table 3. 'Hepho' or lablab was observed to contain good amounts of important minerals such as calcium, phosphorous, iron and zinc. The most abundant mineral in the raw hepho was phosphorus (342.27 mg/100g) followed by calcium (145.21 mg/100g) while the least was recorded for zinc (1.70 mg/100g). Notable reduction ($P<0.05$) in all the mineral content was observed after the processing methods except the iron content which was almost retained during all the processing. Decrease in mineral composition of 'hepho' beans could be due to removal of the hulls and leaching of the minerals into the water during the cooking treatments [19]. Eijigui [6] also reported a great loss of mineral during cooking and dehulling of red kidney beans.

Table 3. *Mean mineral contents of raw and processed 'hepho' or Lablab beans (Lablab purpureus L.) (mg/100g).*

Treatment	Calcium	Phosphorous	Iron	Zinc
Raw	145.21 +0.01[a]	342.27± 0.02[a]	8.20± 0.01[a]	1.70±0.97[a]
DTC	110.16±0.02[e]	241.91±0.01[e]	8.17±0.01[a]	1.40±0.01[b]
	(-24%)	(- 29%)	(- 0.36%)	(-17.65%)
UTC	122.29 ±0.02[d]	250.99±1.41[d]	8.18±0.01[a]	1.35±0.02[c]
	(-16%)	(- 27%)	(- 0.24%)	(- 20.58%)
DPC	137.82±0.39[c]	279.23+0.44[c]	8.19±30[a]	1.54±0.08[d]
	(- 5%)	(- 18%)	(- 0.12%)	(- 9.41%)
UPC	139.73±0.09[b]	297.05+0.05[b]	8.20±0.05[a]	1.60±0.32[e]
	(- 4%)	(-13%)	(0.0%)	(-5.88%)

"Mean not followed by the same superscript letters in the same column are significantly different (P<0.05). NB: DTC stands for De-hulled Traditionally Cooked, UTC stands for Undehulled Traditionally Cooked, DPC stands for Dehulled Pressure Cooked and UPC stands for Undehulled Pressure Cooked." " (-) indicate reduction as compared to the raw sample".

3.9. Calcium

The mean calcium content of raw 'hepho' bean 145.21 mg/100g (Table 3). This was lower than the report of Ejigui [6] for red kidney bean (179.12 mg/100g) but higher than calcium content of mung bean (84.00 mg/100g) (Mubarak, 2005). The different processing techniques employed significantly (P< 0.05) reduced the calcium content of 'hepho' beans as compared to the raw. The reduction by the processing methods employed was in this order DTC > UTC >DPC>UPC (Table 3). This observation was in agreement with the report of Abiodum and Adepeju, (2011) that cooking caused loss of Ca (0.75%) content in Cowpea. The loss of divalent metals was may be to their binding to proteins and formation of phytate-cation in addition to leaching [19].

3.10. Phosphorus

The mean phosphorus content of raw 'hepho' flour (342.27 mg/100g) (Table 3) was higher than the report by Mittal [19] for chickpea (243.00 mg/100g) and by Ekanayake [29] for underutilized legumes (291.24 mg/100g). But it was observed to be lower than the report by Mubarak [18] for mung bean (391 mg/100g). The phosphorus content of 'hepho' bean was significantly (p< 0.05) reduced in all the processing methods employed as compared to the raw and there was also a notable difference among the processing method. The finding was analogous with the report of Abiodum and Adepeju [24] that cooking caused reduction of phosphorus in cowpea and similar reduction in red kidney bean [6]. The loss of element was due to their binding to protein and formation of phytate-cation and leaching of the mineral during the cooking treatment [19].

3.11. Iron

The mean iron content of raw 'hepho' flour (8.20g/100g) (Table 3) was higher than iron content of red kidney (6.22 mg/100g) reported by Eijigu [6] and underutilized legumes (3.64 mg/100g) reported by Ekanayake [29] while it was lower than that of mung bean (9.70 mg/100g) as reported by Mubarak [18]. It was comparable with the work of Mugendi [25] for mucuna bean (7.9 mg/100g). The iron content of 'hepho' was almost retained (very lowest reduction) by all the processing methods applied, no significance difference (p >0.05) as compared to the row. Mubarak [18] reported the greatest retention of minerals by some home traditional processes on mung bean seeds. Cooking under pressure (autoclaving) gave the lowest reduction in the elements Na, Mg and Fe which may attribute to cooking by steam for little time only [18]. The iron content (8.20 mg 100g /100g) of 'hepho' beans and it retention during processing is noteworthy as diets in many developing countries are iron deficient [25].

3.12. Zinc

The mean zinc content of raw hepho flour (1.70 mg/100g) (Table 3) was higher than the report of Ekanayake [29] for underutilized legumes (1.37 mg/100g); however, it was lower than that of mucuna bean (4.1 mg/100g) [25]. All processing techniques significantly (p <0.05) reduced zinc content. The processing methods applied decreased the zinc content hepho in the order of UTC> DTC>DPC>UPC. The findings were in agreement with the previous works Abiodum and Adepeju [24] that cooking reduced the zinc content of Barbara nut. The loss of element was due to their binding to protein and formation of phytate-cation and leaching of the mineral during the cooking treatment [19].

4. Conclusion

Proximate composition and mineral contents of 'hepho'or lablab bean grown in Ethiopia was favorably compared with that of common edible legumes. 'Hepho' was notably rich in protein and other proximate compositions as well as the important micronutrients. The processing methods employed in this study had shown a significant effect in all the parameters examined except the protein and iron content. Both the protein and iron content of 'hepho' were retained by the processing method applied. Among all the nutrients, proteins play a relevant role in consideration of their amino acid composition whichcan easily be balanced in the diet. The high iron content of ‘hepho’ beans and its retention during processing was remarkable as diets in many developing countries are iron deficient. The retention of these two most important nutrients by the processing methods applied can suggest the “effectiveness of the processing” for ‘hepho’ or lablab beans. Generally, it may be able to conclude that ‘hepho’ can be an alternative and cheaper source of supplemental protein and other nutrients to solve protein energy malnutrition which is a prevalent problem in developing countries like Ethiopia.

Acknowledgment

The authors are grateful to the Department of Food Technology and Process Engineering, Wollega University and Ethiopian Health and Nutrition Research Institute (EHNRI), Ethiopia; to show their good will to use their laboratory facilities. We are very grateful to Mr. Dilnesawu Zerfu and Mr. Berhanu from EHNRI to provide us excellent technical assistance.

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