Effect of germination process on nutrients and phytochemicals contents of Fababean (Vicia faba L.) for weaning food preparation

Hagos Hailu Kassegn, Teklebrhan Welday Atsbha and Lijalem Tareke Weldeabezgi

Publisher: Cogent OA

Journal: *Cogent Food & Agriculture*

DOI: http://dx.doi.org/10.1080/23311932.2018.1545738

Effect of germination process on nutrients and phytochemicals contents of Fababean (Vicia faba L.) for weaning food preparation

Hagos Hailu Kassegn[1*] Teklebrhan Welday Atsbha[1] Lijalem Tareke Weldeabezgi[1]

Co-authors: Teklebrhan Welday Atsbha, **Email: teklebrhan2005@gmail.com**;

Lijalem Tareke Weldeabezgi**, Email: lijom98@hotmail.com**

[1]**Department of Food Science and Post-harvest Technology, P. O. Box 231, Mekelle University, Mekelle, Ethiopia.**

*__Corresponding author:__

Hagos Hailu Kassegn:-

Department of Food Science and Post harvest Technology, Mekelle University,Tel: +251914785740, E-mail: hagoshailu74@gmail.com,

Manuscript Number: COGENTAGRI-2018-0099

Abstract

Fababean is an important cheap source of legume protein which can be used as a substitute for animal protein and used to produce weaning food. Two levels of germination duration were applied and mixture design was used to prepare the weaning food flours of roasted barley, germinated fababean, and carrot powder. The flour ratios used were barley 50 to 70%, fababean 25 to 35%, and carrot 5 to 15%. A significant decrease in condensed tannin was observed during germinations (11.13 to 4.5 mg/100 g for 48 h and to 2.26 mg/100 g after 72 h). After 72 h of germination its protein content increased by 3-4%, carotenoid content from 0.051 to 0.085 mg/g and the Fe and Zn mineral content increased significantly. Crude protein content of the weaning food ranged from 15.1% to 16.25%. The iron content of the raw fababean, 48-h germinated fababean and 72-h germinated fababean, carrot powder, flour blends and control was 6.60, 6.75, 6.82, 3.60, 4.39 and 2.90 mg/100 g, respectively. Germination process improved the nutrient and reduced tannin contents of the prepared flours.

Key words: fababean, germination, iron, protein, tannin

1. Introduction

Legumes provide a high proportion of dietary fiber in the diet and they have been successfully used as part of the dietary treatment of diabetes Brand et al. (1990). It has an impact in lowering blood cholesterol levels Soni et al. (1982) and Singh et al. (1983) which indicates their possible therapeutic importance. Pritchard et al. (1973) & Hove et al. (1978) reported that the values of the dietary fiber 15–30% seems to depend on the seed variety

Fababean (*Vicia faba, L.)* is one of the oldest crops and ranks sixth in production among the different legumes grown in the world after soybean, peanut, beans, peas and chickpeas (Milner, 1973). It is also contains a large amount of proteins, carbohydrates, B-group vitamins and minerals. The protein content of faba bean ranges from 20% to 41%, values which depend on the variety Chavan et al. (1989). Fababean seeds contain 51% to 68% of carbohydrate of which 41–53% is constituted by starch and it is also a good source of dietary minerals such as, phosphorus, potassium, calcium, sulfur and iron. Calcium content of fababean ranges from 120 to 260 mg/100 g dry mass Chavan et al. (1989).

Although fababean seeds are considered to be one of the most nutritious plant foods, certain anti-nutritional factors limit their biological value and acceptance as a food. This is the reason why the seeds have to be processed using methods such as germinating, fermentation and cooking before being consumed (Abusin, 2015). Germination of fababean improves protein digestibility at a lower level than cooking. It also degrades proteins to simple peptides and improves crude protein, non protein nitrogen, and crude fiber content Elmaki et al. (1999). Germination decreases lysine, tryptophan, sulphur and total aromatic amino acids, but most contents are still higher than proposed by the FAO/WHO. (2007).

Formulation of weaning food rich in protein, carbohydrate, minerals and other nutrients at the high proportion to complement breast milk and infant feeding will bring about the end of the children high mortality rate typical of developing countries UNICEF.(1998). Weaning foods, whether manufactured or locally prepared must satisfy the nutritional requirement of infants and should also be soft and semi-solid in texture (Ugwu, 2009). It is mostly prepared in the form of thin porridge or gruels Silvia et al. (2007). Development of nutrient foods is guided by the following principles of high nutritional value to supplement breastfeeding, acceptance, energy density, low anti-nutritional content and use of local food items (Dewey & Brown, 2003) ; Pelto et al. (2003). The objective of this study was to investigate the effect of germination process on the nutrients and phytochemicals of fababean for weaning food preparation.The final product may have a great contribution to minimize the high incidence of mothers and children malnutrition in countries, Ethiopia.

2. Materials and Methods

2.1. Samples

The barley, fababean and carrot were purchased from Maichew and Adishiho local markets found in the Southern highlands of Tigray Region, Ethiopia. Samples were placed in labeled dry plastic bags and taken for analysis to Food Science and Post-harvest Technology laboratory, Haramaya University Institute of Technology, Ethiopia.

2.2. Experimental design

A simple mixture design was used to study the effect of the mixtures of barley (B), germinated fababean (Fb) and carrot powder (C) flours to prepare weaning food products. The flour ratio used was barley 50 to 70%, fababean 25 to 35% and carrot 5 to 15%.

2.3. Preparation of barley flour

Barley was dried to a uniform moisture content of 10% so as to suppress the differences in moisture content on roasting behavior. The conditioned grain was roasted at 280± 5 ^{o}C for 20 seconds in a traditional sand roaster. The roaster consisted of an iron pan having a diameter of 920 mm and depth of 600 mm. The barley grain was vigorously stirred with the sand to ensure uniform heating Sharma et al. (2011). It was immediately removed from the hot sand by sieving and spreading on a marble slab for cooling. It was ground in the cyclone sample mill (model 3010-081P, Colorado, USA) to pass through ≤ 710 µm sieve to obtain barley flour.

2.4. Fababean germination process

Fababean grain was soaked in tap water (1:5, w/v) at room temperature (≈ 23 ^{o}C) for 12 h., the water was drained off and the grain allowed to sprout. During germination, the wet grains were covered with moist fine cloth and kept in a dark place at a temperature of about (≈ 23 ^{o}C) for 48 and 72 hrs. The germinated beans were dried at 50 ^{o}C over night in a drying oven (model 101-1A. China) (Khalil & Mansour, 1995). After drying the fababean was roasted in an iron pan at a temperature of 200 ^{o}C for about 15 minutes until golden brown color was developed. The roasted beans were cooled and ground to pass ≤ 710 µm sieve and kept at cool and dry room until used.

2.5. Preparation of carrot powder

To inactivate peroxides, the sliced carrots (10 mm) handled in a muslin cloth were subjected to hot water blanching (100 ^{o}C) for six minutes (Ranganna, 1986). The blanched sample was immediately cooled to room temperature under running cold water and then spread on a sieve tray to drain. After this step, the carrot was dried at temperature of 70 ^{o}C for 24 h. in an oven (model101-1A, China) and was ground (model A11 basic, IKA, China) to pass ≤ 710 µm sieve Uddin et.al. (2004).

2.6. Proximate composition

The proximate composition (carbohydrate, fat, crude fiber, protein, moisture and ash) of the raw barley, fababean and carrot powder and the blended flours were determined using the method of

AOAC (2000). The nitrogen content of the samples was determined by the micro-Kjedhal method. The nitrogen value obtained was multiplied by 6.25 to convert it to crude protein. The weight difference method was used to determine moisture and ash levels while crude fat of the samples was determined using the Soxhlet apparatus with petroleum ether as solvent. The carbohydrate content was determined by calculation using the difference method

%Carbohydrate= [100−% (protein+fat+moisture+ash+fiber)]

The various proximate parameters were all reported in percentages AOAC (2000). The calorific value of the gross food energy values (kcal/100 g sample) of each sample was estimated using the Atwater factors for protein (4), fat (9) and carbohydrate (4) Zou et al. (2007).

Food energy= (%crude protein×4) + (%fat content×9) + (%carbohydrates×4)

2.7. Mineral Analysis

The dried, powdered samples were first digested with nitric acid and perchloric acid and then the aliquots were used for the determination of iron and zinc contents which was also read by atomic absorption spectrophotometer AOAC. (1990). Minerals were determined with their specific hollow cathode lamps at wavelengths specified by the manufacturer. Standards and reagent blanks were run at regular intervals to ensure consistent instrument performance. All samples were analyzed in triplicates. The mineral content was calculated by using the following formula:

$$\text{Fe/ Zn, mg/1000g} = \frac{\left(\mu\frac{g}{ml}\right)x100}{sample\ mass, g\ (db)}$$

Where: $\left(\mu\frac{g}{ml}\right)$ is the absorbency concentration reading of sample

2.8. Analysis of Antinutritional Factor and Antioxidant Activity

2.8.1. Total Carotenoid

Carotenoid was extracted by homogenizing carrot tissue of 5 g in 30 ml of acetone/ethanol (50:50) solution. The homogenate was filtered under suction in a Buchner funnel and washed with acetone /ethanol solvent until it became colorless. The filtrate was adjusted to 100 mL volume with acetone/ethanol. An aliquot of the total carotenoid solution was placed in a 1 cm cuvette and colorimetric measurement was made using spectrophotometer at 470 nm. The amount of total carotenoid was calculated as described by (Gross ,1991).

$$\textbf{mg carotenoid/ g tissue} = \frac{(AxVx10000)}{A\ 1\%\ xG}$$

Where: A = absorbance at 470 nm; V = total volume of solution; G = gram of sample; and A1% = specific extinction coefficient (2500).

2.8.2. Condensed Tannins

Condensed tannin was analyzed by Vanillin –HCl methods of Price et al. (1978). The sample was milled (model 3010-081P, Colorado, USA) just to pass ≤ 750 micrometer sieve. About 200 mg of the sample was weighed into a screw capped test tube and extracted with10 mL methanol by vortex mixing for 20 minutes. Then it was centrifuged (model 1020 D.E, UK.) at 3000x g for

10 min. The Vanillin (5mL) reagent was mixed with 1 mL of sample extract at 1 min interval to one test sample set and for the blank (1 mL) only 5 mL of concentrated HCl was added in methanol 4% at 1 min interval. The supernatant was used for the analysis after warming up along with theVanillin-HCl reagent in a water bath (Model GLS 400, England) at 30 ^{o}C. Sample 1 mL of the sample extract was taken in a duplicate for each sample (one for mixing with Vanillin reagent and the other for blank) to be deducted from sample absorbance. Then it was immediately incubated in a water bath at 30 ^{o}C for 20 min. After 20 min the absorbance was immediately measured at 500 nm in 1 min interval as per the sequence used for mixing. The sample absorbance was deducted from the blank and the value was estimated from the catechin equivalent (CE) standard curve Price et al. (1978).

2.8.3. Ferric Reducing Antioxidant Power (FRAP)

The FRAP was measured as described by Zhao et al. (2008). The flour sample of 0.5 g was extracted with 1 mL of 80% methanol on wrist action shaker for 2 h.. The extract was mixed with 2.5 mL of phosphate buffer 0.2M pH 6.6 and 2.5 mL of 1% potassium ferricyanide was added, followed by the incubation at 50 ^{o}C for 20 minutes. Trichloroacetic acid solution (10%) was added to the mixture and then centrifuged at 3000 g for 10 minutes. The upper layer of solution 2.5 mL was mixed with 2.5mL distilled water and 0.5 mL ferric chloride 0.1%. The absorbance of the mixture was measured at 700 nm. Increase in the absorbance of the mixture is an indicator of increased FRAP. A standard curve was prepared using various concentrations of ascorbic acid and the results were reported as μmol ascorbic acid equivalents/g of flour.

3. Results and Discussion

3.1. Proximate composition of barley,fababean, carrot flours and their blends

The effect of germination on the proximate composition of fababean seeds and blended flours are presented in Table 1. The moisture, crude fat content and fiber of the non- germinated fababean are significantly lower ($p<0.05$) than that of the germinated fababean, while their crude protein, total carbohydrate, ash and total metabolizable energy content was higher. All results were compared to the control value/non- germinated barley flour. Germinated fababean has lower moisture value than raw fababean. This may due to oven drying and roasting after germination. The moisture content of all the blended flours were ranged from 5.30 to 5.49%. This lower moisture contents of the blended flours were fit to packaging and transport Oduro *et al.* (2007).

Results showed that the ash content of raw barley, fababean and carrot powder was 2.31, 2.30 and 5.50%, respectively and that of the germinated fababean at days two and three were 2.71 and 2.55% and it is closely agreement with the reported value of Elsheikh et al. (1999) (3.09 to 3.54% ash content). The ash content of blended flours ranged from 3.30 to 4.12%, while the control value (barley flour) was 2.24%, which shows significant increase at $P<0.05$ in blending with germinated favabean and carrot powder. The ash content of the blended flours of 0.5% barley, 0.35% geminated fababean and 0.15% carrot powder had the highest amount of ash 4.12%. This indicates the increment of mineral content with the addition of the germinated fababean and carrot powder. Although the other blended flours had low ash content ranged from 3.3 to 3.55%, they are acceptable by the (Protein Advisory Group,1972) standard which recommended that the ash content should not exceed 5%.

Crude fiber content of germinated fababen was lower than that of raw seeds and the germination process causes significant decrease in crude fiber content. Changes in fiber content may attribute to the fact that part of the seed fiber may be solubilized enzymatically during seed germination (El Maki et al., 1999). The crude fiber content of the control barley flour 5.68% was higher than that of blended flours ranged from 4.9 to 5.48%.

The observed decrease in the fat contents of the germinated seeds might be due to the increased activities of the lipolytic enzymes during germination. They hydrolyze fat to simpler products which can be used as a source of energy for the developing embryo and it is same as the reported value was made for bambara groundnuts reported by (Elegbede, 1998). A fat composition of the prepared weaning food flours had ranged from 1.41 to 1.60% and it agrees to below the recommended fat level for weaning foods (Protein Advisory group, 1972) which is about 10%. Hence a food sample with high fat content is more liable to spoilage than one with a lower fat content.

The obtained crude protein content of the control (barley flour), non- germinated fababean, carrot powder, germinated fababean's at days two and three was 12.5%, 26.40%, 7.50%, 29.71% and 30.60%, respectively. Germination increased protein content of fababean seeds from 26.40 to 30.60% (Table 1) . The high protein contents of the prepared weaning flours were contributed by the germinated fababean. According to FAO/WHO . (1985) a minimum protein content of 15% is required for maximum complementation of amino acids in foods and growth, thus, the weaning food satisfy the protein demand of infants Sanni et al. (1999). Statistical comparison of the protein contents of the germinated and non-germinated fababean shows a significant difference at 95% confidence level in agreement with the reported value of Alonso et al. (2000). The crude protein content of the flour blends ranged from 15.10 to 16.25% indicating higher crude protein as compared to the control (10.5%). This may due to the high protein nature of germinated fababean. Our result validates earlier reports of increased protein content during germination of various cereals, legumes and other seeds (Inyang and Zakari, 2008) ; Yagoub et al. (2008).

The germination process slightly decreased the total carbohydrate contents as compared to the control value, while their total metabolizable energy content was higher. The decreased carbohydrate levels of the germinated fababean might be due to an increase in α-amylase activity (Lasekan, 1996) α-Amylase breaks down complex carbohydrates to simpler and more absorbable sugars which are utilized by the growing seedlings during the early stages of germination. The total metabolizable energy content of the flour blends ranged from 347.21 to 353.6 kcal/100 gram shown in table 1. The calories in an infant's diet are provided by protein, fat and carbohydrates (Harper, 2003). The carbohydrate caloric contents of the flour blends ranged

67.99% to 69.55%. The carbohydrate caloric contents for both products (control and blends) were slightly higher than that of (Protein Advisory Group 1972) of 50-60%, whereas the protein contents fall within the recommended range of 10-20%. This denotes that the flour blends would supply the needed energy to meet infants' growth demands.

The significant improvment in the protein content of the fababean will have changed after germination progresse and it could be partly explained by the renewal of protein synthetic activity by certain enzymes following absorption of water uptake. The nutrient changes that occur during germination are mainly due to the breakdown of complex compounds into a simpler form.

Location of Table 1.

3.2. Mineral composition of barley, fababean, carrot flours and their blends

The iron and zinc contents of raw barley, fababean, carrot and germinated fababean seed and flour blends are presented in Table 2. The iron content of the raw barley and fababean, germinated fababean (FB2 and FB3), carrot powder and the control value were 3.21, 6.60, 6.75, 6.81, 3.60 and 2.90 mg/100g, respectively, whereas the zinc content of the flours blends ranged from 3.81 to 3.96 mg/kg. However, the iron and zinc contents of the flour blends were higher than the control value and non- germinated fababean.

All of the flour blends value examined had iron contents ranged from 4.35 to 4.42 mg/100g. The result of raw and germinated fababean were in agreement with a reported value of 5.97 to 7.47 mg/100g Al-Numair et al. (2009). There was no significant ($p>0.05$) difference in iron contents of germinated fababean. The high value of iron found during the germination process could be due to the loss of divalent metal bond (Ca, Fe & Zn) which became low because of their binding to protein and also the formation of tannin-cation protein complexity (Lee & Karunanithy,1990).

The increase in the iron content of fababean as germination progressed is in agreement with the findings of Kumari et al. (2014) for soybean.

The availability of zinc from germinated fababean was enormously increased as a result of germination (Tbale 2). The germination of fababean at FB2 and FB3 have no significant effect on zinc content (p>0.05). The zinc content of the flour blends which ranged from 3.81-3.96 mg/100g was higher than that of control value. The germination process of fababean slightly increase the zinc value which it may be due to loss of divalent metal and their binding to protein and the formation of phytate-cation protein complex that were known to leach out on soaking and germination process (Lee & Karunanithy, 1990).

Hence, the blending of barely flour with germinated fababean resulted in improvement of the iron and zinc content of weaning food preparation to be used as complementary food.

Location of Table2.

3.3. Antioxidant and Condensed Tannin contents of barley, fababean, carrot flours and their blends

3.3.1. Total Carotenoids

Carotenoids are an extensive group of naturally occurring fat-soluble colorants. Beta-carotene, as an antioxidant, has been shown to act as an immune modulator, quench singlet oxygen, and reduce peroxyl radicals at a low partial oxygen pressure(Vitthalrao and Sharead, 2016). The total carotenoid content of barley, raw fababean and carrot powder was 0.026, 0.051 and 46.48 mg/g, respectively (Table 3). There was not significant (p> 0.05) difference in the total carotenoid contents of the germinated fababean at FB2 and FB3. The carotenoid content of the flour blends ranged from 2.42 to 7.15 mg/100g and it was higher that of the control value 0.12 mg/ 100 g. This might be due to the addition of carrot powder in flour blends. It indicates the fortification of carrot with cereals and legumes to enrich the carotenoid content of the cereal based weaning food formula is a possible way. The product has a major role in fulfilling of the vitamin A requirement for the people with a low income having this micronutrient deficit.

3.3.2. Condensed Tannins Contents

The condensed tannin content of raw fababean, FB2 and FB3, which was shown in Table 3 were 11.13, 4.50 and 2.26 mg/100g respectively. The germination process significantly decreased the concentration of tannins in fababean. Alonso et al. (2000) reported that the condensed tannin content of raw fababean was 15.00 mg/100g which was higher than that of tannin content of raw fababean found in this study, which might be due to the varietal and environmental difference. Germination reduced the content of tannin fourfold (Table 3). There was no significant ($P > 0.05$) difference in the total carotenoid contents of the germinated fababean FB2 and FB3. The decreased value in the tannin content of fababean germination may be attributed to the increasing activity of poly phenol oxidase and other catabolic enzymes which is in agreement with the reports of Deshpande et al (1986 and Khandelwal et al. (2010).

The condensed tannin content of the complementary food ranged from 1.12 to 2.71 mg catechin equivalent /100g

The observed reduction in tannin content after germination was a result of formation of hydrophobic association of tannins with seed proteins and enzymes. In addition, loss of tannins during germination may also be due to the leaching of tannins into the water (Shimelis and Rakshit, 2007) as well as washing during germination and binding of polyphenols with other organic substance such as carbohydrate or protein Saharan et al. (2002).

Location of Table 3.

3.3.3. Ferric Reducing Antioxidant Power (FRAP)

The reducing power is an indicator of presence of antioxidant activity Lee et al. (2007). The availability of FRAP in raw barley, fababean, and carrot powder were found 59.41, 26.76 and 54.42μmol Acetic Acid/g, respectively, while the corresponding values obtained the germinated fababean at days two and three were 19.72 and 21.55 μmol AA/g (Table 3). There was a significant difference on FRAP between the germinated fababean (FB2 and FB3) ($P<0.05$). The roasted barley shows an increment of FRAP when compared to the raw barley (Table3). Sharma et.al. (2011) reported the sand raosted barley had FRAP value of 62.6 to 83.4 μmol AA/g, while microwave cooked barley had FRAP value 54.6 to 67.3 μmol AA/g. Thus, sand roasting increased the FRAP value of barley. The Maillard reaction products, which were generated during the roasting might have contributed to enhance the FRAP Woffenden et al. (2002). Carrot powder also contained a high content of FRAP (54.42 μmol AA /g). The FRAP detected in the flour blends ranged from 46.51 to 51.82 μmol AA/g. All the flour blends had lower value than the control. This was due to the mixing ratio, roasting and germination duration of fababean. The combined effect of roasted barley, germinated fababean and carrot powder mixture at different ratios show significant decrease in FRAP ($p<0.001$).

4. Conclusion

Germination did not affect significantly on the proximate composition of fababean, except for protein and ash contents. Roasting and germination of barley and fababean and mixing with carrot powder in the preparation of weaning foods were found to increase the iron, zinc, protein and carotenoid contents,while there was a decreased in condensed tannin content. There were minor changes in carbohydrate and metabolizable energy contents during germination in the final flour blends but these were not statistically significant. Finaly, cereals-legume mixture with the addition of carrot powder resulted in an increase in some essential nutrients required for complemenetary food.

5. Authors' contributions

Study conception, design and acquisition of data Hagos HK. Analysis and interpretation of data and drafting of manuscript: critical revision lijalem TW and Teklebrhan WA. All authors read and approved the final manuscript.

6. Author details

Hagos Hailu Kassegn, Lijalem Tareke and Teklebrhan Welday lecturers @ Department of Food Science and Post-Harvest Technology @ Mekelle University, Mekelle, Tigray, Ethiopia.

7. Acknowledgements

This research was supported by Tigray Agricultural Research Institute for the development of weaning food to combating the malnutrition problem in the rural communities.

8. Competing interests

The authors declared that they have no competing interests.

9. Availability of data and materials

This developed weaning food has improved the mineral and protein content, reduction of the anti- nutritional factor content by germination of fababean that increase mineral absorption and mixing of carrot powder also increase the vitamin A in the weaning food. Therefore, we expect complementary feeding application of this weaning food flours will have minimized the malnourished households at rural communities.

10. Consent for publication

All authors (Hagos, H.K., Lijalem TW and Teklebrhan WA) agreed to publication of the manuscript to this journal (Cogent Food and Agriculture).

11. Ethics approval and consent to participate

Not applicable.

12.Funding

Not applicable.

13. References

1. Abusin, S. A. E. (2015). *Nutritional evaluation of cooked Faba bean (Vicia Faba L.) and white bean (Phaseolus Vulgaris L.) Cultivars* (Doctoral dissertation, UOFK).
2. Al-Numair,K. S., Ahmed, S.E.B., Al-Assaf,A.H., & Alamri, M.S. (2009). Hydrochloric acid extractable minerals and phytate and polyphenole contents of sprouted fababean and white bean cultivars. Food Chemistry. 113, 997-1002.
3. Alonso, R., Aguirre, A., & Marzo, F. (2000). Effects of extrusion and traditional processing methods on antinutrients and in vitro digestibility of protein and starch in Faba and kidney beans. *Food chemistry*, *68* (2), 159-165.
4. Amankwah, E. A., Barimah, J., Nuamah, A. K. M., Oldham, J. H., Nnaji, C. O., &

Knust, P. (2009). Formulation of weaning food from fermented maize, rice, soybean and fishmeal. *Pakistan Journal of Nutrition*, *8* (11), 1747-1752.

5. AOAC. (1 990). Official methods of analysis. *Virginia: Arlington. 1117p*.
6. AOAC. (2000). Official methods of analysis of the AOAC(18th ed.). Washington, DC: Author.
7. Bran,J.C., Snow,B.J., Nobhan,G.P., & Truswell,A.S.(1990). Plasma glucose and insulin responses to traditional Pima Indian meals. American Journal of Clinical Nutrition, 51 (1990), 216-221.
8. Chavan, J. K., Kute, L. S., & Kadam, S. S. (1989). Broad bean. *Handbook of World Food Legumes: Nutritional, Processing, Technology and Utilization*, *1*, 223-245.
9. Deshpande, S.S., Cheryan, M. & Salunkhe, D.K. (1986). Tannin analysis of food products. *CRC Critical Reviews in Food Science and Nutrition*, 24(4), 401-409.
10. Dewey, K. G., & Brown, K. H. (2003). Update on technical issues concerning complementary feeding of young children in developing countries and implications for intervention programs. *Food and nutrition bulletin*, *24* (1), 5-28.
11. Elegbede, J.A. (1998). Legumes. In: Osagie AU and Eka OU (Eds), "Nutritional Quality of Plant Foods. Post Harvest Research Unit, Department of Biochemistry, University of Benin, Benin City, Nigeria, 120-133.
12. Elmaki, H. B., Babiker, E. E. & Tinay A. H. E. (1999). Changes in chemical composition, grain malting, starch and tannin contents and protein digestibility during germination of sorghum cultivars. *Food Chemistry,* 64, 331–336.
13. Elsheikh, E. A. E., El Tinay, A. H., & Fadul, I. A. (1999). Effect of nutritional status of Faba bean on proximate composition, anti-nutritional factors and in vitro protein digestibility (IVPD). *Food chemistry*, *67* (4), 379-383.
14. FAO/WHO-UNU. (1985). Energy and Protein Requirements: Report of a Joint FAO/WHO/UNU Expert Consultation, WHO Tech Rep Ser no.724, Geneva: WHO.
15. Gross, J. (1991). Carotenoids. In *Pigments in vegetables* (75-278). Springer US.
16. Harper, L. (2003). Development of weaning food formulations based on cereal. International Journal of Food Science &Technology, 3, 24-28.

17. Hove, E. L., King, S., & Hill, G. D. (1978). Composition, protein quality, and toxins of seeds of the grain legumes Glycine max, Lupinus spp., Phaseolus spp. Pisum sativum, and Vicia faba. *New Zealand Journal of Agricultural Research*, *21* (3), 457-462.

18. Inyang, C.U., & Zakari, U.M. (2008). Effect of Germination and Fermentation of Pearl Millet on Proximate, Chemical and Sensory Properties of Instant "Fura"- A Nigerian Cereal Food. *Pakistan Journal of Nutrition*, 7(1), 9-12.

19. Khalil, A. H., & Mansour, E. H. (1995). The effect of cooking, autoclaving and germination on the nutritional quality of faba beans. *Food Chemistry*, *54* (2), 177-182.

20. Khandelwal, S., Udipi, S.A., & Ghugre, P. (2010). Poly phenols and tannins in Indian pulses: Effect of soaking germination and pressure cooking. *Food Research International*,43(2), 526-530.

21. Kumari, A.S.S., Krishnan,V.,& Jolly, M. (2014). In vivo bioavailability of essential minerals and phytase activity during soaking and germination in soybean (Glycine max L.). *Australian Journal of Crop Science*, 8 (8), 1168-117.

22. Lasekan, O.O. (1996). Effect of germination on α-amylase activities and rheologcal properties of sorghum (Sorghum biocolar) and acha (Digitaria exilis) grains. Journal of Food Scienceand Technology, 33, 329-331.

23. Lee, C. K., & Karunanithy, R. (1990). Effects of germination on the chemical composition of Glycine and Phaseolus beans. *Journal of the Science of Food and Agriculture*, *51* (4), 437-445.

24. Lee, Y. R., Woo, K. S., Kim, K. J., Son, J. R., & Jeong, H. S. (2007). Antioxidant activities of ethanol extracts from germinated specialty rough rice. *Food Science and Biotechnology*, *16* (5), 765-770.

25. Luo, Y. W., Xie, W. H., Jin, X. X., Wang, Q., & He, Y. J. (2014). Effects of germination on iron, zinc, calcium, manganese, and copper availability from cereals and legumes. *CyTA-Journal of Food*, 12(1), 22-26.

26. Milner, M. (1973). *Nutritional improvement of food legumes by breeding* (No. 633.31 M636n Ej. 1 009131). protein advisory group of the united nations system,.

27. Oduro, I., Ellis, W., Sulemana, A., & Oti-Boateng, P. (2007). Breakfast meal from breadfruit and soybean composite. Discovery Innovation, 19, 238-242.

28. Pelto, G. H., Levitt, E., & Thairu, L. (2003). Improving feeding practices, current patterns, common constraints, and the design of interventions. *Food and Nutrition Bulletin*, *24* (1), 45- 82.

29. Price, M. L., Van Scoyoc, S., & Butler, L. G. (1978). A critical evaluation of the vanillin reaction as an assay for tannin in sorghum grain. *Journal of Agricultural and Food Chemistry*, *26* (5), 1214-1218.

30. Pritchard, P. J., Dryburgh, E. A., & Wilson, B. J. (1973). Carbohydrates of spring and winter field beans (Vicia faba L.). *Journal of the Science of Food and Agriculture*, *24* (6), 663-668.

31. Protein Advisory Group. (1972). Guidelines of Protein Rich Mixture for Use in Weaning Foods. Protein Advisory Group, New York, pp: 50.

32. Ranganna, S. (1986). *Handbook of analysis and quality control of fruit and vegetable products*. Tata McGraw-Hill Education.

33. Saharan, K., Khetarpaul, N., & Bishnoi, S. (2002). Antinutrients and protein digestibility of Faba bean and Rice bean as affected by soaking, dehulling and germination. *Journal of Food Science &Technology,* 39, 418-422.

34. Sanni, A.I., Onilude A.A.,& Ibidapo, T.I. (1999). Biochemical composition of infant weaning food fabricated from fermented blends of cereal and soybean. Food Chemistry, 65, 35-39.

35. Sharma, P., Gujral, H. S., & Rosell, C. M. (2011). Effects of roasting on barley β-glucan, thermal, textural and pasting properties. *Journal of Cereal Science*, *53* (1), 25-30.

36. Sharma, P., Gujral, H. S., & Rosell, C. M. (2011). Effects of roasting on barley β-glucan, thermal, textural and pasting properties. *Journal of Cereal Science*, *53*(1), 25-30.

37. Shimelis, E.A., & Rakshit, S.K. (2007). Effect of processing on antinutrients and in vitro protein digestibility of kidney bean (Phaseolus vulgaris L.) varieties grown in East Africa. Food Chemistry, 103,161-172.

38. Silvia, R., Saldiva, D.M., Escuder, M. M., Mondini, L. , Levy R. B., & Venancio, S. I.

(2007). Feeding habits of children aged 6 to 12 months and associated maternal factors. Journal of Pediatric, 83 (1), 53-58.

39. Singh, R., George, M., & Soni, G. L. (1983). Role of dietary fiber from pulses as hypocholesterolemic agent. *Journal of food science and technology*, *20* (5), 228-230.

40. Soni, G. L., George, M., & Singh, R. (1982). Role of common Indian pulses as hypocholesterolemic agents. *Indian Journal of Nutrition and Dietetics*, *19*, 184-190.

41. Uddin, M. B., Ainsworth, P., & İbanoğlu, Ş. (2004). Evaluation of mass exchange during osmotic dehydration of carrots using response surface methodology. *Journal of Food Engineering*, *65* (4), 473-477.

42. Ugwu, F. M. (2009). The potentials of roots and tubers as weaning foods. *Pakistan Journal of Nutrition*, *8* (10), 1701-1705.

43. UNICEF. (1998). *Complementary feeding of young children in developing countries: a review of current scientific knowledge*. WHO.

44. Vitthalrao,B. K., & Sharad, G. J. (2016). Sprouting Exert Significant Influence on the Antioxidant Activity in Selected Pulses (Black Gram, Cowpea, Desi Chickpea and Yellow Mustard). *World Scientific News*, 35 (2016) 73-86.

45. WHO & United Nations University. (2007). *Protein and amino acid requirements in human nutrition* (Vol. 935). World Health Organization.

46. Woffenden, H. M., Ames, J. M., Chandra, S., Anese, M., & Nicoli, M. C. (2002). The Effect of kilning on the antioxidant and pro-oxidant activities of pale malts. *Journal of agricultural and food chemistry*, *50* (17), 4925-4933.

47. Yagoub, A.E.G.A., Mohammed, M.A. & Baker, A.A.A. (2008). Effect of Soaking, Sprouting and Cooking on Chemical Composition, Bioavailability of Minerals and in vitro Protein Digestibility of Roselle (Hibiscus sabdariffa L.) Seed. *Pakistan Journal of Nutrition*, 7(1), 50-56.

48. Zhao, H., Fan, W., Dong, J., Lu, J., Chen, J., Shan, L., & Kong, W. (2008). Evaluation of antioxidant activities and total phenolic contents of typical malting barley varieties. *Food Chemistry*, *107*(1), 296-304.

49. Zou, M. L., Moughan, P. J., Awati, A., & Livesey, G. (2007). Accuracy of the Atwater factors and related food energy conversion factors with low-fat, high-fiber diets when energy intake is reduced spontaneously. *The American journal of clinical nutrition*, *86*(6), 1649- 1656.

PUBLIC INTEREST STATEMENT

Food lacking the necessary ingredients cannot help people to sustain healthy life. Feeding children separate crops and un-processed grains will not fulfill their nutritional requirement. Preparation of weaning food by mixing of roasted barley flour, germinated fababean flour and carrot powder have improved nutrient content. The nutrient increment that occur during fababean germination are mainly due to the breakdown of complex compounds into a simpler form. The germination process significantly decreases the concentration of nutrient-binding components found in non-germinated fababean due to leaching out in to water. The high prevalence of malnutrition occurring in developing countries can be minimized by introducing such simple processing technology. The product has a major role in fulfilling of the vitamin A, iron and zinc requirement for low income community having micronutrient deficiency.

ABOUT THE AUTHOR

Hagos Hailu Kassegn

Hagos Hailu has published peer-reviewed articles in the areas of food safety, thyme herbal tea development, cereal chemistry, weaning food preparation and preparation of training manual and consulting to technical and vocational college instructors in the area of Honey Beverage Processing. He has conducted assessments of food safety issues in the cow milk supply chain in urban and per-urban areas of Tigray, Ethiopia. The information in the current perspective article is important for safe food preparation and enhancing nutrient contents of weaning food. Malnutrition affects children and women of low income society in developing countries. Information can support households and communities to minimize malnutrition of children and women.

Effect of germination process on nutrients and phytochemical contents of Fababean (Vicia faba L.) for weaning food preparation

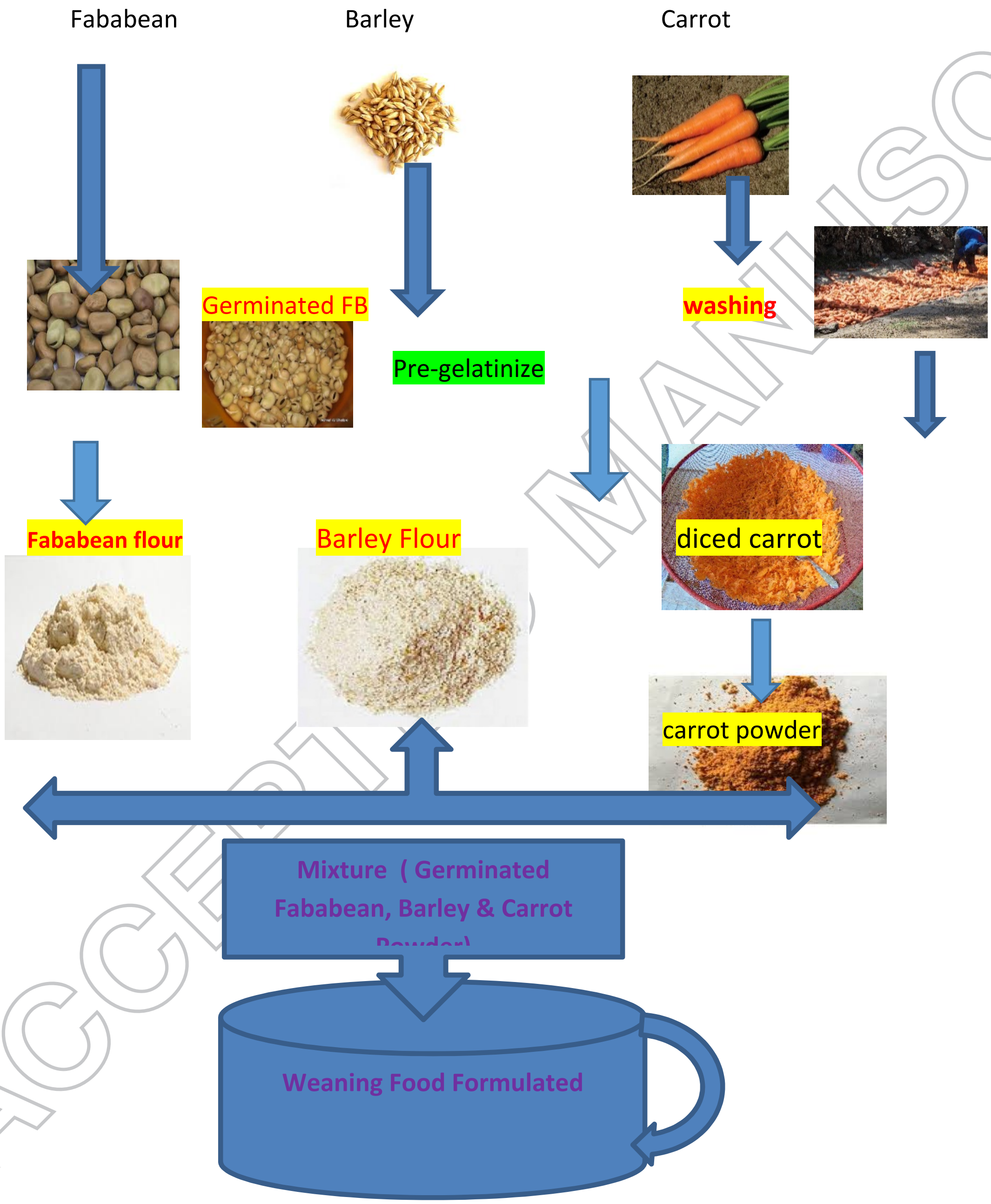


Table 1. Proximate composition of barley,fababean, carrot flours and their blends

Samples				GD	Moisture %	Ash%	Fiber%	Fat%	Protein %	Carbohydrate%	Energy Kcal.
B					9.50±0.02b	2.31±0.04d	5.68±0.07b	2.70±0.05a	12.5±0.30c	67.31±0.50b	343.54b
Fb					11.0±0.10a	2.30±0.10e	1.31±0.02c	1.55±0.02b	26.40±0.03d	56.44±0.29e	345.31b
C					5.71±0.02dc	5.50±0.05a	11.00±0.3a	1.00±0.01d	7.50±0.18e	69.29±0.15a	316.1c
FB2				2days	5.72±0.02dc	2.71±0.05c	1.20±0.02d	1.30±0.04c	29.71±0.20b	59.36±0.22d	367.98a
FB3				3days	5.75±0.03c	2.75±0.12b	1.15±0.04e	1.25±0.03c	30.60±0.30a	58.50±0.33c	367.65a
Runs	**Ingredients**				**Preparation of weaning food flours**						
	B	**FB**	**C**								
B1	0.7	0.25	0.05	FB2	5.30±0.12	3.30±0.05e	5.0±0.03c	1.60±0.01a	15.10±0.2h	69.70±0.1a	353.60
B2	0.6	0.35	0.05	FB2	5.35±0.03	3.42±0.02c	4.95±0.04c	1.55±0.02b	15.80±0.1de	68.93±0.5	352.87
B3	0.55	0.3	0.15	FB2	5.44±0.02	3.35±0.05d	5.31±0.02b	1.41±0.01d	15.96±0.1d	68.53±0.12	350.65
B4	0.5	0.35	0.15	FB2	5.36±0.03	4.12±0.13a	5.48±0.04a	1.41±0.01d	16.00±0.18c	67.63±0.15	347.21
B5	0.55	0.35	0.1	FB3	5.50±0.05	3.50±0.02b	5.32±0.02b	1.45±0.02c	16.25±0.00a	67.98±0.1	349.97
B6	0.65	0.25	0.1	FB2	5.49±0.00	3.31±0.01e	5.30±0.01b	1.46±0.02c	15.75±0.00de	68.69±0.05	350.90
B7	0.6	0.3	0.15	FB3	5.30±0.04	3.55±0.03b	5.12±0.05c	1.45±0.0c	15.78±0.1f	68.80±0.04	351.37
B8	0.65	0.3	0.05	FB3	5.32±0.09	3.33±0.02d	4.80±0.05d	1.44±0.01c	16.21±0.1b	68.90±0.3	353.40
Mean					5.38±0.1	3.48±0.3	5.16±0.24	1.47±0.05	15.86±0.4	68.65±0.5	351.25
Range					5.30-5.49	3.3-4.12	4.9-5.48	1.41-1.60	15.1-16.25	67.99-69.55	347.21-353.6
Cont.	1	0	0	0	5.5±0.05	2.51±0.05	4.82±0.01	1.41±0.00	10.5±0.05	75.26±0.25	355.73

Values are in mean ± STDEV. Means within a column with the same letter are not significantly different (p>0.05). Where: B is raw barley, Fb is raw fababean and C is carrot powder. GD is germination duration, FB is geminated Fababean, FB2 and FB3 are germinated Fababean at days 2 and 3 and B1 to B8 is run of blended ratio and Cont. is roasted barley used as control.

Table 2. Mineral composition of barley, fababean, carrot flours and their blends.

Sample Code				**GD**	**Fe, mg/100g**	**Zn, mg/100g**
B				-	3.21±0.14d	2.95±0.0c
Fb				-	6.60±0.02b	6.30±0.1b
C				-	3.60±0.05c	2.25±0.04d
FB2				48 hrs/2 days	6.75±0.03a	6.35±0.02a
FB3				72 hrs/3days	6.81±0.02a	6.36±0.00a
Runs	**Ingredients**			**GD**	**Fe, mg/100g**	**Zn, mg/100g**
	B	**Fb**	**C**			
B1	0.7	0.25	0.05	FB2	4.35±0.02	3.81±0.02
B2	0.6	0.35	0.05	FB2	4.39±0.03	3.85±0.02
B3	0.55	0.3	0.15	FB2	4.38±0.01	3.86±0.02
B4	0.5	0.35	0.15	FB2	4.40±0.02	3.83±0.00
B5	0.55	0.35	0.1	FB3	4.42±0.02	3.96±0.02
B6	0.65	0.25	0.1	FB3	4.37±0.02	3.94±0.02
B7	0.6	0.3	0.15	FB3	4.41±0.03	3.88±0.02

B8	0.65	0.3	0.05	FB3	4.39±0.00	3.92±0.00
Mean					4.39±0.03	3.41±0.07
Range					4.35-4.42	3.81-3.96
Cont.	1	0	0	0	2.90±0.03e	2.71±0.05f

Values are in mean ± STDEV. Means within a column with the same letter are not significantly different ($p>0.05$). Where: B is raw barley, Fb is germinated and roasted fababean and C is dried carrot powder. GD is germinating duration, FB2 and FB3 are germinated fababean at days 2 and 3, B1 to B8 is blended ratio and Cont. is roasted barley used as control.

Table 3. Condensed tannin, Ferric reducing antioxidant power (FRAP) and total carotenoid content of barley, fababean, carrot flours and their blends.

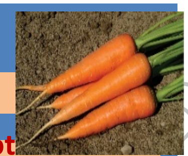
Sample code	**GD**	**Con. Tannin (Mg/100g)**	**FRAP (µmol AA/g)**	**Total carotenoid (mg/g)**
B		1.25±0.11[d]	59.41±4.26[a]	0.026± 0.004[b]
Fb		11.13±1.11[a]	26.76±2.40[c]	0.051±0.003[b]
C		0.58±0.00[e]	54.42±0.72[b]	46.48±0.845[a]
FB2	2days	4.50±0.00[b]	19.72±0.75[e]	0.078±0.001[b]
FB3	3days	2.26±0.00c	21.55±0.40[d]	0.085±0.001[b]

Runs	Ingredients				Weaning	Food	Products
	B	Fb	C				
B1	0.7	0.25	0.05	FB2	1.91±0.06^{d}	50.80±0.58^{c}	2.42±0.05^{d}
B2	0.6	0.35	0.05	FB2	2.25±0.00^{b}	49.98±0.49^{e}	2.46±0.05^{d}
B3	0.55	0.3	0.15	FB2	2.71±0.06^{a}	46.51±0.15^{f}	7.15±0.09^{a}
B4	0.5	0.35	0.15	FB2	1.96±0.06^{c}	50.58±0.11^{d}	7.13±0.05^{ba}
B5	0.55	0.35	0.1	FB3	1.28±0.06^{e}	51.21±0.22^{cb}	4.92±0.05^{c}
B6	0.65	0.25	0.1	FB3	1.12±0.00^{f}	51.82±0.23^{b}	4.89±0.09^{c}
B7	0.55	0.3	0.15	FB3	1.12±0.06^{f}	51.46±0.15^{b}	7.11±0.09^{b}
B8	0.65	0.3	0.05	FB3	1.17±0.00^{f}	50.99±0.23^{cb}	2.42±0.05^{d}
Mean					1.69±0.6	50.42±1.9	4.81±2.04
Range					1.12-2.71	46.51-51.82	2.42-7.15
Control	1	0	0	0	0.99±0.00g	79.86±3.86^{a}	0.12±0.00^{e}

Values are in mean ± STDEV. Means within the column for each constituent with the same letter are not significantly different (p>0.05). Where: AA is ascorbic acid equivalent. B1-B8 is blended samples 1 to 8; B is raw barley, Fb is germinated and roasted fababean; C is dried carrot powder. GD is geminated duration. FB2 and FB3 are fababean germinated at days 2 and 3.

Fababean

Barley

Carrot


COGENT FOOD & AGRICULTURE

FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE