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Evaluating the Effect of Blending Ratios and Fermentation Conditions on Anti-Nutritional Factors and Mineral Contents of Kocho-Fababean Blended Product

Aklilu Dolla Wana
School of Public Health, Wolaita Sodo University, Wolaita Sodo Ethiopia P.O.Box 138

Abstract
A study was conducted at Wolaita zone Southern Nations Nationalities and Peoples Regional State, Ethiopia with the objective of evaluating the effect of anti-nutritional factors and mineral contents on nutritional quality of kocho-fababean blended product. The experiment consisted of a completely randomized design in factorial arrangements with 25, 15 and 5% fababean blending ratios in kocho and 30 day fermentation conditions. The fermentation conditions included (co-fermentation of fababean and kocho for 30 days, fababean added on the 15th day and fababean added after 30 days kocho fermentation). Fababean at 25% kocho showed a significant effect ($p<0.001$), that resulted in an increased iron, zinc, phytic acid and condensed tannin content from 5.06, 4.62, 12.06, 2.00 mg/100 g to 7.22, 4.97, 120.05, 8.03 mg/100 g, respectively. Phytic acid content decreased from 120.05 to 67.03 and 67.05 and condensed tannin content also decreased from 8.03 to 3.42 and 3.73 mg/100 g. The iron, zinc, phytic acid and condensed tannin content of this products (15% fababean per100 g kocho blend subjected to fababean added on the 15th day of kocho fermentation) were 4.48, 4.19, 51.07, 2.04 mg/100 g, respectively. Thus, 15% fababean per 100 g kocho blend subjected to fababean added on the 15th day of kocho fermentation produce acceptable kocho-fababean blended product.
Keywords*:* - Kocho, Fababean, Blending ratios, Fermentation conditions, anti-nutritional factors and mineral contents.

Introduction

Ethiopia is a country, which has high production of Enset plantation (Asnakech, 1997). Enset (*Ensete ventricosum (Welw.), Cheesman*) is endemic to Ethiopia and cultivated as important food crop in southern, southwestern and central parts of the country (Spring *et al*., 1996). Enset, consisting of more than 100 varieties, is a perennial herbaceous monocot banana-like large (grow 4 to 8 m which even sometimes reach up to 11 m in height) plant belonging to the family Musaceae, genus of banana (Randy *et al*., 2007). According to CSA, (2008) enset occupies 233,492 ha of land in Ethiopia, of which 71.6, 28.2 and 0.2% were grown in Southern Nations Nationalities and Peoples Regional State, Oromia and Gambela regions respectively. It is a major crop for peoples indigenous to southern Ethiopia (Kippie, 2002).

Enset plant is used to make many locally known food products, among these are unleavened kocho bread (simply called kocho), bulla porridge (*genfo*), thick cooked bulla gruel (atmit) and a shredded flake made of a mixture of kocho and bulla (*firfir*). Kocho, Bulla and Amicho are well known raw materials obtained from the enset plant but the most common is Kocho. Kocho by its self is a good source of starch and provides a lot of calories. The approximate content of protein per 100 g dry matter kocho is 1.1-2.8g. As many as 7 million people consume the low-protein Enset products as staple or co-staple foods, sometimes with Vitamin A foods but commonly without the needed protein supplement (Asnakech, 1997). All products of enset have low protein content, which results in protein malnutrition and kwashiorkor in the country especially in Enset consumers regions (Kippie, 2002). The implication of heavy dependence on these poor nutrition crops may have serious implication on the physical and mental health of the Enset consuming and planting people (Shank, 1994).

The most important nutritional problems in most developing countries like Ethiopia are protein energy malnutrition and micronutrient deficiencies (Kaluski *et al.,* 2002). The high cost and inadequacy in production of protein-rich foods have resulted in increased protein energy malnutrition among children and other vulnerable groups in the developing world (Otegbayo *et al*., 2002). Child malnutrition may also lead to higher levels of chronic illness and disability in adult life which may have intergenerational effects as malnourished females are more likely to give birth to under-weight babies (Silva, 2005). High numbers of children in developing countries are malnourished and this has resulted in stunted growth, retardation in cognitive development, increase in morbidity and mortality rate (Ijarotimi, 2008).

Pulse crops, account for the highest grain production of Ethiopia. Most grown legumes worldwide are fababean, peanut, peas, chickpeas and lentils (Salunkhe and Kadam, 1989). They are the basis of non-meat national dishes, are a vital protein supplement to the cereal diet. Fababeans are good source of protein of adequate nutritional quality. They provide sufficient quantities of essential amino acids. (Frias *et al*., 2000).

The blending of kocho with different cereals and legumes results in the improvement of its nutritional value with high quality protein from cheap sources could be a major step in the region to avoid diseases caused

by protein energy malnutrition. Thus, this research intends to achieve the improvement of nutritional value of kocho by supplementing it with fababean.

Materials and Methods

Study Area Description

Sample preparation, blending, fermentation and kocho processing were conducted in Wolaita zone of Southern Nations Nationalities and Peoples Regional State, Ethiopia. It is located at a distance of 390 km to southwest from the capital city of the country, Addis Ababa.

Experimental Materials

Faba bean seed and kocho from fully matured enset plants were obtained from Areka Agricultural Research Center (AARC) and Humbo Larena kebele in Wolaita zone of Southern Nations Nationalities and Peoples Regional State, Ethiopia respectively. Wolaita zone is selected for source of enset plant and preparations because kocho is the main staple food in the area. In addition this is the area where people with good experience of processing kocho blended traditional foods.

Experimental Design

A factorial design (two factors each at three levels) was used for this study. The independent variables considered are blending ratios and co-fermentation durations of the kocho-fababean blend.

Chemical Analysis

Mineral Content Analysis

Iron Content Analysis by Atomic Absorption Spectroscopic method

Iron content in baked products sample was determined by Atomic Absorption Spectroscopic method (AACC, 2000). Sample (1.0 g) was taken into the ashing vessel (that was pre-ignited at 500 – 550^{0}C and cooled in desiccators). The preparation of reagents was begin at this stage. Charring was done on a blue flame or a hot plate or at the lip of the muffle furnace and ashing was done at 500^{0}C until ashing was completed (overnight). The cake was broken up by magnetic stirring rod and dissolved in about 30 ml of dilute 6M HCl with boiling and was diluted to 100 ml. The solution was boiled and evaporated nearly to dryness on steam bath to dissolve the residue. The residue was re- dissolved to 20 ml, 2M HCl and gently boiled if necessary. Then it was filtered through coarse porosity filter paper into 100 ml volumetric flask. The paper and the residue was washed with distilled water and diluted to 100 ml mark. Set up of the instrument was done according to the instruction manual of the manufacturer and absorbance was measured directly at 248.3 nm using air acetylene as a source of flame for atomization with AAS or was diluted with 0.5M HCl to get at least four working standard solution in the working range (2 – 20 µg/ml) of the instrument. Flash burner with distilled water and zero absorption point was re-established each time between samples. Calibration curve of absorbance versus concentration (µg/ml) was prepared (appendix figure, 1). Iron content was calculated by using the following formula:

$$\text{Fe (ppm) (mg/1000g)} = \frac{(\mu g/ml) \times 100}{\text{Sample mass(g)}}$$

Analysis of Zinc content by Atomic Absorption Spectroscopic method

Zinc content of baked products was determined by Atomic absorption spectroscopic method (AACC, 2000). Sample (2.0 g) was taken into the ashing vessel (that was pre- ignited at 550^{0}C and cooled in desiccators). Charring was done on a hot plate and ashing was done at 500^{0}C. Then the ash was dissolved in a minimum volume of HCl-H_2O (1+1), 20 ml of this solution was added and evaporated to dryness on a steam bath. After this 20 ml of 0.1M HCl was added and heated for 5 minutes. Finally, it was transferred to volume with 0.1M HCl. After cooling to ambient temperature, absorbance was read at 213.8 nm using air acetylene as a source of flame for atomization with AAS. Standard solution (10 µg Zn/ml) was prepared from analytical grade ZnO by dissolving 1.3830 g into 10 ml 6M HCl and was diluted to 100 ml. finally. 5 ml of the solution was taken and diluted to 500 ml mark with distilled water and a series of ten standard solutions (0.5-5.0 µg Zn/ml) was prepared and used to a construct the calibration curve (Appendix figure, 2). Zinc content was calculated by using the following formula:

$$\text{Zn (ppm) (mg/1000g)} = \frac{(\mu g/ml) \times 100}{\text{Sample mass (g)}}$$

Table 1. Instrumental operating conditions for determination of iron and zinc content

Element	Wavelength (nm)	Detection limit(mg/L)	Slit width (nm)	Lamp current (mA)	Energy (kcal)
Fe	248.3	0.030	0.2	7.0	3.003
Zn	213.8	0.0005	0.7	2.0	3.238

Source: AACC, 2000.

Determination of Anti-nutritional Factor

Determination of condensed tannins

The amount of condensed tannins was determined by the modified Vanillin assay (Maxson and Rooney, 1972). About 200 mg sample was weighed and then extracted with 10 ml absolute methanol for 20 minutes in rotating screw cap culture tubes (13 x 100 mm). The mixture was then be centrifuged for 10 minutes at 3000 x g and the supernatant was used in the analysis. About 1.0 ml aliquots of cat chin standard were dispensed into two sets of culture tubes and each sample was brought to 1.0 ml by the addition of absolute methanol. The tubes were incubated in the water bath at 30^0C (Type GLS400, Grant instruments (Cambridge) LTD, ENGLAND). 5 ml of the working vanillin reagent was added at 1 min interval to one set of standards and 5 ml of the 4% HCl solution was added at 1min intervals to the second set of standards. The sample in a water bath was kept for exactly 20 min and then removed and the absorbance at 500 nm was read using Uv-visible spectrophotometer (Model 6505, Jenway LTD and UK).

The absorbance of the blank was subtracted from the absorbance of the corresponding vanillin-containing sample. A standard curve was constructed (absorbance vs. cat chin) and the linear portion of the curve was extrapolated to produce the standard curve. Finally, the tannin content was calculated as follows:

$$\text{Tannin (\%)} = \frac{\text{C x Volume of the extract (10 ml)}}{\text{Sample wt (200 mg)}} \text{ x } 100$$

Where: C = Concentration corresponding to the optical density

Determination of Phytic acid content

Phytic acid was extracted from 0.25 g flour sample with 12.5 ml 3% trichloro-acetic acid for 45 min in a shaking water bath 23ºC (Type GLS400, Grant instruments (Cambridge) LTD, ENGLAND) with occasional vortex (Model D-91126, Heidolph Instruments, Germany) mixing at room temperature followed by centrifugation. A centrifuge (Model 1020DE, Ford Airfield Industrial Estate and UK) at 400 rpm for 10 min as described by Wheeler and Ferrel (1971) and adopted for our laboratory.

Extract supernatant (10 ml) was taken and 4 ml of $FeCl_3.7H_2O$ was added immediately. The tube and the contents were heated in a boiling water bath for 45 min and 1-2 drops of Na_2SO_4 was added after the 30^{th} min and heated until it becomes clear. The content was centrifuged (10 min at 400 rpm), washed twice by 20 ml 3% TCA heating in a boiling water bath, centrifuged and the supernatant was decanted. The content was washed again with distilled water, centrifuged and the clear supernatant was decanted followed by phytate-phosphorus analysis. The content was transferred to 20 ml test tube, 1 ml concentrated H_2SO_4 was added and digested at 350ºC until clear (30 min) to decompose the precipitate and 2 drops of H_2O_2 (30%) was added to hit test tube wall just above acid levels and boiled gently. The content was cooled, followed by addition of 5 ml distilled water, 0.4 ml sodium sulphite.$7H_2O$ ($Na_2SO_3.7H_2O$) (33%), 3 ml ammonium molybdate ($(NH_4)6Mo_7O_{24}.4H_2O$) (2%) and 2 ml L-ascorbic acid (2%) and heated (100ºC) in a boiling water bath 7-10 min (until blue color was developed). After cooling to ambient temperature and adjusting to 20 ml volume absorbance reading was taken at 820 nm using Uv-vis spectrophotometer (Model 6505, Jenway LTD, UK). The phosphorus level was estimated from calibration curve prepared from KH_2PO_4 (Appendix Figure, 3). Phytate- phosphorus obtained was multiplied by the factor 3.55 to estimate the phytic acid level based on the empirical formula $C_6P_6O_{24}H_{18}$ and result was reported on a dry mass basis.

Data Management and analysis

Triplicate data was subjected to analysis of variance (ANOVA) to evaluate the effect of anti-nutritional factors and mineral contents of kocho-fababeana blend. The statistical analysis system (SAS Institute and Cary, NC, USA) was used for descriptive statistics of kocho-fababean blended final product. Duncan's multiple range test (DMRT) was used for multiple mean comparison at probability level of ($p \leq 0.05$).

Results and discussion

Anti-nutritional factors and mineral contents of kocho and fababean flour used in this study were given in Table

2.

Table 2. Mineral and anti-nutritional composition of kocho and fababean flou per 100 gram on dry mass basis

Parameters	Fababean	Kocho
Iron (mg)	5.06±0.51	10.57±0.32
Zinc (mg)	4.62±0.46	6.61±0.02
Phytic acid (mg)	12.6±0.03	415.21±0.03
Tannins (mg)	2.00±0.01	7.27±0.01

Values are means ± standard deviation

Mineral content

Effect of main factors of blending ratios and fermentation conditions on mineral content

Significant difference ($p<0.001$) for each of the blending ratios and fermentation conditions were observed on iron content of kocho-fababean blended products (Table 3). Increasing fababean proportion increases iron content of blend kocho (F_{x2}) from 5.06 mg/100g to 7.22 mg/100 g from 0 to 25 g/100 g (B_3). Fermentation conditions showed effect on iron content of the blends that resulted in 6.21 mg per 100 g for separately fermented kocho (F_{x1}) blended with fababean. Iron content of 6.37 mg per 100 g sample was recorded for the fully co-fermented kocho-fababean blend whereas Iron content of 6.27 mg per 100 g sample was determines for the sample blended with fababean after 15 days of fermentation. Combination of cooking and fermentation improves the nutrient quality and reduces the content of anti-nutritional factors to safe level in comparison with other methods of processing (Obizoba and Atii, 1991).

Significant differences ($p<0.001$) for each of the blending ratio and fermentation condition was resulted in zinc content of products (Table 3). Zinc content of the blends increased from 4.62 mg/100 g for separately fermented kocho that was used as a control (F_{x2}) to 4.97 mg/100 g for the sample blended with 25 g fababean flour per 100 g kocho-fababean blends (B_3). Fermentation conditions showed effect on zinc content of the blends that result in 4.84 mg/100 g for separately fermented kocho that was used for final blending (F_{x1}). Co-fermentation from day 1 resulted in 5.20 mg/100 g zinc in the blend products. Fermentation results in a lower proportion of dry matter in the food and the concentrations of minerals appear to increase when measured on a dry weight basis (Adams, 1990) in addition to destruction of phytic acid on fermentation.

Table 3. Effect of main factors of blending ratios and fermentation conditions on mineral content per 100 g

FC	Fe (mg)	Zn (mg)
F_1	6.37±1.74^a	5.20±0.45^a
F_{15}	6.27±1.85^b	5.03±0.48^b
F_{x1}	6.21±1.85^c	4.84±0.79^c
BR (g)		
F_{x2}	5.06±0.03^d	4.62±0.04^c
B_1	5.14±1.01^c	4.65±0.89^c
B_2	6.50±1.56^b	4.67±0.74^b
B_3	7.22±2.01^a	4.97±0.59^a
DMRT (p=0.05)	***	***
CV	0.51	0.69

Values are Means ± standard deviation. Values followed by different letters with in a column indicate significant difference (P < 0.05")*, ***= value is significantly different at P= 0.001.Note: FC=Fermentation Conditions (F_1, F_{15} and F_{x1} are fababean addition at 1st,15th and 30th day of processing respectively, BR=Blending Ratios (fababean proportion (B_1= 5,B_2= 15 and B_3= 25 g fababean flour/100g blend flour, F_{x2} = without fababean addition that was used as a control)), Fe=Iron, Zn=Zinc, CV= Coefficient of Variance and DMRT=Duncan's multiple-range test

Interaction effect of fermentation conditions and blending ratios on mineral content

Fermentation conditions and blending ratios interaction showed significant difference ($p<0.001$) on iron content of kocho-fababean blended products (Table 4). Iron content of the blends due to interaction showed the lowest value of 5.09 mg/100 g for 5 g fababean per 100 g kocho blend which was fermented by blending on the 15th day of kocho fermentation ($F_{15}B_1$). The highest iron content of 7.50 mg/100 g was recorded in 25 g fababean per 100 g kocho blend which was blended on day 1 and co-fermented for 30 days (F_1B_3) (Table 4). Fermentation results

in a lower proportion of dry matter in the food and the concentrations of minerals appear to increase when measured on a dry weight basis (Adams, 1990).

Fermentation conditions and blending ratios interaction showed significant difference ($p<0.001$) in zinc content of the products too, (Table 4). Zinc content of the blends due to fermentation conditions by blending ratios showed the lowest value of 2.96 mg/100 g for 5 g fababean per 100 g kocho blended after sole fermentation of kocho ($F_{x1}B_1$). The highest zinc content of 5.41 mg/100 g was recorded in 25 g fababean per 100 g blend which was blended after the 30th day of kocho fermentation ($F_{x1}B_3$) (Table 4). The control kocho had zinc content of 4.62 mg/100 g. Combination of cooking and fermentation improves the nutrient quality and reduces the content of anti-nutritional factors to safe level in comparison with other methods of processing (Obizoba and Atii, 1991).

Table 4. Interaction effect of fermentation conditions and blending ratios on mineral conten per 100 g.

FC	BR (g)	Fe (mg)	Zn (mg)
F_1	B_1	5.13 ± 1.04^{c}	4.47 ± 0.26^{e}
F_1	B_2	6.48 ± 1.64^{b}	4.84 ± 0.31^{c}
F_1	B_3	7.50 ± 1.76^{a}	5.37 ± 0.26^{a}
F_{15}	B_1	5.09 ± 1.10^{c}	4.43 ± 0.33^{e}
F_{15}	B_2	6.48 ± 1.65^{b}	4.91 ± 0.17^{b}
F_{15}	B_3	7.08 ± 2.28^{a}	5.25 ± 0.70^{b}
F_{x1}	B_1	5.19 ± 1.08^{c}	2.96 ± 0.63^{f}
F_{x1}	B_2	6.52 ± 1.69^{b}	4.70 ± 0.34^{e}
F_{x1}	B_3	7.11 ± 2.29^{a}	5.41 ± 0.04^{a}
F_{x2}	-	5.06 ± 0.51^{c}	4.62 ± 0.46^{c}
DMRT (P=0.05)		***	***
CV		0.51	0.69

Values are Means ± standard deviation. Values followed by different letters with in a column indicate significant difference (P < 0.05")*, ***= value is significantly different at P= 0.001. Note: FC=Fermentation Conditions (F_1, F_{15} and F_{x1} are fababean addition at the 1st, 15th and 30th day of processing respectively, BR=Blending Ratios (fababean proportion (B_1= 5, B_2= 15 and B_3= 25 g fababean flour/100g kocho flour)), CV = Coefficient of Variance and DMRT = Duncan's multiple-range test

Anti-nutritional factors

Effect of main factors of blending ratios and fermentation conditions on anti-nutritional factors

Blending ratios had a significant ($p<0.001$) effect on phytic acid content of the products (Table 5). The phytic acid content of the blend increased from 44.06 mg/100 g for 5% fababean blend (B_1) to 120.05 mg/100 g for 25% fababean blend (B_3) with increasing the proportion of fababean (Table 5) since fababean has high phytic acid content (Table 2).

Fermentation conditions shows a significant ($p<0.001$) difference on phytic acid content (Table 5). The fermentation conditions of F_1 (fermentation of kocho-fababean blend by adding the fababean flour on the 1st day of processing) and F_{15} (fermentation of kocho-fababean blend by adding the fababean flour on the 15th day of kocho fermentation) showed a significant reduction of phytic acid content to 67.03 and 67.05 (mg/100 g), respectively as compiled to F_{x1} (blending separately fermented kocho with fababean after the 30th day of fermentation (84.07 mg/100 g) (Table 5). Fermentation resulted in a reduction of phytate, which may increase the amount of soluble iron, zinc and calcium several fold (Blandino *et al.,* 2003). Fermentation is the most effective processing method to reduce phytic acid and trypsin inhibitor activity (Kim *et al*., 2000b).

There was a considerable effect of Blending ratios ($p<0.001$) and fermentation conditions ($p<0.01$) had a significant effect on condensed tannin content (Table 5). The condensed tannin content of kocho-fababean blend increased from 2.06 mg/100 g of 5% fababean blend (B_1) to 5.06 and 8.03 mg/100 g of the 15 and 25% fababean blend respectively showing increasing trend with increasing the proportion of fababean (Table 5), this is because fababean has higher condensed tannin contents (Table 2).

Fermentation conditions showed a significant effect ($p<0.01$) on condensed tannin content (Table 5). There is no significant differences in condensed tannin content between fermentation of kocho-fababean blend by adding the fababean flour on the 1st day (F_1) (3.42 mg/100 g) and on the 15th day of fermentation (F15) (3.73 mg/100g). Both of these treatments, however, exhibited significantly lower tannin as compared to the third treatment of blending fababean at the end of kocho fermentation which exhibited 6.04 mg/g tannin. The

diminishing effect of condensed tannins during enset fermentation is due to the activity of poly-phenol oxidase enzyme (catalyzed the condensed tannin formation) in fermenting kocho (Kelbessa *et al.,* 1997b).

Table 5. Effect of main factors of blending ratios and fermentation conditions, on some anti-nutritional factors (ANFs) per 100 g.

Fermentation conditions (FC)	Phytic acid (mg/g)	Condensed tannins (mg/g)
F1	67.03±0.31[b]	3.42±0.03[b]
F_{15}	67.05±0.29[b]	3.73±0.02[b]
F_{x1}	84.07±0.44[a]	6.04±0.02[a]
DMRT	***	**
CV	1.64	1.74
BR (g)		
F_{x2}	12.06±0.02[d]	2.04±0.01[c]
B_1	44.06±0.18[c]	2.06±0.01[c]
B_2	56.03±0.04[b]	5.06±0.02[b]
B_3	120.05±0.07[a]	8.03±0.01[a]
DMRT (p=0.05)	***	***
CV	1.64	1.74

Values are Means ± standard. Values followed by different letters with in a column indicate significant difference (P < 0.05")*, ***= value is significantly different at P= 0.001. Note: FC=Fermentation Conditions (F_1, F_{15} and F_{x1} are fababean addition at 1st, 15th and 30th day of processing), respectively, BR=Blending Ratios (fababean proportion (B_1= 5, B_2 =15 and B3=25g fababean flour/100g blend flour, F_{x2}= sign indicates without faba bean addition that was used as a control)), CV= Coefficient of Variance and DMRT=Duncan's multiple-range test

Interaction effect of blending ratios and fermentation conditions on some anti-nutritional factors

As shown in Table 6 there was a significant ($p<0.01$) difference on condensed tannin content by blending ratios and fermentation conditions of kocho-fababean blend. The interaction shows an effect of increasing condensed tannin content from 1.93 mg/100g of separately fermented kocho that was used as a control (F_{x2}) to 5.09, 4.07 and 4.04 (mg/100 g) of separately fermented 25 g fababean/100 g kocho blend which was blended after the 30th day of fermentation ($F_{x1}B_3$), 25g fababean/100 g kocho blend which was fermented by blending on the 15th day ($F_{15}B_3$) and 25 g fababean/100 g kocho blend which was fermented by blending on the 1st day of processing (F_1B_3) for kocho based baked products, respectively (Table 6). Fermentation results in a reduction in phytate, which may increase the amount of soluble iron, zinc and calcium several, fold (Blandino *et al.,* 2003).

The effect of blending ratios and fermentation conditions of kocho flour with fababean flour was significantly different ($p<0.001$) on phytic acid content of kocho-fababean blended products. The result showed that an effect of increasing the phytic acid content from 20.07 mg/100 g of separately fermented kocho that was used as a control (F_{x2}) to 119.07, 107.06 and 104.06 (mg/100 g) of separately fermented 25 g fababean/100 g kocho blend which was blended after the 30th day of fermentation ($F_{x1}B_3$), 25 g fababean/100 g kocho blend which was fermented by blending on the 15th day ($F_{15}B_3$) and 25 g fababean/100 g kocho blend which was fermented by blending on the 1st day of processing (F_1B_3) for kocho based baked products, respectively (Table 6). The quantity as well as the quality of food proteins generally increased while the anti-nutritional factors show a decline during fermentation (Paredes-López and Harry, 1988).

Table 6. Interaction effect of blending ratios and fermentation conditions on some anti- nutritional factors (ANFs) per 100 g.

FC	BR (g)	Phytic acid (mg/g)	Condensed tannin (mg/g)
F_1	B_1	39.07±0.02^{j}	2.05± 0.01^{cd}
F_1	B_2	50.05± 0.02^{h}	2.10±0.01^{cd}
F_1	B_3	104.06± 0.06^{d}	4.04±0.01^{bc}
F_{15}	B_1	40.04±0.01^{j}	1.05±0.01^{cd}
F_{15}	B_2	51.07±0.01^{h}	2.04±0.01^{cd}
F_{15}	B_3	107.06±0.01^{e}	4.07±0.01^{bc}
F_{x1}	B_1	45.13±0.01^{i}	2.05±0.01^{cd}
F_{x1}	B_2	53.11±0.01^{h}	3.03±0.01^{c}
F_{x1}	B_3	119.07± 0.03^{b}	5.09±0.01^{b}
F_{x2}	-	20.07±0.01^{l}	1.93±0.01^{cd}
DMRT (P=0.05)		***	**
CV		1.64	1.74

Values are Means ± standard. Values followed by different letters with in a column indicate significant difference (P < 0.05")*, ***= value is significantly different at P= 0.001.Note: FC=Fermentation Conditions (F_1, F_{15} and F_{x1} are fababean addition at 1st,15th and 30th day of processing respectively, BR=Blending Ratios (fababean proportion (B_1= 5,B_2= 15 and B_3= 25 g fababean flour/100g kocho flour, - sign indicates without fababean addition that was used as a control)), CV= Coefficient of Variance and DMRT=Duncan's multiple-range test

Conclusions and recommendations

The study clearly showed that evaluating the effect of blending ratios and fermentation conditions on anti-nutritional factors and mineral contents of kocho-fababean blended product. Blending ratios was the most dominant factor affecting anti-nutritional factors and mineral content of kocho-fababean blended products. Fermentation of kocho-fababean blends had decreased anti- nutritional factors thus improved the availability of nutrient for the benefit of the consumer. Generally the present result suggests blending 15% fababean with 85% kocho on the 15th day of kocho fermentation shows better results for increased nutritional content and decreased anti-nutritional factors of kocho-fababean blended products is the best recommended for application.

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