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EFFECTS OF KOCHO FLOUR BLENDING WITH FLAXSEED FLOUR ON NUTRITIONAL QUALITY AND SENSORY ACCEPTABILITY OF COMPOSITE FLAT BREAD

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ABSTRACT: *In Ethiopia, there are various traditional foods with potential to be developed in to nutritional foods. It is important to reduce the incidence of malnutrition, through supplementation and development of nutritious food from locally available resources such as enset plant and flaxseed crops. This study was, therefore initiated with the objective to improve the nutritional quality of kocho products by combining with flaxseed. The study was conducted with two factors, flaxseed varieties and blending ratio (95:05, 90:10, and 85:15) of kocho to flaxseed flour with control 100% kocho flour using completely randomized design and treatment means were tested at significance level of p < 0.05 with three replications. Assessment was made on the proximate composition, mineral content and sensory acceptability of food in the form of bread. Flaxseed flour had influence on moisture, ash, crude protein, crude fiber, crude fat and energy content of breads. With 15% flaxseed substitution, percentage moisture, ash, crude protein, crude fat, and crude fiber and energy (kcal) were to 5.12, 2.14, 4.30, 6.78, 4.01 and 388.82, respectively. Carbohydrates were high for control. Kocho bread blending with flaxseed flour at 5%, 10%, and 15% showed a significant (P < 0.05) effect on minerals. With 15% flaxseed substitution Ca, P, Zn, and Fe contents (mg/100g) to 123.30, 136.85, 1.89 and 2.99, respectively. Sensory acceptability of the product increased with increasing level of flaxseed flour supplementation. In conclusion, Kocho bread has lacking nutritional content hence, blending of flaxseed in production of Kocho flat bread to improve nutritional, mineral and sensory acceptability of Kocho-flaxseed bread.*

KEY WORDS: Enset, Flaxseed, proximate, kocho-flaxseed bread, sensory acceptability.

INTRODUCTION

Enset [false banana, *Ensete ventricosum (Welw.) Cheesman*, *Musaceae*] is a monocarpic short lived perennial plant which is cultivated in Ethiopia since ancient times. It is drought tolerant; withstanding droughts that seriously damage cereals. About 20% of the human population in Ethiopia depends on enset as a food source (Shigeta, 1990; Brandt et al., 1997). Enset is the main source of food in the densely populated areas of central and south western Ethiopia. The vegetative growth habit of enset is similar to banana plants, but enset is not grown for the fruits which contain mostly large and very hard seeds (Karlsson et al., 2011). For humans, edible parts of enset are the Pseudo stem which is chopped and fermented to provide a food, it is called *kocho* and the corm (the underground stem) that can be cooked like an enormous potato, weighing up to 70 kg (Brandt et al., 1997). The pseudo stem is also excellent source of fiber used for making ropes, gunny bags, carpets and kocho squeezing fiber. Enset plant grows tall and robust, ranging from 4 to 11 meters in height and does not produce edible fruit, but its corm and pseudo-stem are scraped to separate the starchy pulp from the fiber, and the pulp is made to ferment in earthen pit. Enset leaves are used for many purpose; for lining fermentation pits and wrapping kocho during baking; for making mattress and cushion; for animal feed and for fuel (Taye,1984; Mehtzun and Yewelsew, 1994).

Flax (*Linum usitatissimum L*.) is a seasonal plant that has been used for centuries as food ingredient with health benefits because of its soluble fiber, lignans, high alpha linolenic acid (ALA, $\omega 3$ fatty acid) and proteins. It is an important dietary food consuming as a whole grain, oil, milled or ground flaxseed forms (Hall et al.,2005; Barbary et al., Truan et al.,2010; Rabetafica et al., 2011). In Ethiopia, whole or crushed flaxseed is included in bread or breakfast cereals as a health component and also it is consumed with stews, porridge or drinks. Although, flaxseed is having excellent source of essential micro nutrients such as essential fatty acids ; linoleic acid (LA, C18:2 n-6) and linolenic acid (LNA, C18:3 n-3) which play role in reducing the risk of cardiovascular diseases, and helping proper infants growth (Horrobin Manku 1990; Morris, 2004). The flaxseed fiber is also considered to reduce the blood glucose and cholesterol levels by delaying and reducing their absorption in the body (Kris-Etherton et al., 2007).

Kocho is consumed as a major stable food product in Ethiopia and prepared from Enset through baking as a form of thin bread. It provides a good source for Calcium and Iron (Abebe et al., 2007; Atlabachew and Chandravanchi, 2008), whereas low in protein which can be substantially improved by supplementation with nutrient rich food. Blending of the kocho flour with flaxseed may enhance nutritional (i.e., protein, lipid, Omega-3 fatty acid, dietary fiber and antioxidant potential) and sensory quality of the food such as texture, color, taste, and appearance. Information on availability and characteristics of kocho content that are supplemented with flaxseed is limited (so far, no report). Therefore, this study aims to supplement kocho with flaxseed for the purpose of improving the nutritional status and sensory quality.

MATERIALS AND METHODS

Experimental site

The materials required for the study included fermented kocho and flaxseed. kocho samples were taken from South West Shoa Wonchii Woreda and three flaxseed varieties from Holleta Agricultural Research Center, Ethiopia. The flaxseed varieties, grown for kola (Kulumusa1), weyna Dega (Belay96) and Dega (Jeldu) were selected based on biodiversity.

Experimental laboratory: The sample analysis was conducted at Haramaya University in Food Science and technology laboratory for proximate composition, mineral contents, and sensory evaluation of the product.

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Experimental Plan: The experiment was conducted in 3 x 3 factorial design. One factor was flaxseed variety of three different types and the other factor was kocho blending ratio with three levels. The plan is shown in Table 1.

Table 1. Experimental Plan

Blending Ratio Flax (%)	**Flaxseed Variety y**		
	B	J	K
5	B5	J5	K5
10	B10	J10	K10
15	B15	J15	K15

Where: 5 = 5% flaxseed flour, 10 = 10% flaxseed flour ,15 = 15% flaxseed flour, K = Kulumsa 1 flaxseed variety,
J = Jeldu flaxseed variety, B= Belay 96 flaxseed variety, B= 100% of the kocho flour (control).

Sample Preparation and Processing

Kocho flour: Matured enset plants were harvested from the farm and the pit was prepared at the homestead and inner part of the pit was lined with enset leaves to collect and prevent the juice part from leaking in to the ground. Pseudo stem was removed from the enset plant tightly secured on a wooden pole and, using a bamboo scraper, the fleshy part was scrapped down towards the pit. The enset plant corm was serrated to pulverize pieces and mixed with the scrapped pseudo stem pulp and a small quantity of pre fermented kocho was mixed with it as a starter to initiate the fermentation. End of three-month fermentation period the moist fibrous of kocho was squeezed, to remove the fluid part, kneaded and shredded with a knife. Finally, it was sifted to remove the fibers and dried in hot air oven at 105°C. Dried material was grounded and sieved through 2 mm mesh. Samples of the kocho flour was kept in sealed plastic bag in 5 ˚C refrigerator temperature.

Ground flaxseed: All impurities were cleaned from flaxseed grain and the cleaned flaxseed grains were ground by stainless steel grinder and the powder pass through 750µm sieve, packed in air tight plastic bag and kept at 5oC.

Preparation of flaxseed kocho bread: Kocho flour containing flaxseed of the desired proportion was mixed with potable water in a 1:1 (w/v) ratio and made into dough by hand kneading until a constant consistency was attained. The dough was immediately baked on a pre-heated baking griddle or plate. The baking time and the temperature of the un leaved bread was about 35 min and 155^{o}C respectively.

Chemical Analysis

Samples of kocho flaxseed and the composite breads were analyzed for proximate composition and mineral contents using analytical methods recommended by AACC (2000). The baked kocho bread samples were oven dried at 65 C for 12 hr to a constant weight and then finally ground using a mortar and pestle to pass through 750 micro meter sieve. Samples were kept in a sealed plastic bag at refrigeration temperature (5oC) until needed for analysis.

Moisture content: Sample of 5 g was taken in a tarred crucible and dried in hot air oven at 105oC till a constant weight The moisture contents was calculated by the formula given below.

$$Moisture(\%) = \frac{(Wt. of\ original\ sample - Wt. of\ dried\ sample) \times 100}{Wt. of\ original\ sample}$$

Ash content: Oven dried sample of 5 g was taken in a pre-weighed crucible and charred on a burner. Then it was ignited in a muffle furnace at 550oC till constant weight of grayish ash was obtained. The ash of sample was calculated by using the following formula.

$$Ash(\%) = \frac{Weight\ of\ ash\ \times 100}{Weight\ of\ sample}$$

Crude protein: Samples of 1 g was digested in digestion flask with 5 ml of H2SO4 Anhydrous Na2SO4 was used to raise the boiling point of H2SO4 and a catalyst CuSO4 was used to speed up reaction in the presence of a digestion mixture for 3-4 hrs till the contents of digestion flask get transparent in color. Sample was then diluted by water and a concentrated 40 % NaOH was added to neutralize the acid and to make the solution slightly alkaline. The ammonia from the samples was distilled in to receiving flask which consists of standard strong acid such as excess 4 % boric acid solution using methyl red as an indicator to determine nitrogen content in a sample. Boric acid was used for indirect titration and ammonia bound to an equivalent of borate ion is directly titrated with standard acid (0.1 N HCI). The crude protein percentage was calculated by using the following formula:

$$N(\%) = \frac{VHCl \times NHCl \times 14}{m \times 1000} \times 100$$

P = F × N Where:

V is volume of HCI in L consumed to the end point of the titration, N is the normality of HCI used (about 0.1 N), 14.00 is the molecular weight of nitrogen. Protein (%) was calculated by multiplying N (%), F is conversion factor (6.25), P is protein (%).

Crude fat content: The crude fat was determined by Soxhlet extraction method (AACC 2000). Ground sample (3 g) was weighed and added in to a thimble. The thimble with sample was placed in 50 ml beaker and dried in an oven for 2 hr at 110 C. A 150-250 ml dried beaker was weighed and rinsed several times with petroleum ether. The sample contained in the thimble was extracted with petroleum ether in a soxhlet extraction apparatus for 6-8 hr. After the extraction is complete, the extracted fat was transferred in to a preweighed beaker (m_i). The beaker with extracted fat was placed in a fume hood to evaporate the solvent on a steam bath until no odor of the solvent is detectable. Then the beaker with content was dried in an oven for 30 minutes at 100 C. Finally, the beaker with its contents was removed, cooled in a desiccator and weighed (m_f). The amount of fat in flour was calculated by using the following formula:

$$Fat(\%) = \frac{(mf - mi) \times 100}{m}$$

Where: m_f is dried mass of fat with beaker (g), m_i is mass of beaker (g) and m is sample mass (g,db).

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Crude fiber content: Crude fiber content was determined by following the method No. 32-10 as described in AACC, 2000. Sample of 2 g was taken and placed in 1000 ml beaker. 200 ml solution of 1.25 % H2SO4 was added in the beaker. The sample was then digested by boiling for 30 min. Then it was filtered by using suction apparatus. The residue was washed with hot water until became acid free. The residue was again transferred to 1000 ml beaker and boiled with 200 ml solution of 1.25 % NaOH for 30 min. It was again filtered and the residue was transfered to pre- weighed crucible and dried in an oven at 100 C for 24 hrs till constant weight was obtained. The dried residue was charred on a burner and ignited in to muffle furnace at 550-600 C for 5-6 hrs, cooled in desiccators and weighed. The loss in weight during incineration represents the weight of crude fiber in sample. The crude fiber % was calculated by using the following formula:

$$Crude\ fiber(\%) = \frac{(Weight\ of\ residue - Weight\ of\ ash) \times\ 100}{Weight\ of\ sample}$$

Energy value: This was calculated using the at water conversion factors (Osborne & Voogt, 1978). E (kcal per 100 g) = [9 × Lipids (%) + 4 × Proteins (%) + 4 × Carbohydrates (%)].

Utilizable carbohydrate: This was determined by subtracting the sum of other constituents from 100. Carbohydrates (%) = 100 - (% Moisture + %Crude protein + % Crude fat + % Crude fibre + % Ash) (Monrow & Burlingame, 1996).

pH: About 10 g of ground sample was mixed with 100 ml of distilled water, and supernatant was

decanted into a 250-ml beaker. Immediately pH of each homogenate was determined using a glass electrode attached to a pH meter (pH 510; EUTECH Instruments, Klang, Malaysia) (AOAC, 1995).

Minerals Analysis

Iron: Iron content was analyzed by UV-VIS spectrophotometer method (AACC, 2000). Sample (2 g) was weighed in to ashing vessel (that has been pre-ignited at 550˚C and cooled in adessicator). The sample was carbonized over ablue flame of unsen burner and put in the muffle furnace at 550 C until ashing was completed. Then, the ash was dissolved in 10 ml dilute 3M HCl. The solution was boiled and evaporated nearly to dryness on steam bath. The residue was re-dissolved quantitatively in 20 ml 1M HCl and was filtered through course porosity filter paper in to 100 ml volumetric flask. Standard solution (10 μgFe/ml) was prepared from analytical grade iron wire by dissolving 0.1 g in 20 ml HCl and 50 ml distilled water and then it was diluted to 1 L. Finally, 100 ml of this solution was diluted to 1 liter. Sample (10 ml) was taken in to 25 ml volumetric flask and 1 ml of 1, 10phenonthroline was added and aseries of standarde solutions (0.2-4.0 μgFe/ml) was made. After 30 minutes, absorbance of sample, standard and blank was read with UV-VIS spectrophotometric at 510 nm. Iron content was calculated with the following formula:

$$Iron\left(\frac{mg}{100g}\right) = \frac{C\ \times\ DF\ \times\ 10}{Sample\ mass(g)}$$

Where:
C is concentration of sample in ppm, DF is dilution factor (if any used) and
10 s a conversion factor since 10 ml was analyzed from 100 ml.

Zinc: Zinc content was determined by Atomic Absorption Spectrophotometer (AACC, 2000). Sample (2.0 g) was taken in to the ashing vessel (that was pre-ignited at 550 ˚C and cooled in desiccators). Ashing was done at 550 C and then the ash was dissolved in volume of $HClH_2O$ (1:1); 20ml of this solution was added and evaporated to dryness on a steam bath. After cooling to ambient temperature, absorbance was read at 213.8 nm using air-acetylene as a source of flame for atomization with Atomic Absorption standard solution (10µg Zn/mL) was prepared from analytical grade ZnO by dissolving 1.3830 g in to 10 ml 6M HCl and diluted to 100ml and 5ml of the solution was taken and diluted to 500ml mark with distilled water and a serious of standard solutions to construct the calibration curve. Zinc content was calculated by the following formula:

$$Zn(mg/100g) = \frac{\left(\frac{\mu g}{mL}\right) \times 100}{Sample\ mass\ (g)}$$

Where: µg /ml is the concentration of sample used for absorbance reading.

Calcium: The sample taken is similar with that of iron and the method used is AACC (2000). In this step sample was ashed as described for the iron analysis. The residue was re-dissolved quantitatively in 15 mL 1 M HCl. It was filtered through coarse porosity fiter paper into 100 Ml volumetric flask. The paper and the residue was washed thoroughly with water and was diluted to 100 mL mark. Lanthanum (La) stock solution was added to make the final dilution 1% La (i.e., 5mL La solution to 20-mL flask, 15 mL flask). Standard calcium solutions containing 0.1-1.0 mg/L was prepared using the same 0.1 mol/L of HNO_3 solution. Both the standard solutions and the sample absorbance was measured at 422.7 nm using the atomic absorption spectrometer. Concentration of samples was read from plot of absorption against micro-gram/mL of Ca.

$$Calcium\ (mg/100g) = \frac{(Cs - Cb)V\ x\ D}{S}$$

Where: Cs and Cb are concentration in micro-gram/mL of analyte and blank, respectively. V is original volume (100 mL), D is dilution factor (if original solution is diluted) = dilution volume (mL/original aliquot volume (mL) used for dilution. S is sample mass in g.

Phosphorus: Phosphorus (P) content was determined by measuring the absorbance of phosphomolybdate blue method (Bultosa, 2007). Sample (0.2g) was measured in to screw capped test tube (30 ml). Concentrated sulfuric acid (98 %) 1 mL was added and heated gently at 350^{o}C until digestion was completed. Three-four drops of H_2O_2 (2 %) was added to hit test tube wall just above acid level and mixture was shaked well to mix. When it was clear, the sample was boiled for about 2 minutes in shaking water bath and allowed to cool. Water (10 ml) was added down washing of the tube inner wall in to a mixture. Sodium sulfite.$7H_2O$ (33%) (0.8mL) solution was added to the digested sample to acidify. Then, 5 mL $(NH_4)6Mo_7O_{24}.4H_2O$ (2%) was added directly in to the sample taking care not to touch the wall of the tube and 3 mL of L-ascorbic acid (2 %) was added and heated (at 100 C) in boiling water bath (for about 7-10 minutes). The blue color developed after cooling to ambient temperature and adjusting to volume of 30 mL, absorbance was measured at 822 nm with UV-VIS spectrophotometer. Standard solution (100 micro-gram P/mL) was prepared from analytical grade K_2HPO_4 (0.10975 g) give the desired P amount in to 250 mL distilled water. From the solution, a series of six standard solutions (0.2-1.2 μg P/mL) was prepared in 30 mL screw capped test tubes. Phosphorus content was calculated by using the following formula:

$$P\ (mg/100g) = \frac{\left(\frac{\mu g}{mL}\right) \times 100}{Sample\ mass\ (g)}$$

Where: µg/mL is the concentration of sample used for absorbance reading.

Sensory Acceptability Evaluation

A total of thirty sensory panelists were selected and accustomed to kocho bread as staples, were involved in the sensory evaluation. Kocho bread was stored in **mesob** (traditional storage facility made of woven grass straw) by slicing/cutting into eighth of the whole bread with sharp and nit knife to prevent contamination among different kocho bread samples. Sensory evaluation was conducted within 2 hr after baking. Sensory acceptability of sour character, colour, odour, flavour, texture and over all sensory acceptability were evaluated on a 7-point hedonic scale as described in Yetneberk et al. (2004).

Statistical Analysis

Triplicate data were analyzed using two factors analysis of variance (ANOVA) using SAS (Version 9.1; SAS Institute, Cary, NC, USA). DMRT was used for mean separation at $P < 0.05$.

RESULTS AND DISCUSSIONS

Three improved flaxseed varieties namely, Jeldu, Belay96, and Kulumusa1 mixed with kocho flour were used for bread production in the present study. The flours were analyzed for their chemical composition and mineral contents. The breads were also analyzed for proximate composition, mineral contents and evaluated for sensory acceptability.

Proximate Composition and pH of Kocho Flour and Flaxseed Flour

Proximate composition of the kocho flour and of the three improved flaxseed varieties were analyzed that included moisture content, ash, crude protein, crude fat, fiber and carbohydrates (Table 2). The results revealed that the kocho flour contained 9.16% moisture, 1.51% ash, 1.13% protein, 2.13% fiber, 0.95% fat, and 85.1% carbohydrate. These results are in agreement with the finding of EHNRI (1997).

The result of proximate analysis of the flaxseeds showed that variety Belay 96 contained 6.20 % moisture, 3.74 % ash, 20.40 % protein, 38.47 % fat, 9.84 % fiber, and 21.34 % carbohydrate. Similarly, Jeldu variety showed 5.90 % moisture, 3.78 % ash, 22.09 % protein, 39.07 % fat, 10.10 % fiber, and 19.05 % carbohydrate. The third variety kulumusa had also showed 5.53 % moisture, 3.81 % ash, 22.21% protein, 40.03 % fat, 9.93 % fiber, and 18.47 % carbohydrate. These are in line with the work of Morris, (2003) who reported the proximate composition of flaxseed flour. As could be seen in the table, the three flaxseed varieties exhibited significant ($P < 0.05$) differences in almost all components of proximate composition except the ash content. The flaxseed moisture content was found to be low because oil seeds usually bear lower moisture content than cereal grains owing to their low starch contents. The moisture content found in three oil seeds could be regarded as safe for

storage than kocho. The flaxseeds had higher level of ash, protein, fat, fiber and energy contents than kocho, while their total carbohydrate contents were very much less. These are in agreement with the findings of Bernacchia et al.,2014 who reported fat content 41% and ash content of 3.4%.
PH values of 5.97, 6.03 and 6.24 for flaxseeds of varieties Belay96, Jeldu and Kulumusa1, respectively. Likewise, the energy contents were 513.23, 516.26, and 523.08 k cal, respectively.

Mineral Content

Data of the Calcium, phosphorous, Zinc and Iron contents of kocho flour and the flaxseed varieties are presented in Table 3. Kocho flour had calcium content of 76.66 mg/100g and the values were 247.77 mg/100g in Jeldu flaxseed variety, 251.97 mg/100g in Kulumusa1 & 239.77 mg/100g in Belay 96. The calcium content of flaxseed and kocho showed significant ($P < 0.05$) differences among them. The phosphorous contents of the kocho and flaxseed varieties showed significant ($P < 0.05$) differences. Kocho had 59.67 mg/100g whereas the result of the flaxseeds showed that variety Belay96 contained 632.33mg/100g, Jeldu 638.11 mg/100g and Kulumusa1 637 mg/100g. The iron contents of the kocho and the flaxseed varieties also showed significant ($P < 0.05$) differences. Kocho exhibited 3.67 mg/100g was the results of the flaxseeds were 5.33 mg/100g for variety Belay 96, 5.50 mg/100g for jeldu and 5.68 mg/100g for kulumusa1. The zinc contents of the kocho and flaxseed varieties also showed significant ($P < 0.05$) differences. The kocho zinc content, 1.16 mg/100g was found significantly lower than those of the flaxseeds Belay 96 (4.31 mg/100g), Jeldu (4.09 mg/100g) and Kulumusa (4.20 mg/100g).

Table 2. Proximate composition, energy and pH of kocho and flaxseed flour

Sample	MC (%)	Ash (%)	CP (%)	CF (%)	CB (%)	CHO (%)	Energy (kcal/100g)	PH
B	6.20±0.01^{b}	3.74±0.03^{a}	20.40±0.52^{b}	38.47±0.57^{c}	9.84±0.01^{b}	21.34±0.64^{b}	513.23±2.84^{c}	5.97±0.01^{c}
J	5.90±0.01^{c}	3.78±0.01^{a}	22.09±0.07^{a}	39.07±0.60^{b}	10.10±0.10^{a}	19.05±0.15^{c}	516.26±0.29^{b}	6.03±0.37^{b}
K	5.53±0.06^{d}	3.81±0.01^{a}	22.21±0.08^{a}	40.03±0.06^{a}	9.93±0.05^{b}	18.47±0.10^{c}	523.08±0.23^{a}	6.24±0.01^{a}
Con.	9.16±0.05^{a}	1.51±0.24^{b}	1.13±0.08^{c}	0.95±0.03^{d}	2.13±0.02^{c}	85.10±0.36^{a}	353.50±1.43^{d}	4.37±0.01^{d}
CV	1.41	3.96	1.68	0.96	1.68	1.08	0.30	0.37
LSD	0.19	0.25	0.55	0.57	0.12	0.78	2.86	0.04

CV= coefficient of variation, LSD= least significance difference; where MC, moisture content; CP, crude protein; CF, crude fat; CB, crude fiber; CHO=Charbohydrate Con.: Kocho flour; B: Belay96 flaxseed variety; J: Jeldu flaxseed variety; K: Kulumusa1 flaxseed variety. Values are Means ± standard error. Means followed by the same letter in a column are not significantly different at $P < 0.05$ level of significance.

Table 3. Mineral Composition of kocho and flaxseed flour

Sample	Ca (mg/100g)	P (mg/100g)	Fe (mg/100g)	Zn (mg/100g)
B	239.77±1.34^{c}	632.33±0.33^{b}	5.33±0.08^{c}	4.31±0.02^{a}
J	247.77±0.96^{b}	638.11±1.64^{a}	5.50±0.10^{b}	4.09±0.05^{c}
K	251.67±1.66^{a}	637.00±1.15^{a}	5.68±0.06^{a}	4.20±0.01^{b}
Con.	76.66±1.66^{d}	59.67±0.33^{c}	3.67±0.08^{d}	1.16±0.01^{d}
CV	0.56	0.22	1.59	0.90
LSD	2.29	2.13	0.16	0.06

CV= coefficient of variation, LSD= least significance difference; Con : Kocho flour; B: Belay96 flaxseed variety; J: Jeldu flaxseed variety; K: Kulumusa1 flaxseed variety. Values are means ± standard error. Means followed by the same letter in a column are not significantly different at $P < 0.05$ level of significance

Effect of Kocho Flour substitution with Flaxseed Flour on Proximate Composition of Kocho Bread Products

Table 4 presents proximate composition data of the flaxseed-kocho composite bread. The data showed the effect of flaxseed variety on moisture contents of the breads with average values of 4.86, 4.83 and 4.79% wet basis, for those supplemented with flaxseed varieties Belay 96, Jeldu and Kulumusa1 varieties, respectively. All three values are statistically ($P < 0.05$) different from each other. These same breads exhibited ash content records of 1.95, 1.96 and 1.96 % respectively. In regard to crude protein content of the composite breads, the 3.28 and 3.29% of the breads supplemented with flaxseed varieties Jeldu and Kulumusa1 were not statistically ($P < 0.05$) different from each other but significantly higher than the 3.11% of those supplemented with variety Belay96. The crude fat content also varied significantly between bread samples supplemented with flaxseed varieties Belay96, Jeldu and Kulumusa1 with values of 4.75, 4.81 and 4.91%, respectively. The crude fiber content, however, of these three composite breads showed no significant difference ($p > 0.05$) showing values 3.49, 3.52 and 3.51%, respectively. Their utilizable carbohydrates were 81.82, 81.59 and 81.53%, respectively. Similarly, the pH values of the composite breads were 5.23, 5.24 and 5.26, respectively with significant differences among them.

The effects of the blending ratio of the flaxseed on the proximate composition were presented in the same table 7. The moisture contents of the bread samples with flaxseed blending ratio of 0, 5, 10, and 15% were 4.50, 4.53, 4.83 and 5.12%, respectively. All these values were significantly ($P < 0.05$) different from each other. Pohjanheimo et al. (2006) had reported flaxseed based breads retained moisture and softness more efficiently than flaxseed free bread which is similar to this work. The ash content of the same bread samples were 1.66, 1.76, 1.95 and 2.14%, respectively, with significant differences among them. The ash content increased as the percentage of flaxseed increased and this can be explained by the fact that the flaxseed exhibited very much higher mineral contents than kocho (Table 3). This finding was in agreement with the work of (Hussain et al., 2011) who reported that the ash content increased with progressive increase in supplementation of 15% flaxseed in biscuits production.

Flaxseed varieties had made significant ($P < 0.05$) difference regarding the protein content of the breads. Varieties Jeldu and Kulumusa1 had resulted relatively higher percentage (3.28 and 3.29% respectively) than the 3.11% of the Belay96 variety. Crude protein contents of the bread samples exhibited significant ($P < 0.05$) increment as the percentage of flaxseed increased. The values were 1.13, 2.15, 3.23 and 4.31% for samples containing 0, 5, 10 and 15 % flaxseed powder, respectively. This is true because the protein contents of all the flaxseed varieties were very much higher than that of kocho (table 2). A review (Hussain et al., 2011) indicated an increased in the CP content from 6.5% to 8.5% in biscuits processed from composite flours containing ground flaxseed, which is similar to this work.

Crude fat content of breads having flaxseed blends also differed significantly at $P \leq 0\ 05$ with value of 4.91, 4.81 and 4.75% with varieties Kulumusa1, Jeldu and Belay96 respectively. These again can be explained by the fat that their fat content varied in that order the highest 40.0% belonging to kulumusa1 and the lowest 38.47% to Belay96 variety (Table 2). In addition to this increase is important in two aspects: (i) in terms of nutrition, flaxseed contains 40-60% lipid, of which about 59% is ALA which is the precursor fatty acid for the synthesis of EPA and DHA, both are linked in the control of cardiovascular diseases (Tour‘e and Xueming, 2010; Truan et al , 2010) and (ii) in terms of technology, an increased in lipids had the potential to reduce the starch retro-gradation by amylose-lipid complex formations (Biliaderis, 1991).

The crude fiber contents of the breads having different varieties of flaxseed did not show statistically difference ($P < 0.05$) having values of 3.49, 3.52 and 3.51% for those with Belay96, Jeldu and Kulumusa1 varieties. The reason for this is relatively high proportion of bran, which is high in fiber (Kaleab, 2014). As regards the effect of percentage of flaxseed the fiber content increased from 2.51 of pure kocho bread to 3.01, 3.51 and 4.01% of those having 5, 10 and 15 % flaxseed. Again, the reason for increase in the fiber content is attributed to the higher fiber content of the flaxseed than that in the kocho flour (Table 2). The high level of dietary fiber is an indication in which it helps to lower the risk of constipation, colon, rectal cancer and the level of low-density lipoprotein cholesterol in blood (Felicity and Maurica, 1992). Such increase in crude fiber in breads is beneficial for control of diabetes because dietary fibers are known to modulate blood sugar contents (Barbary et al., 2010; Rabetafika et al., 2011).

Flaxseed varieties had made significant ($P < 0.05$) differences regarding the pH content of the breads. Varieties Belay96, Jeldu and Kulumusa1 had resulted relatively higher values (5.23, 5.24 and 5.26 respectively) than the 4.85 of the control. Likewise, Energy contents of the bread samples exhibited significant $P < 0.05$ increment as the percentage of flaxseed increased. The values were 370.05, 377.07, 382.94 and 388.82 kcal/100g for samples containing 0, 5, 10 and 15% flaxseed powder. This is true because the Energy contents of all the flaxseed varieties were very much higher than that of kocho (table 2).

Effect of Variety and Blending Ratios on Mineral Contents of Flaxseed-kocho Breads

Table 5 shows mineral content data of flaxseed-kocho breads. The average calcium contents of breads formed by combining kocho flour with 5, 10, and 15% flaxseed of Belay96, variety was recorded to be 98.66 mg/100g, 110.32 mg/100g and 123.30 mg/100g whereas that of the breads formed by mixing same percentages of Jeldu variety ended up in average calcium contents of 111.12 mg/100g. The kocho breads produced by substituted 5, 10, and 15% kocho with kulumusa1 flaxseed were found having average calcium content of 111.51 mg/100g. These values happened because all the flaxseeds have very much higher calcium with values of 239.77, 247.77, and 251.67 mg/100g. Even if the calcium content of the base material, kocho, was very much lower, 76.66 mg/100g, then the flaxseed varieties, the composite breads were found having calcium contents in excess of 110 mg/100g. Similar works were reported by Girma (2012) on productions of teff flour with flaxseed flour substitution.

In similar manner the same table gives the phosphorus content data with average values of 104.71, 105.29, and 105.18 mg/100g for samples having flaxseed flour of varieties Belay96, Jeldu and Kulumusa1 respectively. The control sample exhibited phosphorous content of 43.66 mg/100g. These increases in the phosphorous contents of the composite breads were due to the very high level of the mineral (table 5) in the flaxseed's components. Likewise, the zinc content of kocho breads in which kocho flour was mixed with flaxseed powder were recorded to be 1.69, 1.67 and 1.68 mg/100g for samples in which variety Belay96, Jeldu and Kulumusa1, respectively, used. The increased in the zinc content of the breads for the composite flours due to the fact that all the flaxseed flour had much higher zinc than kocho as show in Table 3.

Increase in zinc content of the breads was also significantly affected by the proportion of flaxseed flour added to the kocho flour. The values were 1.47, 1.68, and 1.89 mg/100g for those with 5, 10 and 15% flaxseed addition as compared against the 1.33% of the breads having no flaxseed at all. All these four values were significantly ($P < 0.05$) different from each other.

The iron content of the kocho breads supplemented with flaxseed flour didn‘t show significant difference ($P > 0.05$) because of flaxseed variety. The values were 2.69, 2.72 and 2.73 mg/100g for those supplemented with variety Belay96, Jeldu and Kulumusa1, respectively as compared with the 2.28 mg/100g of the pure kocho bread. The increase could be once again be attributed to the much higher iron content of the flaxseed as shown in the table 5.

The increase in the iron content of these breads was also strongly affected by the level of flaxseed substitution. The value were 2.44, 2.72 and 2.99 mg/100g for these with 5, 10, and 15%, respectively, with significant ($P < 0.05$) differences among them and from that of the control which was found to be 2.28 mg/100g. Similar to this, a significant increase in the mineral contents (Fe, Zn and Mn) in wheat bread was reported (Gambus et al. 2004) with substitution by full fat flaxseed flour.

Table 4. Effect of main factors (variety and blending ratio) on proximate composition and energy content of flaxseed-kocho composite bread

Factors	MC (%)	Ash (%)	CP (%)	CF (%)	CB (%)	CHO (%)	Energy (Kcal/100g)	PH
Flaxseed variety								
B	4.86±0.26[a]	1.95±0.16[c]	3.11±0.88[b]	4.75±1.66[c]	3.49±0.42[c]	81.82±3.4[b]	382.51±4.9[c]	5.23±0.26[c]
J	4.83±0.25[b]	1.96±0.16[b]	3.28±0.95[a]	4.81±1.69[b]	3.52±0.44[a]	81.59±3.5[c]	382.82±5.0[b]	5.24±0.26[b]
K	4.79±0.23[c]	1.96±0.20[a]	3.29±0.96[a]	4.91±1.73[a]	3.51±0.43[b]	81.53±3.5[d]	383.50±5.3[a]	5.26±0.27[a]
Con.	4.50±0.00[d]	1.66±0.01[d]	1.13±0.06[c]	0.95±0.01[d]	2.51±0.04[d]	89.24±0.06[a]	370.05±0.01[d]	4.85±0.01[d]
Blending ratio								
05%	4.54±0.01[c]	1.76±0.01[c]	2.15±0.04[c]	2.86±0.04[c]	3.01±0.01[c]	85.66±0.07[b]	377.07±0.23[c]	4.94±0.01[b]
10%	4.83±0.03[b]	1.95±0.01[b]	3.23±0.09[b]	4.82±0.07[b]	3.51±0.01[b]	81.65±0.13[c]	382.94±0.46[b]	5.24±0.01[c]
15%	5.12±0.04[a]	2.14±0.01[a]	4.30±0.14[a]	6.78±0.11[a]	4.01±0.02[a]	77.63±0.20[d]	388.82±0.69[a]	5.55±0.02[d]
Con.	4.50±0.00[d]	1.66±0.01[d]	1.13±0.06[d]	0.95±0.01[d]	2.51±0.04[d]	89.24±0.07[a]	370.05±0.01[d]	4.85±0.01[a]
CV	0.17	0.08	1.76	0.78	0.20	0.06	0.04	0.05
LSD	0.01	0.002	0.05	0.03	0.01	0.05	0.15	0.002

Values are Means± standard deviation with different letters after data within a column represents differences at P ≤ 0 05 Factors=Effect of variety and blending CV=coefficient of variance LSD=least significant difference, where M, moisture; CP, crude protein; Cf, crude fat; CB, crude fiber; CHO=Carbohydrate; B, J, and K= Belay96, Jeldu and Kulumusa1 flaxseed varieties, respectively; 05%,10%, and 15%=flour flaxseed substitution levels, respectively Con.=control sample(100%kochobread)

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Table 5. Effect of main factor (variety and blending ratios) on mineral content of flaxseed substitution kocho bread

Factors	Ca (mg/100g)	P (mg/100g)	Zn (mg/100g)	Fe (mg/100g)
Flaxseed variety B				
	110.32±10.38^{c}	104.71±27.38^{b}	1.69±0.18^{a}	2.69±0.23^{a}
J	111.12±10.72^{b}	105.29±27.63^{a}	1.67±0.17^{c4}	2.72±10.23^{a}
K	111.51±10.89^{a}	105.18±27.58^{a}	1.68±0.18^{b}	2.73±0.24^{a}
Blending ratio				
05%	98.66±0.27^{c}	73.27±0.147^{c}	1.47±0.01^{c}	2.44±0.01^{c}
10%	110.98±0.53^{b}	105.06±0.28^{b}	1.68±0.01^{b}	2.72±0.02^{b}
15%	123.30±0.08^{a}	136.85±0.42^{a}	1.89±0.20^{a}	2.99±0.20^{a}
Con.	90.88±0.06^{d}	43.66±0.10^{d}	1.33±0.01^{d}	2.28±0.12^{d}
CV	0.12	0.33	0.18	2.54
LSD	0.12	0.29	0.01	0.06

Values are Means± standard deviation with different letters after data within a column represents differences at $P \leq 0.05$.Factors=Effect of variety and blending CV=coefficient of variance LSD=least significant difference, where, Ca, Calcium; P, phosphorous; Zn, zinc; Fe, Iron; B, J, and K= Belay96, Jeldu and Kulumusa1 flaxseed varieties, respectively; 05%, 10%, and 15% = flour flaxseed substitution levels, respectively. Con. = control sample (100% kocho bread).

Interaction Effect of Flaxseed Variety and blending Ratio on Proximate Composition of Kocho Composite Breads

Table 6: Ash contents of breads supplemented with flaxseed flour were significantly affected by the interaction of the two factors, flaxseed variety and proportion. The three highest values, 2.15, 2.14 and 2.14% were recorded for samples with 15% Kulumusa1, Jeldu and Belay96 varieties, respectively. The lowest three values (1.76, 1.77 and 1.77%) were of those with 5% Belay96, Jeldu and Kulumusa1 varieties, respectively. All the intermediate values belonged to breads supplemented with 10% flaxseed. It can be observed from these data that the interaction effect is highly dominated by the flaxseed proportion than variety. This can be explained by the fact that the flaxseeds have much higher mineral contents than kocho (table 2) and ash content is the reflection of the minerals in food materials.

Concerning the protein contents of the breads, the top three values (4.38, 4.14 and 4.13%) belonged to breads loaded with 15% flaxseed of Jeldu, Kulumusa1, and Belay96 varieties, respectively. On the other hand, the lowest three values (1.76, 1.77 and 1.77%) were recorded for samples with 5 % flaxseed of Belay96, Jeldu and Kulumusa1 varieties, respectively. Again, the intermediate values were of those supplemented with 10 % flaxseed of the three varieties. One can easily note that proportion of the flaxseed dominated in the interaction of the two factors in regard to the protein contents. The difference was statistically significant at $P \leq 0\ 05$.

The interaction also resulted in significant differences in crude fat contents of breads. Both factors played their roles which can easily be noted in the values. The highest records in case of blends by each variety happened to those with the 15% flaxseed proportion and the lowest occurred to those having only 5% variety wise the highest fat content values for each of the three different flaxseed portions occurred to those mixed with varieties Kulumusa1. With these patterns the highest crude fat value (6.91%) was of the sample with 15% Kulumusa1 flaxseed and the lowest (2.833%) was of those with 5% Belay96.

Crude fiber contents of the breads were also affected significantly ($P < 0.05$) by the interaction of the two factors and was dominated, strongly, by the proportion of flaxseed. The top three values (4.02, 4.00 and 3.98%) were of bread mixed with 15% flaxseed of Jeldu, Kulumusa1 and Belay96 varieties, respectively. The lowest three values (3.00, 3.01 and 3.00%) belonged to breads having 5% flaxseed of Belay96, Jeldu and Kulumusa1 varieties, respectively. The carbohydrate content of the breads was also affected by the interaction reducing significantly with increase in flaxseed proportion.

The energy content of the breads was influenced by the proportion of the flaxseed. The top three values (389.65, 388.63 and 388.17 kcal/100g) were recorded for breads having 15% flaxseed of varieties Kulumusa1, Jeldu and Belay96, respectively. The bottom three values (377.34, 377.01 and 376.85 kcal/100g) were of those samples having 5% flaxseed of varieties Kulumusa1, Jeldu and Belay96, respectively. Both factors appeared to have played their share in the interaction in influencing the energy content.

The pH values of the breads were strongly affected by the interaction which was dominated by the proportion of flaxseed than by variety. The values ranged between 4.93 of the bread with 5% Belay96 flaxseed and 5.57 of sample having 15% Kulumusa1 flaxseed. All the pH value including that of the

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control showed that the breads were slightly acidic in nature. This is attributed to the lactic acid produced by the bacteria during the fermentation process.

Interaction Effects of Variety and Blending Ratio with Flaxseed Substitution Levels on Mineral Content of Kocho Composite Bread

Table 7 shows the calcium content of the kocho breads supplemented with flaxseed flour. The highest three values of calcium (124.09, 123.51 and 122.31 mg/100g) were of those having 15% flaxseed of Kulumusa1, Jeldu and Belay96 varieties, respectively. The least three values (98.92, 98.73 and 98.33 mg/100g) were of those supplemented with only 5% flaxseed of same varieties, respectively. Similarly, the highest three values of phosphorus (137.03, 137.19 and 136.33 mg/100g) were recorded for breads having 15% flaxseed of Kulumusa1, Jeldu and Belay96 varieties, respectively. On the other hand, the least three values (73.33, 73.38 and 73.09 mg/100g) were of those supplemented with 5% flaxseed flour of same varieties, respectively. Similar trends of increment in zinc and iron contents of the breads supplemented with flaxseed happened with increase in flaxseed proportion. This is due to the fact that the flaxseeds are rich in the minerals. The interaction effect is not dominated by either of the factors.

Table 6. Interaction effect of flaxseed variety and blending ratio on proximate composition and energy contents and pH of kocho bread

Treatments	M (%)	Ash (%)	CP (%)	CF (%)	FB (%)	CHO (%)	Energy (Kcal/100g)	PH
B*05%	4.55 ± 0.01^{g}	1.76 ± 0.01^{h}	2.09 ± 0.02^{f}	2.82 ± 0.03^{h}	3.00 ± 0.01^{g}	85.75 ± 0.03^{b}	376.85 ± 0.14^{h}	4.93 ± 0.01^{h}
B*10%	4.86 ± 0.01^{d}	1.95 ± 0.00^{f}	3.11 ± 0.05^{d}	4.75 ± 0.06^{f}	3.49 ± 0.01^{e}	81.82 ± 0.06^{d}	382.51 ± 0.28^{f}	5.23 ± 0.01^{f}
B*15%	5.17 ± 0.02^{a}	2.13 ± 0.01^{c}	4.13 ± 0.08^{b}	6.67 ± 0.08^{c}	3.98 ± 0.01^{c}	77.88 ± 0.09^{f}	388.17 ± 0.43^{c}	5.53 ± 0.01^{c}
J*05%	4.53 ± 0.01^{g}	1.77 ± 0.01^{gh}	2.17 ± 0.01^{e}	2.85 ± 0.01^{gh}	3.01 ± 0.01^{f}	85.64 ± 0.01^{c}	377.01 ± 0.01^{h}	4.94 ± 0.01^{h}
J*10%	4.83 ± 0.01^{e}	1.96 ± 0.00^{e}	3.28 ± 0.01^{c}	4.81 ± 0.01^{e}	3.52 ± 0.01^{d}	81.59 ± 0.0^{e}	382.82 ± 0.03^{e}	5.24 ± 0.01^{e}
J*15%	5.12 ± 0.01^{b}	2.14 ± 0.01^{b}	4.38 ± 0.01^{a}	6.76 ± 0.01^{b}	4.02 ± 0.01^{a}	77.54 ± 0.02^{g}	388.63 ± 0.04^{b}	5.54 ± 0.01^{b}
K*05%	4.51 ± 0.01^{h}	1.76 ± 0.01^{g}	2.18 ± 0.01^{e}	2.91 ± 0.01^{g}	3.00 ± 0.01^{fg}	85.61 ± 0.01^{c}	377.34 ± 0.01^{g}	4.95 ± 0.01^{g}
K*10%	4.79 ± 0.01^{f}	1.95 ± 0.01^{d}	3.29 ± 0.01^{c}	4.91 ± 0.01^{d}	3.51 ± 0.01^{e}	81.53 ± 0.01^{e}	383.50 ± 0.03^{d}	5.26 ± 0.01^{d}
K*15%	5.07 ± 0.01^{c}	2.15 ± 0.01^{a}	4.04 ± 0.01^{a}	6.91 ± 0.01^{a}	4.00 ± 0.01^{b}	77.46 ± 0.01^{h}	389.65 ± 0.04^{a}	5.57 ± 0.01^{a}
Con.	4.50 ± 0.01^{i}	1.66 ± 0.01^{i}	1.16 ± 0.05^{g}	0.95 ± 0.01^{i}	2.51 ± 0.05^{h}	89.22 ± 0.04^{a}	370.07 ± 0.21^{i}	4.85 ± 0.01^{i}
CV	0.20	0.10	1.20	0.81	0.20	0.05	0.04	0.05
LSD	0.02	0.01	0.06	0.06	0.01	0.07	0.29	0.01

Values are Means± standard deviation means with different letters after data within a column represents differences at P ≤ 0 05 Treatment=Interaction of variety and blending ratio. CV=coefficient of variance; LSD=least significant difference, M=, moisture; CP,=crude protein; Cf,=crude fat; FB= crude fiber; CHO=Charbohydrate; B, J, and K= Belay96, Jeldu and Kulumusa1 flaxseed varieties, respectively; 05%, 10%, and 15% = flour flaxseed substitution levels. Con.=control sample (100% kocho bread)

Table 7. Interaction effect of flaxseed variety and blending ratio on mineral content of kocho bread

Treatment	Ca (mg/100g)	P (mg/100g)	Zn (mg/100g)	Fe (mg/100g)
B*05%	98.33 ± 0.07^{h}	73.09 ± 0.02^{f}	1.48 ± 0.01^{g}	2.43 ± 0.01^{h}
B*10%	110.32 ± 0.13^{f}	104.71 ± 0.03^{d}	1.69 ± 0.01^{d}	2.30 ± 0.01^{f}
B*15%	122.31 ± 0.20^{c}	136.33 ± 0.05^{b}	1.91 ± 0.01^{a}	2.97 ± 0.01^{c}
J*05%	98.73 ± 0.08^{g}	73.38 ± 0.08^{e}	1.47 ± 0.01^{h}	2.44 ± 0.01^{gh}
J*10%	111.12 ± 0.09^{e}	105.29 ± 0.16^{c}	1.68 ± 0.01^{f}	2.72 ± 0.01^{e}
J*15%	123.51 ± 0.14^{b}	137.19 ± 0.24^{a}	1.88 ± 0.01^{c}	2.99 ± 0.01^{b}
K*05%	98.92 ± 0.08^{g}	73.33 ± 0.06^{e}	1.48 ± 0.01^{gh}	2.45 ± 0.01^{g}
K*10%	111.51 ± 0.17^{d}	105.18 ± 0.11^{c}	1.69 ± 0.01^{e}	2.73 ± 0.01^{d}
K*15%	124.09 ± 0.25^{a}	137.03 ± 0.17^{a}	1.89 ± 0.01^{b}	3.02 ± 0.01^{a}
Con.	90.88 ± 0.08^{i}	43.67 ± 0.58^{g}	1.33 ± 0.01^{i}	2.28 ± 0.14^{i}
CV	0.13	0.13	0.21	0.31
LSD	0.25	0.22	0.01	0.01

Values are Means± standard deviation with different letters after data within a column represents differences at $P \leq 0.05$. Treatment=Interaction of variety and blending. CV=coefficient of variance LSD=least significant difference, where, Ca, Calcium; P, phosphorous; Zn, zinc; Fe, Iron; B, J, and K= Belay96, Jeldu and Kulumusa1 flaxseed varieties, respectively; 05%, 10%, and 15% = flour flaxseed substitution levels, respectively. Con.=control sample (100%kochobread).

Effect of Main Factors on Sensory Acceptability of Kocho-flaxseed Breads

Table 8 presents data of sensory evaluation which showed the effect of flaxseed variety and flaxseed blending ratio (substituting proportion) on acceptability by consumers. Significant ($P < 0.05$) differences were noted on all the attributes. Blending with variety Belay96 showed statistically higher scores in color, texture and taste with values of 5.40, 5.93 and 5.99 in a scale of 7-points than the other two varieties which exhibited statistical difference between their corresponding values. Variety Kulumusa1 had the highest value (5.63) in flavor and variety Jeldu the lowest (5.36) in sourness. The scores for the above attributes showed liking levels close to moderate liking. The scores of the overall acceptability were all above 6 showing liking levels above moderate. No attribute resulted in scores of below 4 which are interpreted as showing positive response regarding acceptability.

The same table conveys sensory acceptability data showing the effect of flaxseed level in the composite flour on the different attributes. In respect of color acceptability scores significantly reduced with increase in the proportion of the flaxseed. For the control sample it was 6.30 in a scale of 7-points whereas the 5, 10, and 15% flaxseed substitution resulted in 5.81, 5.24 and 4.66, respectively, showing the serious negative impact of flaxseed on color acceptability. All four values indicated above were significantly ($P < 0.05$) different from one another. Similar observation was reported in wheat bread substitution by flaxseed (Hussain et al., 2011).

Flaxseed proportion also exhibited more pronounced and significantly ($P < 0.05$) different values in acceptability of kocho texture. The least score (4.28) was of the control sample and increased to 5.03, 6.05 and 6.40 as the flaxseed proportion increased with values of 5, 10, and 15%, respectively. The texture must have improved considerably in order to show such significant difference. Similar trend was observed in taste scores, the lowest (4.08) belonging to control sample whereas those of samples with 5, 10, and 15% flaxseed earned average scores of 5.06, 6.08, and 6.43, all being significantly ($P < 0.05$) different from each other. This could be due to increase in oil content coming from the flaxseed. Similar softness impact was reported in wheat bread when flaxseed is substituted Pohjanheimo et al., (2006). Regarding the flavor acceptability, the control sample with no flaxseed powder obtained the lowest score 4.06 which showed indifference among the panelists and the values increased with increase in the flaxseed proportion. Here the highest score (5.97) was of those kocho breads having 10% flaxseed addition. All the values in here are significantly different from each other. Contrary to the rest of the data, the control sample exhibited the highest score (6.31) in sourness of attribute. Sample with 5% flaxseed also scored 6.01 while those with 10 and 15% flaxseed obtained significantly lower values of 5.91 and 5.00. Regarding overall acceptability, the control sample exhibited 4.52 whereas samples with 5, 10 and 15% flaxseed received average scores of 5.24, 6.48 and 6.39 with statistical difference ($P < 0.05$) among them. Generally, addition of flaxseed to kocho improved the bread acceptability in all the attributes except color and sourness. Almost all the scores of kocho breads of the composite flours remained above 5 and showed different levels of liking.

Interaction Effects of Flaxseed Variety and Blending Ratio on Sensory Evaluation of Kocho Bread

Table 9 presents sensory acceptability data showing the interaction effect of flaxseed variety and substitution level. In color acceptability the highest score (5.81) was shared by samples having 5% flaxseed of each of the three varieties. The lowest score (4.11 was of those with 15% substitution level of Jeldu variety. It appears that of the two factors, proportion show more dominant role than variety.

In texture of the breads the highest value (6.57) belonged to samples having 15% of Belay96 variety and the next two higher scores, 6.21 and 6.42 were recorded for samples having 15% of Jeldu and Kulumusa1 varieties. Again flaxseed proportion dominated in this interaction. The taste scores were also significantly affected by the interaction of the two factors. Among the lowest scores (5.11, 4.97 and 5.10) were those of the samples with 5% kocho of varieties Belay96, Jeldu and Kulumusa1, respectively. on the other hand, the highest value (6.65 and 6.53) were those with 15% Belay96 , and Kulumusa1 variety. These show the significant role of flaxseed variety in the interaction of the two factors. The highest flavor score (6.20) was of samples having 10% flaxseed of Kulumusa1 variety followed by 6.11 of those having 10% of Belay 96 variety. The lowest values, 5.13 and 4.81, were of samples having 5% of Belay 96 and Jeldu varieties. The 15% blending ratio where combined with all three varieties of flaxseed resulted in intermediate scores of 5.44, 5.11 and 5.52 for Belay96, Jeldu and Kulumusa1 varieties, respectively. All the above data tell that substitution level played dominant role in the interaction of the two factors. In sourness score data highest values, 6.30 and 6.10 were of samples having 10% Belay96 variety and 5% Kulumusa1 variety whereas the least values, 5.11 and 4.91 were of samples having 15% Belay96 variety and 15% Kulumusa1 variety.

In overall acceptability data highest scores of 6.66 and 6.68 were of samples formed by combining 10% Belay96 and 10% Kulumusa1 flaxseeds with kocho. The lowest values, 5.30, 5.11 and 5.31 were of samples having 5% each of Belay96, Jeldu and Kulumusa1 flaxseed varieties. The 15% proportion also obtained relatively high scores of 6.50, 6.15 and 6.54 for samples substituted with Belay96, Jeldu and Kulumusa1 flaxseed varieties. Generally, in sensory acceptability scores, the interaction of flaxseed variety and substitution level was highly dominated by the latter of the two factors. The majority of the scores remained above 5 point in a scale of 7-points showing that all the breads obtained by mixing with flaxseed of up to 15% were acceptable to the consumer.

Table 8. Effect of main factors of flaxseed (variety and blending ratio) on sensory acceptability of kocho bread

Factors	Color	Texture	Taste	Flavor	Sour taste	Overall acceptability
Flaxseed variety						
B	5.40±0.34[b]	5.93±0.61[a]	5.99±0.65[a]	5.56±0.41[b]	5.78±0.60[b]	6.15±0.6[b]
J	4.71±0.43[d]	5.66±0.58[c]	5.63±0.48[c]	5.18±0.33[c]	5.36±0.32[d]	5.79±0.48[c]
K	5.38±0.37[c]	5.89±0.55[b]	5.95±0.61[b]	5.63±0.43[a]	5.78±0.62[c]	6.18±0.61[a]
Con.	6.30±0.01[a]	4.28±0.07[d]	4.08±0.04[d]	4.06±0.04[d]	6.31±0.02[a]	4.52±0.01[d]
Blending ratio						
5%	5.58±0.32[b]	5.03±0.12[c]	5.06±0.06[c]	5.04±0.16[c]	6.01±0.13[b]	5.24±0.09[c]
10%	5.24±0.25[c]	6.05±0.10[b]	6.08±0.19[b]	5.97±0.26[a]	5.91±0.57[c]	6.48±0.26[a]
15%	4.66±0.39[d]	6.40±0.16[a]	6.43±0.23[a]	5.35±0.17[b]	5.00±0.11[d]	6.39±0.17[b]
Con.	6.30±0.01[a]	4.28±0.07[d]	4.08±0.04[d]	4.06±0.04[d]	6.31±0.02[a]	4.52±0.01[d]
CV	0.29	1.02	0.43	0.60	0.33	0.22
LSD	0.005	0.017	0.007	0.009	0.006	0.004

Values are Means± standard deviation with different letters after data within a column represents differences at $P \leq 0\ 05$ Factor= Effect of variety and blending, CV=coefficient of variance LSD=least significant difference. B, J, and K= Belay96, Jeldu and Kulumusa1 flaxseed variety respectively;05%,10%, and15%=flour flaxseed substitution levels Con. =control sample(100%kochobread).

Table 9. Interaction effects of flaxseed (variety and blending ratio) on sensory evaluation of kocho bread

Treatment	Color	Texture	Taste	Flavor	Sourness	Overall acceptability
B*05%	5.81 ± 0.01^{b}	5.11 ± 0.01^{f}	5.11 ± 0.01^{f}	5.13 ± 0.04^{g}	6.11 ± 0.01^{c}	5.30 ± 0.00^{h}
B*10%	5.41 ± 0.00^{d}	6.11 ± 0.01^{d}	6.21 ± 0.01^{c}	6.11 ± 0.01^{b}	6.30 ± 0.01^{b}	6.66 ± 0.01^{b}
B*15%	4.97 ± 0.01^{f}	6.57 ± 0.12^{a}	6.65 ± 0.01^{a}	5.44 ± 0.01^{e}	5.11 ± 0.01^{g}	6.50 ± 0.04^{d}
J*05%	5.12 ± 0.01^{e}	4.86 ± 0.01^{g}	4.97 ± 0.02^{g}	4.81 ± 0.02^{i}	5.81 ± 0.00^{e}	5.11 ± 0.00^{i}
J*10%	4.89 ± 0.02^{h}	5.91 ± 0.01^{e}	5.81 ± 0.00^{e}	5.61 ± 0.00^{c}	5.11 ± 0.01^{g}	6.11 ± 0.00^{f}
J*15%	4.11 ± 0.01^{i}	6.21 ± 0.04^{c}	6.11 ± 0.01^{d}	5.11 ± 0.05^{h}	5.15 ± 0.01^{f}	6.15 ± 0.01^{e}
K*05%	5.81 ± 0.00^{b}	5.13 ± 0.04^{f}	5.10 ± 0.01^{f}	5.16 ± 0.05^{f}	6.10 ± 0.01^{d}	5.31 ± 0.01^{g}
K*10%	5.43 ± 0.05^{c}	6.12 ± 0.00^{d}	6.21 ± 0.01^{c}	6.20 ± 0.01^{a}	5.11 ± 0.00^{g}	6.68 ± 0.01^{a}
K*15%	4.91 ± 0.01^{g}	6.42 ± 0.01^{b}	6.53 ± 0.01^{b}	5.52 ± 0.01^{d}	4.91 ± 0.01^{h}	6.54 ± 0.01^{c}
Con.	6.30 ± 0.01^{a}	4.28 ± 0.07^{h}	4.08 ± 0.04^{h}	4.06 ± 0.04^{j}	6.31 ± 0.02^{a}	4.52 ± 0.01^{j}
CV	0.33	0.87	0.29	0.49	0.29	0.23
LSD	0.01	0.03	0.01	0.01	0.01	0.01

Values are Means± standard deviation with different letters after data within a column represents differences at $P \leq 0.05$. CV=coefficient of variance LSD=least significant difference. Treatment = Interaction of varieties and Blending B, J, and K= Belay96, Jeldu and Kulumusa 1 flaxseed varieties, respectively; 05%, 10%, and15%=flour flaxseed substitution levels, respectively, Con.=control sample (100% kocho bread).

CONCLUSIONS

The study aimed at investigating the influence of flaxseed flour supplementation in kocho flour for kocho breads. The result clearly indicated that kocho breads with up to 15% flaxseed substitution will have improved nutritional composition, mineral contents and sensory acceptability. The use of flaxseed in bread production has significant benefits in region where inadequate quantity of enset is grown. Therefore, incorporation of flaxseed flour in bread production will reduce the deficiency of the nutrients and can improve the value of protein, fiber, fat, energy and the mineral contents of bread particularly the calcium, phosphorous, iron and zinc. It can also enrich the diet with L (ω-3 fatty acid). However, bread color and sourness will be affected negatively. These finding indicated that breads of better nutritional and sensory acceptability can be produced by adding flaxseed flour to kocho flour, showing new windows/ perspectives for further utilization of flaxseed flour. Finally, it is concluded that the results from this study are important in providing baseline information for better utilization of flaxseed in bread production and other products by substituting the kocho flour.

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Appendix I-Sensory Evaluation Sheet

Appendix Table 1. Sensory evaluation sheet of kocho-flaxseed blended breads.

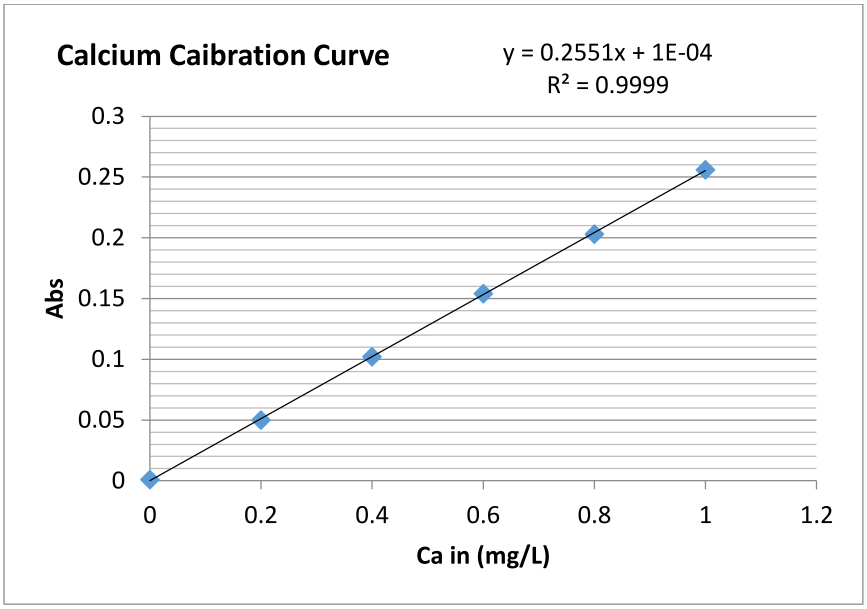
In this sensory evaluation of injera, you are given samples of injera for your evaluation. You are kindly requested to taste the samples and indicate your response by putting thick mark (√) in front of each attributes. Please write the sample code in the space provided and don't forget to rinse your mouth after taste. Gender ---------------- Age --------------- Sample code-----------Date_-- ------------------

Quality Attributes	Sensory perceptions						
	Like very much(7)	Like Moderately (6)	Like Slightly (5)	Neither like nor dislike (4)	Dislike slightly (3)	Dislike moderately (2)	Dislike very much (1)
Color							
Texture							
Taste							
Flavor							
Sour taste							
Overall acceptability							

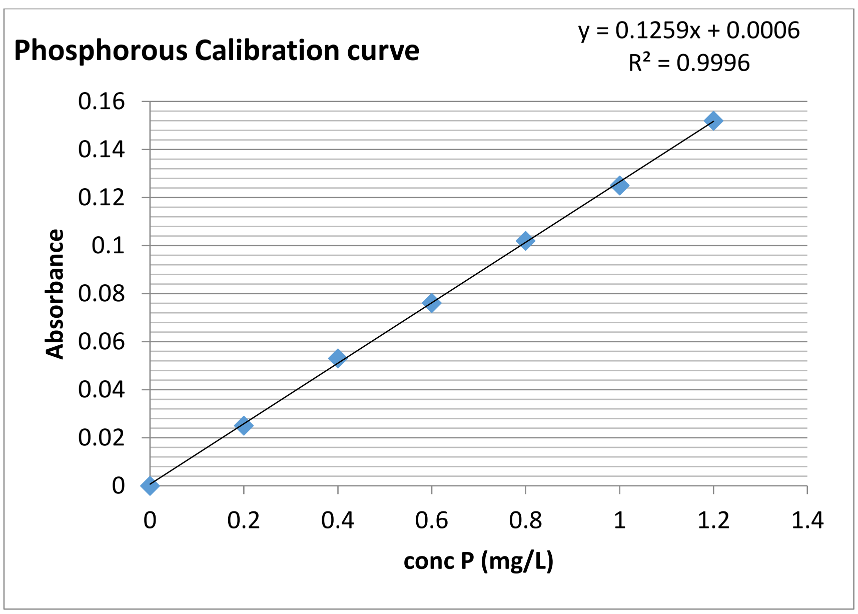
Additional comments--

Thank you very much for your cooperation

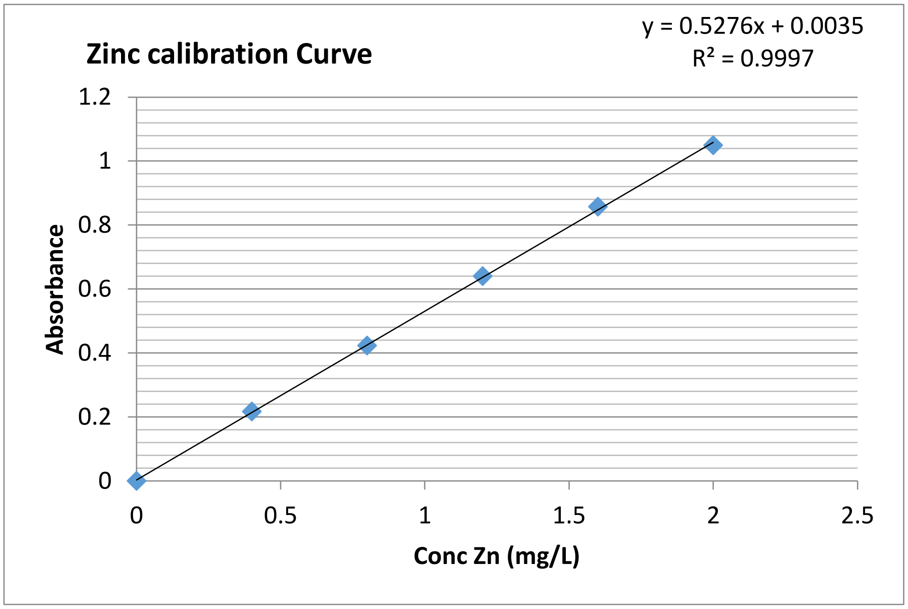
7.3. Appendix III- Figures



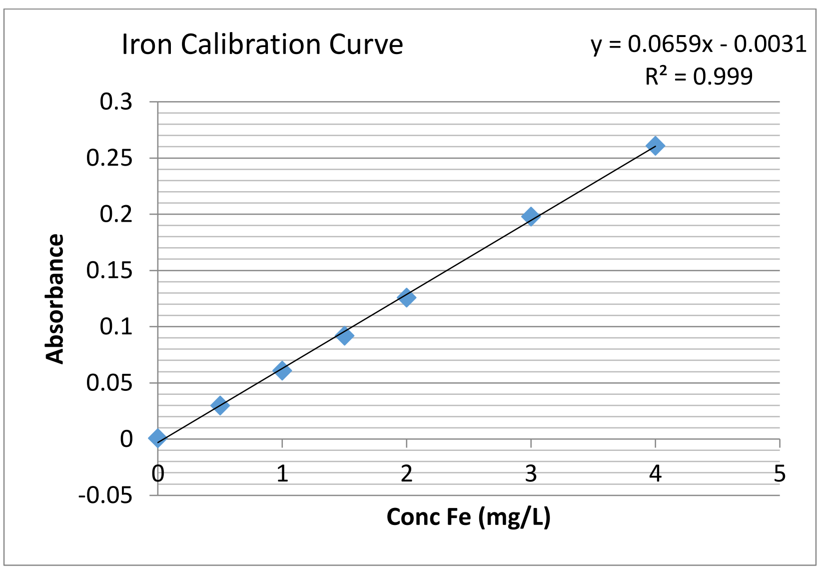
Appendix figure 1. Calibration curve for Calcium



Appendix figure 2. Calibration curve for phosphorous



Appendix figure 3. Calibration curve for zinc



Appendix figure 4. Calibration curve for iron