Research Journal of Food Science and Nutrition
Volume 6(2), pages 14-21, June 2021
Article Number: 34B0F5822
ISSN: 2536-7080
https://doi.org/10.31248/RJFSN2021.114
https://integrityresjournals.org/journal/RJFSN

Full Length Research

Evaluation of maize-based, vitamin A-enriched flat bread from blending ratio of orange fleshed sweet potato (*Ipomoea batatas*) flour at Arbaminch, Southern Ethiopia

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Received 8th May, 2021; Accepted 7th June, 2021

ABSTRACT: This study was conducted to evaluate maize-based; vitamin A enriched flat breads from orange fleshed sweet potato (OFSP). To enhance vitamin A content of maize based flour, five formulations of flat breads were prepared from blending ratio of 100%(S_1), 85:15% (S_2), 75:25%(S_3), 65:35% (S_4) and 55:45% (S_5) maize and OFSP flours, respectively. Designs of the study were Completely Randomized for nutritional composition and randomized complete block design for sensory acceptability with 5 treatments and three replications. Sensory acceptability and nutritional compositions of maize-based, vitamin A-enriched flat bread samples prepared from maize and OFSP were evaluated in triplicate. Sample (S_5) was most accepted in all sensorial acceptability except color at community level panelists compared with other flat bread samples. The nutritional composition of the flat bread samples showed an increase in the values of crude fiber, moisture, ash and carbohydrate content while the protein, fat and energy content of flat bread were increased as OFSP flours were increased in the formulation. The OFSP and maize flour blends flat bread samples and control sample were observed to have significantly different ($p<0.05$) in mean scores of vitamin A content. The vitamin A (µg RAE) content of the sample (S_1) was 0.00 µg RAE. The vitamin A content was highest (331.60 µg RAE) for the S_5 sample. OFSP flour up to 45% can possibly be incorporated in maize-based, flat bread to increase vitamin A content. The moisture content of maize based, vitamin A-enriched flat bread samples are gradual increased with the amount of OFSP flour in blend increased, therefore microbial quality and physical properties of samples will be needed for further research.

Keywords: Flat bread, nutritional composition, orange fleshed sweet potato, retinol activity equivalent, sensory acceptability, vitamin A-enriched.

INTRODUCTION

Vitamin A is an essential nutrient, which is generally provided by retinyl esters in meat and dairy products and pro-vitamin A carotenoids in plants (Bai et al., 2011). Vitamin A is a group of unsaturated organic compounds which is essential, as it cannot be produced by humans, and must be consumed as part of the diet. It includes retinol, retinal and retinoic acid (Tanumihardjo et al., 2016). Globally, vitamin A deficiency places 140 to 250 million people at risk for a number of health problems (Harjes et al., 2008). Vitamin A malnutrition leads to night blindness and increases the risk of child and maternal mortality (WHO, 2010) and also weakens the immune system of children, thus causing an increased risk of death from infectious disease (Tanumihardjo et al., 2016). Vitamin A deficiency (VAD) is a serious public health problem in Ethiopia (Demissie et al., 2010), and may be more serious in Southern Ethiopia.

Jenkins et al. (2015) emphasized that orange fleshed sweet potato is both fairly drought tolerant and easily cultivated, has a short maturing period (3–5 months), can grow under marginal conditions and has flexible planting and harvesting times. The roots contain significant amount of carbohydrate constituent mainly in the forms of starch, sugar and dietary fibers, which play an important role of providing low-cost energy in the diet of consumers. OFSP is known to have an excellent amount of β -carotene which is highly bioavailable and converted into vitamin A (retinol) in human body (Haskell et al., 2004; Jaarsveld et al., 2005). OFSP is a vital root crop to reduce vitamin A deficiency due to its high content of β-carotene.

Among the ways to incorporate OFSP to foods, OFSP flour appeared to be the most effective way of increasing the vitamin A content of OFSP enriched products (Hagenimana and Low, 2000). Most of the time, orange fleshed sweet potato is consumed at Arba Minch, South region of Ethiopia in boiled and cooked form. However, this very important root crop is perishable because of high moisture content, as result it has less shelf life and utilization (personal observation). Due to this reason, OFSP was used only one or two days for consumption purpose. The processing method of OFSP in order to change in to flour to extend shelf life, increase its utilization and have valuable role in food fortification in order to improve vitamin A content in food product had not been researched upon.

Flat bread is traditionally prepared with cereals which provide some energy, minerals and vitamins. They also contain minimal amounts of vitamin A and vitamin C and are not protein dense (Gibson et al., 2010). In order to prevent malnutrition such as vitamin A deficiency and its associated health problems in southern Ethiopia, flat bread formulation from maize and vitamin A-enriched orange-fleshed sweet potato is one of a solution. Therefore, this study was initiated to evaluate nutritional composition and sensory acceptability of maize-based vitamin A-enriched flat bread from blend of maize and OFSP flour.

MATERIALS AND METHODS

Description of the study area and sources of materials

This study was conducted at South Agricultural Research Institute, Arbaminch Agricultural Research Center, South region of Ethiopia, Gamo Zone, Geresie woreda of Fudale kebele farmer training center (FTC) which was far apart 70 km from Arba Minch, 265 km from Hawassa and 480 km from Addis Abeba, Ethiopia. Maize grain and orange fleshed sweet potatoes used for the study were obtained from Arba Minch Agricultural Research Center, Arba Minch, Ethiopia.

Experimental design

Completely randomized design (CRD) was used to analyze nutritional composition and randomized complete block design (RCBD) was used for sensorial acceptability of maize-OFSP flour blends flat bread samples with three replications.

Preparation of orange-fleshed sweet potato and maize flour

The orange-fleshed sweet potato flour was prepared according to the method of Adenuga (2010). During preparation, 10 kg of orange fleshed sweet potato tubers free from dirt and other extraneous materials were cleaned thoroughly with 3.5 liters of potable water and peeled manually with a kitchen knife. The peeled tubers were sliced into smaller sweet potato slices. The slices were placed into plastic materials and uniformly dried by using sun-light till four days. The dried slices were milled by hammer miller and sieved through 500 micron mesh sieve. The flour produced was packaged in an air tight plastic container, labeled and stored in a refrigerator until needed for further use.

Three kilograms (3 kg) of dry maize grain were winnowed to remove dust, dirt and foreign matter. They were soaked in water to soften the hulls, the hulls were removed, oven dried and milled into powder using a milling machine. The flour produced was packaged in an air tight plastic container, labeled and stored at room temperature in food science laboratory until needed for analyses.

Formulation of blending ratio for the preparation of flat bread samples

Maize and orange-fleshed sweet potato flours were mixed thoroughly in the ratios of 85:15, 75:25, 65:35 and 55:45%, respectively. The maize flour without any substitution with orange-fleshed sweet potato flour (100% maize flour) was used as control. The blended samples were separately packaged in airtight plastic containers, labeled and preserved in food science laboratory until needed for analyses.

Baking procedures of maize-based, OFSP blended flat bread samples

100 grams of ingredients of maize and OFSP flour with different proportion were placed and mixed together in five plastic dishes separately. Four plastic dishes for maize and orange fleshed sweet potato flour and one plastic dish with maize flour alone. The ingredients in each plastic dishes were mixed well until they became uniform in size and sieved four times by similar sieve opening of 1.00 mm. One gram of salt and one tea spoon of oil were added and mixed properly during flat bread preparation time. Luke water was added a little at a time while mixing and kneading the dough until it became very soften. Doughs were sheeted and baked in a hot oven with a constant time (10 minutes) and maximum temperature of 78°C. Each flat bread samples were removed from the oven and allowed to cool down before sensory evaluation and nutritional analyses were carried out. The flat bread samples were

evaluated for sensory acceptability by using 20 untrained panelists. Finally, flat bread samples were packed in polyethylene bags separately and were put in desiccator until nutrient composition was conducted.

Nutritional composition

The moisture, crude protein, fat, ash, and crude fiber contents of flat bread samples were determined in triplicate according to the standard analytical methods AOAC (1995) and AOAC (2005)

Moisture content

The moisture content of the samples was determined according to the standard analytical methods AOAC (1995) and AOAC (2005). Pre-washed, cleaned and dried crucible was weighed. About 2 g of sample were weighed, and added weighed sample into a pre-weighed cleaned crucible. The crucible was uncovered and placed in a well-ventilated oven crucible and maintained at 103±2°C. After 16 hours, the crucible was replaced and transferred to desiccator at room temperature to cool for 5 minutes, and quickly weighed the dried sample with crucible. The loss in weight represented percent moisture content as follows:

$$\text{Moisture content (\%)} = \frac{(\mathrm{W1} + \mathrm{W2}) - (\mathrm{W3} + \mathrm{W1})}{\mathrm{W2}} x\ 100$$

W1 = Weight of crucible, W2 = weight of sample before drying, and W3 = weight of sample after drying

Ash content

The ash content of the samples was determined according to the standard analytical methods AOAC (1995) and AOAC (2005). Crucible was washed and dried in an air-hot oven, cooled in a desiccator and weighed. About 2 g of dried sample were weighed into the empty porcelain crucible previously ignited over a hot plate in the fume cupboard to char organic matter. The crucible was placed in a muffle furnace maintained at a temperature of 600°C for 6 hours, transferred to a desiccator, cooled and reweighed immediately.

$$\text{Ash content (\%)} = \frac{W3 - \mathrm{W1}}{\mathrm{W2}} x\ 100$$

Where: W1 = Weight of crucible, W2 = Weight of sample, and W3 = Weight of crucible + Ash

Fat content

The fat content of the samples was determined according to the standard analytical methods AOAC (1995) and AOAC (2005). Soxhlet system HT2 method was followed. 2 g of sample was weighed, and loaded in thimble and plugged with cotton wool. The thimble was dried and inserted into the Soxhlet HT. Extraction beakers were dried and weighed and 25 ml of the solvent was added into each beaker. The beaker was inserted into the Soxhlet HT. The extraction beakers were dried and weighed with boiling chips. 25 ml of the solvent was added to the solvent in each beaker. The breaker was inserted into the Soxhlet HT and extracted for 15 minutes in boiling position and for 30 minutes in “rinsing position”. The solvent was evaporated; the breakers were released and dried at 100°C for 30 minutes. The beaker with fat was cooled in a desiccator and reweighed.

$$\text{\% Fat content} = \frac{W3 - \mathrm{W1}}{\mathrm{W2}} x\ 100$$

Where: W3 = weight of beaker + weight of fat, W2 = Weight of sample, and W1 = weight of beaker

Protein content

The protein content of the samples was determined using micro Kjeldahl method of AOAC (1995) and AOAC (2005).

Digestion: About 1 g of each sample was weighed into a 100 ml micro-Kjeldahl digestion flask. About 1 g of copper sulphate and 10 g sodium sulphate were added to the flask and thoroughly shaken and placed on the digestion rack in an inclined position. The sample in the flask was digested by heating in a flame chamber until frothing ceased. The temperature was increased, allowed to boil for about one hour until the color changed to bluish green. The clear digested sample was allowed to cool.

Distillation: Some distilled water was added to the digested sample with a wash bottle to 100 ml in a 100 ml volume metric flask. A 10 ml of the digest was pipette and transferred into a micro-Kjeldahl distillation flask followed by the addition of 60 ml of 60% sodium hydroxide (NaOH) solution. The flask was immediately fixed to the splash head of the distillation apparatus. A 4% boric acid was added into a 100 ml receiving conical flask, 2 drops of methyl red indicator was added, in such a way that the outlet of the adopter of the delivery tube was extended under the surface of the boric acid solution. The mixture was heated to liberate ammonia into the receiving conical flask containing 100 ml boric acid and the indicator until yellowish green color distillate was obtained.

Titration: The distillate was titrated with 0.1 N hydrochloric acid (HCl) until the end point of pink coloration was obtained. The percentage (%) protein was calculated as:

$$\text{\% Protein} = \frac{\mathrm{T\ x\ 0.0014\ x\ 6.25}}{\text{Weight of sample}} x\ 100$$

Where: 6.25 = protein conversion factor, 0.0014 = correction factor of the acid, and T = titre value of the sample.

Crude fiber content

The crude fiber content of the samples was determined by using the official method of AOAC (2000).

Digestion: Total sample (W_1) was placed in to a 600 ml beaker; 200 ml of 1.25% sulphuric acid was added and boiled gently for 30 minutes while watch glass was placed over the mouth of the beaker. The level of the sample solution was kept constant by using hot distilled water during boiling. After exactly 30 minutes heating, 20 ml of 20% KOH was added and boiled gently for further 30 minutes with occasional stirring.

Filtration: The bottom of a sintered glass crucible was covered with 10 mm sand layer and wet with distilled water. The solution was then poured in to a sintered glass crucible, and filtered with the aid of vacuum pump. The wall of the beaker was rinsed with hot distilled water several times. The washing was transferred in to the crucible and filtered.

Washing: The residue in the crucible was washed with hot distilled water and filtered twice. Again, the residue was washed with 1% H_2SO_4, filtered, and again washed with hot distilled water, filtered and finally washed with 1% KOH, and filtered. At this level also, the residue was washed with hot distilled water, filtered and again washed with 1% H_2SO_4, and filtered. Finally, the residue was washed with water - free acetone.

Drying and combustion: The crucible with the content was dried in a drying oven for 2 hours at 130°C, cooled for 30 minutes in a desiccator and then weighed (W_2). The crucible was then transferred into a muffle furnace, and heating was continued for 30 minutes at 550°C. The crucible was cooled in a desiccator and then the crucible was weighed with the content (W_3). The crude fiber was determined by the formula below:

$$\text{Crude fiber (\%)} = \frac{W2 - \mathrm{W3}}{\mathrm{W1}} x\ 100$$

Where: W_1 = weight of the fresh sample, W_2 = weight of crucible with the sample after oven drying and W_3 = weight of the crucible with the sample after ash.

Carbohydrate content

The carbohydrate content of flat bread samples was determined by difference method that is by subtracting the sum of the percentages of moisture, crude protein, crude fat and ash content from 100 (Mathew and Saleh, 2006).

$$\text{Carbohydrate \%} = 100 - (\text{Protein} + \text{Fat} + \text{Ash} + \text{Moisture content})$$

Determination of gross energy

The energy content was calculated by multiplying percentages of crude fat, crude protein, and carbohydrate by factors of 9 kcal/g, 4 kcal/g and 4 kcal/g, respectively (Shrestha and Noomhorm, 2002), and expressed in calories.

Gross Energy (kcal/g) = (9 x Fat) + (4 x Protein) + (4 x Carbohydrate)

Vitamin A content (β-carotene)

The β-carotene content in food was analyzed using open column chromatography for the extraction and UV visible spectrophotometer for reading the absorbance (de Carvalho et al., 2012). The pigment was extracted by using petroleum and the absorbance was read at a wave length of 440 nm. The *trans* β-carotene values were used to calculate VA contributed to the diet, expressed as retinol equivalents (RE), which was used by FAO/WHO (2002). According FAO/WHO (2002), conversion factor of 6 µg *Trans* β-carotene per 1 µg RE (1µg β-carotene = 0.167µg RE) was used.

Sensory acceptability

Flat bread samples were prepared from both the control (maize flour alone) and various proportion of OFSP-Maize blend. The flat bread samples were evaluated for attributes of color, taste, flavor, appearance and overall acceptability using twenty (20) community level untrained panelists. Prior to the sensory evaluation, the flat bread samples were individually coded and served to the panelists in plastic dishes. Clean water was provided to the judges to rinse the mouth in-between testing of the flat bread samples to avoid residual effect. The judges were instructed to evaluate and score the samples based on the degree of likeness and acceptance of the flat bread using a five-point hedonic scale with 1,2,3,4 and 5 representing very dislike, dislike, neither dislike nor like, like and very-like, respectively.

Data analysis

Nutritional composition and sensory acceptability data were subjected to analysis of variances (ANOVA) and analyzed using SAS software version 9.2 (SAS Inc., Gary, NC). Least significance difference (LSD) between means were attained at ($p<0.05$) by using Fischer's LSD method. The results were expressed as mean separation.

Table 1. Nutritional profile of maize-based, vitamin A-enriched flat bread prepared from blending ratio of OFSP flour.

Samples	Nutritional Compositions						
	Moisture	Ash	Fiber	Fat	Protein	Carbohydrate	Energy
S_1	8.20^a	1.21^d	1.98^d	2.28^a	9.07^a	79.24^c	373.77^a
S_2	8.45^a	1.66^c	2.23^c	2.20^b	8.53^b	79.15^c	370.56^b
S_3	8.51^a	1.67^c	2.38^b	2.02^c	7.59^c	80.18^b	369.29^c
S_4	8.62^a	1.77^b	2.39^b	1.92^d	6.74^d	80.95^b	368.05^d
S_5	8.72^a	1.87^a	2.56^a	1.59^e	5.79^e	82.03^a	365.59^e
LSD(0.05)	1.35	0.05	0.094	0.06	0.14	0.925	1.225
CV (%)	1.48	1.68	2.24	1.67	1.68	0.86	0.71

Where: LSD = Least significant Difference; CV= Coefficient of Variation; S_1 = 100% Maize (Control Sample); S_2 = 85% Maize: 15% OFSP; S_3= 75% Maize: 25% OFSP; S_4 = 65% Maize: 35% OFSP; S_5 = 55% Maize: 45% OFSP.

RESULTS AND DISCUSSION

Nutritional composition of maize-based, vitamin A-enriched flat bread

Nutrient composition of maize- based, vitamin A- enriched flat bread samples are shown in Table 1. The protein, fat and energy content decreased as blending level of OFSP flour increased while moisture, ash, fiber and carbohydrate content increased as proportion of OFSP flour increased in the formulation.

The moisture content of the flat bread samples ranged from 8.20 to 8.72%. The moisture content of flat bread sample showed no significant difference ($p<0.05$) among samples with increased substitution of orange fleshed sweet potato flour in the blend. High moisture content in food has been shown to encourage microbial growth (Asma et al., 2006). The values obtained in this study were lower than the moisture content values (10.03-12.59%) of complementary food formulated from fermented maize, soybean and carrot flours reported by Barber et al. (2017).

The protein content of flat bread samples ranged from 5.79 to 9.07%. The protein content of flat sample prepared from blending of maize and orange fleshed sweet potato shown significantly different ($p<0.05$) among samples. The control sample S_1 prepared only from maize flour had the highest protein content (9.07%). The protein content of samples decreased as OFSP flour substitution increased. This could be attributed to the less amount of protein content in orange fleshed sweet potato flour in the blending. The current study was consistent with reports of Aniedu and Agugo (2010).

The crude fat content of the flat bread samples ranged from 1.59 to 2.28%). The fat content of the samples showed significantly different ($p<0.05$) among samples with increase in orange fleshed sweet potato flour substitution. Crude fat content was found to be significantly highest ($p<0.05$) for the control flat bread sample than other samples in which OFSP flour was incorporated. The fat content of flat bread samples were decreased sequentially with increased substitution of OFSP flour in the formulations. Substituting higher levels of OFSP flour in the formulation reduced the fat content. This was probably due to the lower fat content in OFSP flour than maize flour. The results of the present study slightly agreed with the findings of Aniedu and Agugo (2010) and Ifie (2011).

The crude fiber content of flat bread samples ranged from 1.98 to 2.56%. The fiber content of the samples prepared from blending of maize and orange fleshed sweet potato had a significant difference ($p<0.05$) but the fiber content of S_3 and S_4 had no significant difference ($p<0.05$) even with increase in orange fleshed sweet potato flour substitution. The highest fiber content of sample S_5 (2.56%) could be the result of high amount of orange fleshed sweet potato flour in blend while least fiber content of sample S_1(1.98%) was due to absence of orange fleshed sweet potato in formulation. Unlike the findings, Omwamba et al. (2007) reported a decrease in the amount of crude fiber and ash with an increase in the OFSP flour proportions. In this study, the fiber content of flat bread samples was observed to increase with the increase in OFSP flour proportions. The increase of crude fiber content of developed flat bread samples with increase in the proportion of OFSP flour recorded for this study could be attributed to the high crude fiber content of the OFSP flour used in the formulation. The range of fiber content (1.98 - 2.56%) of the samples were slightly related with the range fiber content (0.36 -2.5%) of the developed complementary foods reported for infant cereal-based food (Lutter and Dewey, 2003).

The ash content of flat bread samples ranged from 1.21 to 1.87%). The ash content of the samples increased significantly with the amount orange-fleshed sweet potato flours in the blends increased. Control sample S_1 was least with mean score of 1.21%, probably because of low ash content of maize flour that is a result of less mineral content of maize while sample S_5 was highest mean score of ash (1.87%). The ash content of a food material is an indication of the amount of minerals in the food product. Incorporation of OFSP flour in the process of flat bread making could enhance mineral intake (Olaoye et al., 2007).

The ranges for carbohydrate content of flat bread

Table 2. Mean value of vitamin A (µg RAE per 100gm).

Samples	β – carotene(µg)	Vitamin A (µg RAE/100g)
S_1	0.00^{e}	0.00^{e}
S_2	865.49^{d}	144.54^{d}
S_3	1054.75^{c}	176.14^{c}
S_4	1619.35^{b}	270.43^{b}
S_5	1985.64^{a}	331.60^{a}
LSD (0.05)	4.79	0.37
CV (%)	0.1	0.1

samples were 79.24 to 82.03%. The carbohydrate content of the samples increased gradually with increase in substitution of orange fleshed sweet potato flours. The highest carbohydrate content of sample S_5 (82.03%) could be due to high carbohydrate of orange fleshed sweet potato. Sweet potato provides higher energy compared to other root vegetables (Amagloh et al., 2013). However, the carbohydrate content (79.24 - 82.03%) of flat bread samples developed in this study was greater than the carbohydrate content (67.59-78.02%) of complementary food prepared from sorghum, African yam bean and mango monocarp flour blends reported by Yusufu et al. (2013). The relatively high carbohydrate content of the formulated flat bread is an indication that the products will provide the infants and children with adequate amount of energy required for optimum growth and development.

The ranges for gross energy of flat bread samples were 365.59 to 373.77 Kcal. The gross energy samples had shown significant difference ($p<0.05$) in mean scores. The significant ($p<0.05$) differences observed in the energy levels of flat bread samples could be attributed to variations in protein, fat and carbohydrate content of maize and OFSP in formulation. The gross energy content of the flat bread samples also decreased gradually with increased substitution of orange fleshed sweet potato flours in the samples. The control sample S_1 has the highest mean score of energy content (373.77) while sample S_5 has the least mean score of energy content (365.59); this could be because of variation in the protein, carbohydrate and fat content as OFSP flour increased in the blending ratio based of information of table 1.

Vitamin A content of maize based, vitamin A enriched flat bread samples

The ranges for vitamin A content of flat bread samples were 0.00-331.60 µg RAE (Table 2). The value of the vitamin A content of the control sample (S_1) was recorded to be zero (0.00 µg RAE) which was very least, this was due to absence of vitamin A content of maize flour. The value of vitamin A content of the sample S_5 was measured to be 331.60 µg RAE/100g, that was the highest among all flat bread samples; this was as a result of high amount of beta carotene in OFSP. The OFSP flour blended flat bread samples (S_2, S_3, S_4 and S_5) and control sample S_1 were observed to have significantly different ($p<0.05$) in mean scores of vitamin A content. The OFSP flour blending can improve β-carotene and contributed significant amount of vitamin A in samples; even if it had passed through many processing operations such as drying, storage and baking. This finding was consistent with the work of Greene and Bowell-Benjamin (2004).

Sensory acceptability score of maize based, vitamin A enriched flat bread by community level panelists

The results of sensorial acceptability are shown in Table 3. There is a significant difference in color of certain flat bread samples. The ranges for color of flat bread samples were 3.27 to 4.60. The mean score of flat bread sample S_1 and flat bread sample S_2 did not show significant difference ($p<0.05$) and also flat bread samples S_4 and S_5 had no significantly different ($p<0.05$). However, flat bread sample S_3 shown statistical significant difference ($p<0.05$). Control sample S_1 had highest mean score (4.60), this was because all panelists were familiar with white color of flat bread sample while sample S_5 had least mean score (3.27) because the orange color of flat bread sample due to the OFSP.

The ranges for flavor score of flat bread samples were 3.80 to 4.85. Flat bread sample S_5 had the highest mean score (4.85) in flavor than other samples while the control sample S_1 had the least mean score (3.80) in favor probably because OFSP had attractive flavor than maize flour. The flavor of the sample S_5 had showed significant difference in mean score compare to other samples (S_1, S_2, S_3 and S_4). The flavor of samples S_2, S_3 and S_4 were not significantly different in mean score, but were significantly difference ($p<0.05$) with the flavor of samples S_1 and S_5. Generally, the flavor of maize based, flat bread samples increased with increase in the amount of OFSP flour in blend, probably due to the attractive flavor of the OFSP.

The ranges for texture mean score of flat bread samples were 4.42 to 4.61. Flat bread control sample S_1 had highest mean score (4.61) than OFSP blended samples (S_2, S_3, S_4 and S_5). Samples (S_2, S_3, S_4 and S_5) showed no significant difference, but control sample (S_1) showed

Table 3. Sensorial acceptability of OFSP flour blended maize-based flat bread samples.

Samples	Sensorial acceptability's					
	Color	Flavor	Texture	Taste	Appearance	Overall acceptability
S_1	4.6±0.50[a]	3.80±0.77[c]	4.61±0.32[a]	4.13±0.50[c]	4.0±0.0[b]	3.93±0.46[c]
S_2	4.27±0.46[a]	4.07±0.26[bc]	4.44±0.63[b]	4.20±0.40[b]	4.20±0.40[b]	4.0±0.38[bc]
S_3	3.80±0.68[b]	4.13±0.50[bc]	4.43±0.24[b]	4.47±0.50[a]	4.20±0.40[b]	4.07±0.26[bc]
S_4	3.40+0.50c	4.47±0.46[b]	4.43±0.24[b]	4.67±0.26a	4.20±0.40[b]	4.27±0.46[b]
S_5	3.27±0.46[c]	4.85±0.41[a]	4.42±0.15[b]	4.80±0.41[a]	4.80±0.41[a]	4.93±0.26[a]
LSD (0.05)	0.38	0.37	0.14	0.32	0.27	0.27
CV (%)	13.64	12.17	7.89	10.02	8.65	8.79

Where: LSD = Least significant Difference; CV= Coefficient of Variation; S_1 = 100% Maize (Control Sample); S_2 = 85% Maize: 15% OFSP; S_3= 75% Maize: 25% OFSP; S_4 = 65% Maize: 35% OFSP; S_5 = 55% Maize: 45% OFSP.

statistical difference ($p<0.05$) in mean score. The texture of sample S_1 had highest mean score (4.61) while sample S_5 had least mean score of taste (4.42) compared with other samples.

The ranges for taste mean score of flat bread samples were 4.13 to 4.80. The taste of sample S_5 had highest mean score (4.80) among other samples while control sample S_1 had least mean score of taste (4.13). The taste of flat bread samples S_3, S_4 and S_5 were not signicantly different ($p<0.05$) in mean scores, but had a significant difference ($p<0.05$) with samples S_1 and S_2. In general, the taste of maize based, flat bread samples prepared from blending ratio of OFSP increased with increase in the amount of OFSP flour in the blend, probably due to the sweet taste of OFSP.

The appearance of flat bread samples had no significant difference ($p<0.05$) in mean score among all samples except sample S_5. The ranges for appearance of flat bread sample were 4.0 to 4.80. The appearance of flat bread sample S_5 had highest mean score compared with other samples while that of control sample S_1 had least mean score among other samples. Appearance of maize-based, vitamin A-enriched flat bread samples increased with increase in the amount of OFSP flour in blends.

The ranges for over-all acceptability of maize-based, vitamin A-enriched flat bread samples were 3.93 to 4.93. The overall acceptability of flat bread sample S_5 had the highest mean score than other OFSP blended samples and control sample (S_1) while control sample S_1 had the least mean score. In general, over-all acceptability of maize based vitamin A-enriched flat bread samples were increased as the amount of OFSP flour in blending ratio increased.

Conclusions and Recommendations

Maize based, vitamin A enriched flat bread sample S_5 (blended with 45% OFSP and 55% maize flour) contributed vitamin A (331.60 µg RAE) with better sensory acceptability except color as compared to flat bread samples S_1, S_2, S_3 and S_4 which is important for children to decrease vitamin A deficiency.

In general, nutritional composition (protein, fat and energy) of maize-based, vitamin A- enriched flat bread samples are decreased while moisture, ash, fiber, carbohydrate and βcarotene or vitamin A content of flat bread samples were increased with the amount OFSP flour increased in formulation.

The use of maize-OFSP flour blend in flat bread preparation appeared to be promising for vitamin A content and certain nutritional components, moreover, with better sensorial acceptability as compared to the local flat bread prepared 100% maize flour.

The protein content of maize based, vitamin A-enriched flat bread samples were decreased as the amount of OFSP flour in formulation increased, so fortification of legume as protein source will be needed for further study. The moisture content of maize based, vitamin A-enriched flat bread samples are gradual increased with the amount of OFSP flour in blend increased, therefore microbial quality, shelf life and physical properties of samples will need further investigation.

ACKNOWLEDGEMENT

We would like to thank South Agricultural Research Institute, Arba Minch Agricultural Research Center for financial support, guidance and facilitating of all necessary materials during the study period. Our heartfelt thanks also go to Arba Minch University and Ethiopia Public Health Institute for permitting us to carry out analysis of samples in their laboratory.

COMPETING INTEREST

The authors declare no competing of interest on this research work that could bias the collection, analysis and publishing of this paper.

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