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# Evaluation of Nutritional, Microbial and Sensory Properties of Complementary Food Developed from Kocho, Orange-Fleshed Sweet Potato (*Ipomoea batatas* L.) and Haricot Bean (*Phaseolus vulgaris*) for under Five Years Children in Boricha Woreda, South Ethiopia

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**Abstract**

In sub-Saharan African specifically in Ethiopia malnutrition is a great challenge. Protein-energy malnutrition, in children associated with poor nutritional knowledge resulting in early weaning, delayed the introduction of complementary foods, low protein diet and sever or frequent infection. In Ethiopia the intake of vitamin A is inadequate; especially provision of the vitamin through dietary improvement, food fortification, and supplementation is less. The consumption of vitamin A-rich fruits and vegetables and foods made from roots and tubers about 24%-25%. Boricha Woreda was selected because of its potential for growing kocho, haricot beans, Orange-Fleshed Sweet Potato (OFSP) and the exposure to food insecurity with a high number of malnourished children. The purpose of this study was to assess nutritional, microbial and sensory properties of complementary food developed from kocho, orange-fleshed sweet potato and haricot beans for less than five years children. Porridge was developed with different proportion of kocho to haricot bean flour: 90:10, 80:20, 70:30 and 100:0 (control) and constant amount of OFSP (15%). The proximate composition analyses of porridge were done by AOAC. The beta carotene/Vitamin A was determined by using High-Performance Liquid Chromatography (HPLC). The total mold and yeast counts and total plate count for the safety were carried out by using the standard procedure for examining of microbial load on the food products. Sensory acceptability of the porridge was evaluated with 30 panelists comprising of mother-children in pair using 5 points hedonic scale. The result of the study showed that the proximate composition (moisture content, crude protein, crude fat, and total ash) fulfills the minimum Recommended Daily Allowance (RDA) for children aged between 6-23 months. OFSP incorporated porridge was rich in Vitamin A content and fulfills 65.14% daily RSI (RDA) of vitamin A. The microbial analyses of the developed porridge were within the microbiologically accepted limit. All porridges were accepted and liked by the consumers. Thus, based on the finding of this study it was suggested that mothers/caregivers should feed their children haricot bean and OFSP incorporated porridge.

**Keywords**: Children; Protein-energy malnutrition; Vitamin A deficiency; Complementary food; Sensory quality; Chemical composition; Microbial load

## Introduction

### Background

High malnutrition rates in Ethiopia pose a significant burden in economic and social development [1]. Major contributing factors to malnutrition among infants and children are poverty and low purchasing power of the family [2]. Food-based strategies represent the key to addressing hunger and malnutrition, and the desired characteristics of foods include high nutrient density, low bulk property as well as utilization of low cost and locally-available crops. This will ensure early adoption at home and at the village level [3]. Despite children's high requirements for nutrients, their diets in developing countries are mostly comprised of cereals or starchy root crops, which when eaten exclusively, resulting in deficiencies of key nutrients such as proteins, iron, zinc, calcium, riboflavin, vitamin A, and vitamin C [4]. Although Ethiopia has a fairly large livestock population, availability of meat and milk for local human consumption is limited, especially in rural areas where wealth index values are in the lower quintiles according to the most recent Demographic and Health Survey.

Pulses (haricot bean) have several important attributes including high nutritional value, long storage times and relatively low cost in comparison to animal products. Haricot bean (*Phaseolus vulgaris*) makes an important contribution in protein, energy and micronutrient provision to populations in the developing world [5]. It is extremely diverse crops in terms of cultivation methods, uses, and the range of environments to which it has been adopted. It provides dietary protein that plays an essential role in human nutrition, especially in combination with low protein foods [6]. The low protein content of onset limits its product (kocho) as food products and the consumer faces the protein-energy malnutrition [7]. Orange-Fleshed Sweet Potato (*Ipomoea batatas L.*) as a staple food has an advantage over most vegetables in that it can supply significant amounts of vitamin A and energy simultaneously, thus helps to address both Vitamin-A deficiency and also undernutrition [8].

Complementary foods can be prepared by mixing kocho with locally available pulse products to produce foods with adequate energy and protein levels and orange-fleshed sweet potato for vitamin A. Applications of food processing techniques like germination and fermentation both minimizes anti-nutritional factors and enhances nutrient intake and palatability [9]. In order to overcome these

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nutritional problems, consideration of locally available, affordable and relevant sources of food is important. The recommendations from FAO/WHO/UNU have been made to add a maximum of 40% legumes/protein rich foods to cereal-based complementary food for young children [10]. However, the feasibility and acceptability of this recommendation deserve testing in Ethiopia, where beans are locally grown and relatively inexpensive (compared to meat). For example, only 20% of young children eat complementary foods prepared from legumes, with most consuming kocho-based foods but little or without animal foods [11]. Thus, the purpose of this study was used to develop and test acceptability, safety and nutrient content of kocho-based complementary food blended with haricot beans and Orange-Fleshed Sweet Potato which are widely available but not well-consumed for under five years children, especially in the study area.

## Objective

### General objective

The general objective of the study is to assess nutritional, microbial and sensory properties of complementary food developed from kocho, Orange-Fleshed Sweet Potato and haricot beans for children's of under five years.

### Specific objectives

1. To prepare complementary food from kocho, haricot bean and OFSP flour with a different blending ratio
2. To assess microbial load and safety of developed complementary foods at storage
3. To determine the proximate composition of developed complementary food
4. To determine vitamin A content of developed complementary food
5. To assess the sensory acceptability of developed complementary foods by the mother and their children

## Materials and Methods

### Description of the study area

The study was conducted in Boricha Woreda; Sidama Zone, South Nations, Nationalities and Peoples Regional State, is located at 311 km South of Addis Ababa. Boricha has an estimated area of 588.05 sq km. Administratively the Woreda comprises 39 Kebeles of which 3 Kebeles are semi-urban and the others are rural. Based on the information from Boricha woreda finance and economy office the Woreda has estimated total populations of 301,312 of these 151,008 are men and 150,304 are women and 95.6 percent of the populations were estimated to be rural inhabitants [12]. The major source of income in the Woreda is crop production, livestock rearing, petty trade, labor, and carpentry. The major crops grown in the area were maize, enset, sorghum, haricot beans, yams, taro and sweet potatoes and fruits (including avocado and pineapple).

### Sample collection and preparation

Kocho, Orange-Fleshed Sweet Potato, and haricot beans were collected from Boricha woreda. Samples were taken randomly from the upper, middle and lower side of sacks/jute. Sample preparation was done in Hawassa University, School of Nutrition, Food Science and Technology Laboratory. All raw materials obtained from Boricha woreda and ingredients obtained from the local market brought in 50 kg lots. Kocho was squeezed, sun-dried, crumbled and passed through a household sieve to reduce fiber. Haricot beans were washed and soaked in clean tap water for 12 hours. After draining, the haricot beans were germinated at room temperature for 24 hours, rinsed, dried in the sun and roasted using an oven to further reduce anti-nutritive factors and improve the flavor of the final product. Processing was done as of Ghavidel and Prakash [13] by slight modification. The roasted haricot beans were milled into flour. Orange-Fleshed Sweet Potato was prepared by selecting healthy one, washing in clean water, peeling, slicing, soaking in a salt solution (1% NaCl/30 minute, drying in the solar dryer, milling to flour, and sieved [14].

### Formulation and development of complementary food

Different kocho, Orange-Fleshed Sweet Potato and haricot bean flours were blended in the ratios shown in Table 1 below to investigate their effects on the proximate, microbial and sensory quality of porridge. Then the complementary porridge was prepared by using 100 g of the mixtures and added to 300 ml of boiling water and cooked for 15 minutes.

### Proximate composition determination

The proximate composition (moisture content, crude protein, crude fat, crude fiber, and total ash) analyses of porridge were done in duplicates by using the methods described by AOAC [15]. Besides, carbohydrate content, calorie value, and beta carotene were determined by the methods developed by Mathew [16], FAO/WHO [17], and Rodriguez [18], respectively.

### Microbial analysis

The total mold, yeast, and bacteria count were carried out on the porridge samples using the procedures developed by Olaoye et al. [19] with slight modification.

### Sensory evaluation of porridge

Sensory quality in terms of color, taste appearance, flavor, texture and overall acceptability of the porridge samples were evaluated in triplicate by 30 consumer based panelists using 5 points hedonic scale according to Olaoye et al. [19] with slight modification.

### Data management and analysis

Completely Randomized design (CRD) was used to investigate the effect of the different blending ratios on the nutritional composition and microbial load but Randomized Complete Block Design (RCBD) was used for sensory analysis. Data analysis was carried out using one-way analysis of variance (ANOVA) taking blending ratio as independent variables and the parameters (proximate, vitamin A, sensory and microbial) as dependent variables. When ANOVA produces a significant difference at $p<0.05$, the means of each parameter was compared using the Fischer's least significant differences (LSD) procedures. The analysis was carried out by using the Statistical Analysis System (SAS for Windows; SAS 9. 1 software version, Institute, Inc. Cary, NC, USA).

| Blend proportion | Koch flour (%) | Haricot bean flour (%) | OFSP flour (% ) |
|---|---|---|---|
| C | 100 (control) | 0 | 0 |
| T1 | 90 | 10 | 15 |
| T2 | 80 | 20 | 15 |
| T3 | 70 | 30 | 15 |

**Table 1:** Blending Ratio of Kocho, Haricot Bean and OFSP.

## Results and Discussion

### Effects of blending proportion on proximate composition of developed porridge

As shown in Table 2, there was a significant (p<0.05) difference in the proximate composition of developed porridge. With an increase in the haricot bean flour proportion from 10%-30% in the porridge, there was a decrease in the moisture content, crude fiber, and total carbohydrate, whereas the amount of crude fat, crude protein, total ash increased. Gross energy of the product was irregularly increased with increasing the proportion of haricot bean in the formulation.

The moisture contents of porridge obtained in this study were 5.73 to 7.84, which is in agreement with the values obtained from [20] that are within the range of 5.76-7.84. It was also in agreement with the maximum limit specification of the moisture content of porridge determined by the World Health Organization is 10%. Thus, the shelf life of the composite flour might be prolonged due to less moisture content and water activity, which diminishes the product's susceptibility to microbial spoilage.

The haricot bean content in the product positively affected the crude fat content, i.e., fat value increased. This could be due to the high amount of fat in haricot bean flour. Lalude and Fashakin [21] reported that the fat content of weaning food from sorghum and oil-seeds is 9.87% but this value is higher than the current finding but legumes have higher fat content compared kocho.

To increase the quality of protein in complementary foods, mixing kocho and haricot bean is important in developing countries. Protein content (2.85%) of the control sample was significantly lower than the treated samples protein content: T1 (7.24%), T2 (9.56%), and T3 (11.99%). This might be due to the amount of protein content in the haricot bean, which satisfies the standard made to cereal-based porridges by MOH [22]. The finding of this study was above the minimum (6.3%) suggested by Reeds and Garlick [23] and between the range of 11%-13% reported by Walker [24]. The required amount of protein intake, 20 g/day RDA for children aged between 6-23 months, depending on the amount of breast milk consumed but it is difficult to obtain this amount per day. In our study, the amount of protein that contains 30% soybean blended porridge fulfill (59.95%) of the RDA for children aged between 6-23 months. Incorporating 30% haricot bean flour to kocho increased the amount of protein content in porridge the diet of children, which partially fulfills the recommended dietary allowance for daily intake of protein for children.

The higher value of ash content was recorded for T3 (3.88 g/100 g) in a porridge formulated from 30% haricot bean and 70% kocho. This implies that the haricot bean total ash content is higher than that of a control sample of kocho (1.99 g/100 g). This might be due to the result of the total ash level found in haricot bean, this is the indicator of the minerals in food products.

The added amount of haricot bean during formulation of porridge negatively affects the amount of crude fiber in the porridges, i.e., increase in haricot bean proportion decreased the fiber content of the product. This might due to the presence of higher fiber content in kocho but the whole samples were at food grade level for crude fiber content. This is in agreement with the standard for the complimentary food, which does not exceed 5 g/100 g dry matter [25].

The carbohydrate was found to be within the range of 66.38%-71.74% for the 10%-30% haricot been incorporated porridge and 78.89% for the control. When the amount of haricot bean increases, the amount of carbohydrate decreases in the kocho-haricot bean porridge; this might be due to the presence of high carbohydrate content in kocho flour. Children better to consume complementary foods of semisolid consistency with adequate energy and nutrient densities to supplement breast milk. Breast milk alone is no longer sufficient to meet the nutritional requirement of the children from 6 months onward [26]. The calculated energy values of the porridges of the present study range from (398 kcal/100 g to 412 kcal/100 g), which was found to be above the minimum recommended level. This could be due to the higher energy value found in kocho. The minimum desirable level of energy that complementary foods should provide was suggested to be 370 kcal/100 g [24].

### Effects of blending proportion on vitamin A contribution for RDA of children

Many new products development trials focus on improving the protein and energy density of baby foods. However, new product development has to get attention to Vitamin A Deficiency alleviating foods for children. Vitamin A deficiency in children is around 37.7% [27] which also shows that the area requires serious attention on new food product development. OFSP is an easy crop to cultivate in farmer's field, nutritional, drought resistant, high yield and shorter harvesting period. Hence children, which are the most vulnerable group of the rural communities to vitamin A deficiency, primarily benefited from OFSP flour-based product such as porridge. Incorporation of OFSP (15%) improved the vitamin A content (260.58 μg/100 g) of porridge compared to that of the control (0% Vitamin A content). According to FAO/WHO [17] recommendation RDA of Vitamin A (recommended safe intake (RSI) for children's are 400-450 μg/day. So if children eat around 15% OFSP incorporated porridge daily, they can get 65.14% daily RSI (RDA) of vitamin A. Therefore, growing OFSP as a home garden crop is a practical food-based approach to alleviate vitamin A deficiency in the community, which is easily acceptable by children because of its sweet taste; as a result this helps to alleviate vitamin A deficiency.

### Effects of blending proportion on microbial load of porridge

The microbial load (total plate, mold and yeast count) on the porridge indicated in terms of log cfu/g presented in Table 3. There were no statistically significant differences in microbial load on entire samples made of kocho and haricot bean at different proportions with a constant proportion of OFSP. However, total plate count ranges from

| Kocho: Haricot bean | Moisture | Crude fat (%) | Crude protein (%) | Ash (%) | Crude fiber (%) | Total Carbohydrate | Energy (Kcal/100 g) |
|---|---|---|---|---|---|---|---|
| C (100:00) | 7.84 ± 0.01$^{a}$ | 8.43 ± 0.01$^{d}$ | 2.85 ± 0.01$^{d}$ | 1.99 ± 0.00$^{d}$ | 4.76 ± 0.01$^{a}$ | 78.89 ± 0.00$^{a}$ | 402.83 ± 0.01$^{c}$ |
| T1 (90:10) | 6.92 ± 0.01$^{b}$ | 9.12 ± 0.00$^{c}$ | 7.24 ± 0.00$^{c}$ | 2.98 ± 0.01$^{c}$ | 3.04 ± 0.01$^{b}$ | 71.74 ± 0.00$^{b}$ | 398 ± 0.01$^{d}$ |
| T2 (80:20) | 6.33 ± 0.01$^{c}$ | 11.64 ± 0.15$^{b}$ | 9.56 ± 0.01$^{b}$ | 3.46 ± 0.05$^{b}$ | 2.56 ± 0.01$^{c}$ | 69.01 ± 0.00$^{c}$ | 419.04 ± 0.02$^{b}$ |
| T3 (70:30) | 5.73 ± 0.01$^{d}$ | 12.02 ± 0.07$^{a}$ | 11.99 ± 0.01$^{a}$ | 3.88 ± 0.02$^{a}$ | 2.98 ± 0.00$^{d}$ | 66.38 ± 0.00$^{d}$ | 412.56 ± 0.02$^{a}$ |

Values are means ± standard deviation. Means with different letters across the column are significantly different at 95% Confidence Interval (P<0.05). All values are average of duplicates

**Table 2:** Effects of blending proportion on proximate composition of developed porridge.

| Kocho: Haricot Bean | Total plate count | Mold and Yeast count |
|---|---|---|
| 100: 00 | 0.62 ± 0.05[a] | 1.12 ± 0.00[a] |
| 90: 10 | 0.61 ± 0.06[a] | 1.04 ± 0.10[a] |
| 80: 20 | 0.63 ± 0.06[a] | 1.03 ± 0.05[a] |
| 70: 30 | 0.60 ± 0.00[a] | 1.13 ± 0.04[a] |
| Values are means ± standard deviation. The means with the same letters across the column are not significantly different at 95% Confidence Interval (P<0.05). All values are average of duplicates | | |

**Table 3:** Microbial Load ($log_{10}$ cfu/g) on Porridge.

| Kocho: Haricot bean | Color | Appearance | Flavor | Taste | Mouth feel | Overall acceptability |
|---|---|---|---|---|---|---|
| 100:00 | 4.51 ± 0.49[a] | 4.53 ± 0.48[a] | 4.69 ± 0.41[a] | 4.62 ± 0.49[a] | 4.68 ± 0.41[a] | 4.65 ± 0.48[a] |
| 90: 10 | 4.48 ± 0.56[a] | 4.51 ± 0.50[a] | 4.61 ± 0.46[a] | 4.59 ± 0.56[a] | 4.60 ± 0.46[a] | 4.61 ± 0.56[a] |
| 80: 20 | 4.53 ± 0.62[a] | 4.63 ± 0.49[a] | 4.77 ± 0.42[a] | 4.54 ± 0.62[a] | 4.70 ± 0.42[a] | 4.56 ± 0.56[a] |
| 70: 30 | 4.62 ± 0.52[a] | 4.60 ± 0.62[a] | 4.64 ± 0.51[a] | 4.61 ± 0.52[a] | 4.68 ± 0.51[a] | 4.63 ± 0.51[a] |
| Values are means ± standard deviation. The means with the same letters across the column are not significantly different at 95% Confidence Interval (P<0.05). All values are average of duplicates | | | | | | |

**Table 4:** Sensory acceptability test of mothers/caregivers (N=30).

(0.60 to 0.63) $log_{10}$ cfu/g (1.03 to1.13) $log_{10}$ cfu/g, whereas mold and yeast count ranges from (1.03 to 1.13) $log_{10}$ cfu/g. The finding of this study was in agreement with the finding of Mohammad et al. [27]. The lower count of microbial load of this study might be due to the soaking with a salt solution, and cooking killed some of the heat-sensitive micro-organisms in the production of porridge [28]. The International Commission for the microbiological specification for foods, states that ready-to-eat foods with plate count between (0 to 103) cfu/g are acceptable, between (104 to 105) cfu/g is tolerable and 106 cfu/g and above and above is unacceptable [29]. For foods, the number of yeasts and fungi must not exceed $10^2$ cfu/g [30]. Thus, the finding of the present study was within the acceptable limit and therefore, the product is microbiologically safe.

### Effects of blending proportion on sensory acceptability

Table 4 shows the sensory acceptability test of the porridge. There were no differences in sensory acceptability of porridge blended with a different proportion of kocho, haricot bean and Orange-Fleshed Sweet Potato Flour. Sensory evaluation in the present study was done with mothers and their children at an age below two years. All the products, i.e., control sample and whole treated samples were organoleptically accepted. According to the finding of Ebunoluwa et al. [31] the formulation of complementary food developed by the blends of orange flesh sweet potato, sorghum, and soybean with the maximum amount of the blending ratio up to 30% was equally accepted with the control product. Sensory quality of formulated complementary food corresponding to food choice of infants is important apart from nutrient and sufficient energy density [32]. Vasantharuba et al. [33] also reported that substitutions of 30% of wheat flour by sweet potato flour were feasible and acceptable for baked products. Consumer tests in a market in Mozambique showed a strong preference for golden bread made with boiled and mashed sweet potato 38% of the weight of wheat flour [34]. Even though most of these researches agree on the above sweet potato flour substitution proportion and Omosa [35] recommended that the levels of substitution are higher for non-sweet products and lower for sweet products in order to increase the acceptability by consumers.

## Conclusion and Recommendations

### Conclusion

All porridge developed from kocho and haricot bean flour in different proportions and constant amount of OFSP (15%) were improved some proximate compositions such as crude fat, crude protein, and total ash, whereas moisture content, crude fiber, and total carbohydrate amount decreased. The new product developed for children's were microbiologically safe and organoleptically accepted. The porridge can serve as a vehicle for delivering protein and VA through the food-based approach to the children in the study area, these products are characterized by nutritional, microbiological as well as sensorial quality and fulfill the children's requirements.

### Recommendation

Based on the study result, the following recommendation is derived. Food-based approaches require a multi-sectoral collaborative work. Thus Woreda agricultural officials, health officials, and education in the study area and Hawassa university work together to promote protein and Vitamin A rich haricot bean and OFSP incorporated kocho based porridge to the mothers/caregivers of children to feed their children to prevent protein-energy malnutrition and vitamin A deficiency problem of children in the study area.

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