Formulation of Nutritionally Improved Mashed Food from Orange-fleshed Sweet Potato (Ipomea batatus) and Haricot Bean (Phaseolus vulgaris) for Pre-School Children: The Case of Dale Woreda, Southern Ethiopia

Abebe Haile*1 and Dereje Getahun2

1College Development Studies, Centre for Food Security Studies, Addis Ababa University, Zip code 1176, Addis Ababa, Ethiopia
2School of nutrition, Food Science and technology, College Agriculture, Hawassa University, Zip code 05, Hawassa, Ethiopia

Abstract

Protein-energy malnutrition and vitamin A deficiencies are among the public health problems in Ethiopia. To address the problems, food based strategies are necessary. Thus aim study was to assess the consumption of orange-fleshed sweet potato (OFSP) to formulate mashed food from OFSP and haricot bean in proportion (70:30; 80:20; 90:10 and 100:00). Cross-sectional survey and experimental study designs and purposive sampling technique were employed. Structured questionnaires were used to collect survey data. Sensory evaluation was carried out using five-point hedonic scales with 17 consumer oriented panelists in triplicate. Data from the survey and experiments were analyzed using SPSS version 16.0 and SAS version 9.0 software. Likewise, the factorial (CRD and RCBD) experimental design was employed for microbial load and sensory analysis respectively. All the formulated foods were accepted by mothers and preschool children for sensory attributes of color, taste, flavor, mouth feel and overall acceptability. As recommendation, nutritionally improved and acceptable mashed foods can be prepared from OFSP and haricot bean at 70:30 proportions. The formulated foods were safe to be consumed within 24 hours of formulations. It was concluded that formulation of mashed food from OFSP and haricot bean can be used for improvement of preschool children’s RDA of protein and vitamin A. Besides, nutrition education using food-based interventions were also recommended in the study area to improve the nutritional status of preschool children.

Keywords: Haricot bean; OFSP; Preschool Children; Mashed food; Sensory evaluation

Introduction

Globally, Protein-Energy Malnutrition (PEM) continues to be a major health burden in developing countries and the most important risk factor for illnesses and death especially among young children. The World Health Organization estimated that about 60% of all deaths, occurring among children aged less than five years in developing countries, could be attributed to malnutrition. The improvement of nutrition therefore, is the main prerequisite for the reduction of high infant and under five mortality rates, the assurance of physical growth, social and mental development of children as well as academic achievement. Sub-Saharan Africa bears the brunt of PEM globally and 25 to 35% of mortality is associated with protein-energy malnutrition.

Pulses have several important attributes including high nutritional value, long storage times and relatively low cost in comparison to animal products. They make an important contribution in protein, energy and micronutrient provision to populations in the developing world [1]. Beans provide dietary protein that play essential role in human nutrition, especially in combination with other foods [2]. Pulses grow in various parts of Ethiopia; however, consumption of pulses is not widely practiced in Ethiopia. For example, only 20% of young children eat complementary foods prepared from pulses, with most consuming cereal-based foods but little or no added animal foods [3].

Sweet potato (Ipomoea batatus Lam) is the third most important food crop in East Africa and ranked seventh among the food crops produced in the world. It is one of the most important crops for at least 20 million Ethiopians. It is the third important root crop in Ethiopia next to ‘Enset’ and potato. It grows as a staple crop next to ‘Enset’ in the Southern Ethiopia [4]. Sweet potatoes vary in color and carotenoid concentration. It can have a wide range of flesh color varying from white to cream, yellow, orange and dark orange. OFSP is a particularly promising food, because levels of β-carotene are extremely high in many varieties (100-106 µg RAE/100 g for varieties in Africa) and it was generally well accepted by young children [5].

Protein-energy malnutrition and micronutrient deficiencies are the most common forms of under nutrition in Ethiopian children [6]. Like iron and zinc deficiencies, VAD is also a serious public health problem in Ethiopia [7]. Even though there is a national VA supplementation program, the coverage is not still as expected as the efforts conducted. According to Ethiopian demographic and health survey, about 57% and 52% of urban and rural Ethiopian children received vitamin A supplementation [3]. In order to hinder PEM and VAD in rural areas, food based interventions which suits for local setup are necessary. People live in rural areas have resources, for example, land. They produce pulses and root and tuber crops on their farm but most of the time they sell the pulses. Since their children are not privileged to consume protein-source foods, they are susceptible for PEM. Pre-school children are at the age of highly in need of protein for mental and physical development. The success of any newly introduced crop will depend not only on production characteristics, but also on its acceptability to consumers in terms of both sensory and utilization characteristics [5]. A complementary field study conducted by the

*Corresponding author: Abebe Haile, College Development Studies, Centre for Food Security Studies, Addis Ababa University, Zip code 1176, Addis Ababa, Ethiopia, Tel: + 251- 916-823834; E-mail: abebe.haile@aau.edu.et

Received April 06, 2018; Accepted June 30, 2018; Published July 04, 2018


Copyright: © 2018 Haile A, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
International Center for Women in Western Kenya noted that, OFSP and sweet potato based food products were acceptable to both producers and consumers in terms of appearance, taste and texture. Consumer preferences in terms of the characteristics of the crop such as color, dry matter content, texture and flavor are important. In Kenya, for example, adults preferred sweet potato with low dry matter content. Vitamin A deficiency continues to be a major public health problem in Ethiopia in spite of the various intervention measures. The major strategies which have been adapted globally to control and eliminate vitamin A deficiencies are first promote and support exclusive breastfeeding up to six months of age in the first six months of life. The second approach is supplementation in areas where vitamin A deficiency is common. Thirdly food fortification with vitamin A involves adding one or more vitamins and minerals to commonly consumed foods for the purpose of preventing or correcting a demonstrated deficiency. The fourth one is food based approach. This is an important long-term, sustainable strategy for prevention of vitamin A deficiency. People should be encouraged to grow and consume vitamin A rich foods throughout the country at all times. This requires nutrition education to change dietary habits, as well as providing better access to vitamin A or provitamin A rich foods, such as mangoes, papaya, carrot, OFSP and dark green leafy vegetables. Encouraging home gardening or local cooperatives to grow such foods may be necessary in regions where they are not locally available or too expensive [8]. This study aimed to formulate nutritionally improved mashed food from orange-fleshed sweet potato and pulses for pre-school children living in rural area, Dale woreda, Sidama zone, Southern Ethiopia. Specifically this study focused to assess the consumption of mashed food from OFSP and haricot bean by pre-school children in the study area. And to formulate mashed foods from OFSP and haricot bean in different proportions, analyze the microbial load and the sensory acceptability of the formulated foods.

Materials and Methods

Study area

The study was conducted in Sidama zone, Dale woreda, which is located 45 km from Hawassa, and 320 km from Addis Ababa. According to Ethiopian CSA report in 2007, the population of the woreda was 242,658, of whom 122,918 are men and 119,740 women. The woreda consists of 36 kebeles comprising of 51,044 residential houses with an average household family size of 5. The elevation of this woreda varies from about 1200 meters above sea level along the shores of Lake Abaya to about 3200 meters at its western most point. The total area of the woreda is 197.07sq km. The average temperature of the woreda is between 18-25°C. The woreda is known for growing enset, chat, maize, barley, wheat, teff, Irish potato, sweet potato, banana, avocado and haricot bean (CSA, 2011).

Source population

The source populations for the assessment were mother-child pairs who reside in Debub Mesenqela, and Soayama kebeles (local name). The two kebeles were selected because CIP-OFPS project was existing and working.

Study population

The study populations for the assessment were mother-child pairs who reside in Debub Mesenqela, and Soayama kebeles, who produce and consume OFSP and haricot bean.

Sampling method and sample size

Households who produce and consume OFSP and haricot bean in the two kebeles were identified by the kebeles' officials. There were 50 households who produce and consume OFSP in both kebeles (25 households in each kebeles). They also produce and consume haricot bean. All of the 50 households were included for the study. Therefore, it was purposive sampling method.

Inclusion criteria

Mothers who were living in kebeles, producing and consuming OFSP and haricot bean and voluntary to participate in the survey were included.

Exclusion criteria

For consumer oriented sensory evaluation, mothers who did not have 3-6 years old children were excluded.

Data collection

Structured questionnaires were used for survey data collection. The questionnaires were pretested (5%) for its understandability of the study participants. Based on the pre-test result, modifications were made in terminologies and time allowed for interview. The interview was conducted by trained data collectors who understand English language and speak sidamigna.

Data quality control and analysis

Data collection procedures were checked by the researcher and problems that faced during the data collection were reported and appropriate solutions were given. SPSS version 16.0 was used to analyze the survey data. The survey data results were presented by frequency and percent.

Preparation of OFSP and haricot bean

Orange-fleshed sweet potato was prepared by Christina [9] method with slight modification. Orange fleshed sweet potato, Tulla variety, was bought from two members of the study populations (one from each kebeles). Then it was washed with clean water until all the soil was removed. Tips, roots and other inedible portions were discarded. Then the OFSP was placed in a clean black plastic bag and tighten. This was to retain beta-carotene during cooking. Then it was placed in a clean saucepan which contained enough water and then cooked until the OFSP became soft.

Haricot bean was prepared by Audu and Aremu [10] method with slight modification. Haricot bean (red, small) was bought from local market of the study area. Then it was cleaned by hand to remove extraneous objects. Then it was washed with clean water until it was free from any dirt. Then after, it was placed in a clean saucepan which contained clean water in 1.5 w/v ratios. Then it was cooked until it became soft enough to mash. When it was soft, it was allowed to stay on gentle heat to absorb the residual water. This was because to retain minerals which were leached during cooking.

Formulation of OFSP-haricot bean mashed foods

When the OFSP was simmered to the desired level, it was transferred to a clean bowl while it was tighten with the plastic. The plastic was loosened and the OFSP together with the residue water in the plastic were discharged to the bowl. Then it was allowed to be cooled. When cooled, it was peeled by clean hand and mashed in the bowl together with the residue water by clean glass bottle. Whereas the haricot bean...
Experimental design and data analysis

Randomized Complete Block Design (RCBD) was used for sensory analysis and Completely Randomized Design (CRD) was used for the remaining analysis. Data from sensory acceptability test analysis were subjected to one way analysis of variance (ANOVA) by using SAS version 9.0 software. Factorial ANOVA was used to observe the interaction effect of time and formulation proportions on microbial load. The mean separation values were determined using Fischer LSD test. Significant differences were declared at p<0.05.

Ethical consideration

The ethical approval was obtained from Hawassa College of health, Hawassa University review committee. The participants were informed about the product and its contribution for their future nutritional benefits for the woreda and the country as a whole. The verbal consent was obtained from each participant it was assured that the information obtained from them was maintained confidential.

Results and Discussion

Socio-demographic and economic characteristics of the study population

A total of 50 mothers from the two kebeles who produce OFSP on their farm were included on the survey and the response rate was 100%. The results of the socio-demographic and economic characteristics are shown in Table 1.

The aim of conducting the socio-demographic and economic survey was to assess the determinants of under-nutrition. It was seen that the average family size was 5.62 which is higher than the national data on which the average family size was reported to be 4.8 [3]. The increment of the average number of the households in the present study might be due to the small sample size. It was also seen that the average land size of the study subjects was 0.37. About 76% of the study subjects’ monthly income was less than 100 Birr. The three variables (family size, land size and monthly income) are important denominators for a household to consume enough and different types of foods. Demissie et al. [12] reported that the consumption of vitamin A rich foods is affected by factors like large family size and small land size. They contribute to inadequate consumption of vitamin A in Developing countries. This might be due to the fact that if the family size of the household is higher, the food shared to all the children is decreased and the amount of food each child gets is low. The amount of the land also influences the production of fruits and vegetables that are rich in Vitamin A. This remains true for protein rich foods also. Regarding the monthly income, it is another determinant for consumption of vitamin A and protein rich foods. Solomon and Zemene [13] and Beka et al. [14] reported that risk of malnutrition increased in low-income family. In another study conducted in Jimma Ethiopia, children with low-income families were found undernourished than those with high monthly income families [15]. An inverse relationship is observed between household wealth and stunting levels of children in Ethiopian mini demographic health survey [16].

Educational status is an important factor to healthy nutritional habit. In this study, about 64% of the study subjects were uneducated. According to the Ethiopian Mini Demographic survey [16], the mother’s level of education has an inverse relationship with stunting levels. For example, children of mothers with more than secondary education are the least likely to be stunted (11%), while children whose mothers have no education are the most likely to be stunted (42 percent). In another study conducted in...
Variables Frequency (%)

Marital status
- Married 50 (100)

Family size
- 4 8 (16)
- 5 13 (26)
- 6 19 (38)
- 7 19 (38)
- Mean ± SD 5.62 ± 0.99

Mothers’ age in years
- 21-25 8 (16)
- 26-30 13 (26)
- 31-35 19 (38)
- 36-40 10 (20)
- Mean ± SD 10 (20)

Education level of mothers
- Illiterate 32 (64)
- Elementary school 10 (20)
- Junior school 6 (12)
- Secondary school 2 (4)

Religion of the mothers
- Orthodox 9 (18)
- Protestant 36 (72)
- Muslim 5 (10)

Occupation of mothers
- House-wife 38 (76)
- Petty-trader 12 (24)

Monthly income of family
- <100 38 (76)
- 301-500 7 (14)
- 501-700 4 (8)
- 901-1100 1 (2)

Land size in hectares
- <0.5 38 (76)
- 0.5-0.74 7 (14)
- 0.75-0.99 4 (8)
- 1-2.24 1 (2)
- Mean ± SD 0.37 ± 0.23

Table 1: Socio-demographic and economic characteristics of the study subjects.

Bangladesh, the maternal illiteracy was associated with a fourfold increase in the risk of severe acute malnutrition in their children [17].

Availability of OFSP and haricot bean on farm and local market

The results of the availability of root and tuber crops and pulses on farm and local market are shown in Table 2.

Grain legumes occupy an important place in human nutrition, especially in the dietary pattern of low-income groups of people in developing countries. Legumes, considered as poor man’s meat, are generally good sources of nutrients [18]. They are an important and inexpensive source of protein, dietary fiber and starch for a large part of the world’s population, mainly in developing countries [19].

From Table 2, it was observed that all (100%) of the respondents produce haricot bean. This is a good opportunity to the children of the respondents to get protein. But it is not necessarily mean that the produced haricot bean is used for consumption. It requires awareness creation regarding the importance of consumption of haricot bean.

As it was also responded by the study subjects the most abundantly available pulse on the local market was haricot bean. This is also promising information for students as well as other researchers who have interest in conducting researches on product development as well as nutrition education on pulses to enhance the nutritional status of the children in the study area. But OFSP was not available on the local market. This might be due to it is newly introduced to the study area for few households. The availability of OFSP and haricot bean on farm and local market is a predecessor for consumption by children. Then after, it is awareness creation that plays role in consumption of OFSP and haricot bean together.

Frequency of OFSP and haricot bean consumption

Seventeen mothers who had preschool children were interviewed to respond about the frequency of OFSP and haricot bean consumption of their children in a week. The results are shown in Tables 3 and 4.

As it was shown in the Table 3, the preschool children were consuming haricot bean three times in a week, as responded by 47% of the respondents, and two times in a week, as responded by 53% of the respondents. This shows that the children were obtaining protein from haricot bean in a very low frequency. This might be due to different reasons; the mothers might sell the haricot bean that was produced on their farm purchase other food items, spices, salt and kerosene instead. The other reason of selling haricot bean might not know its nutritional benefits. They might not have awareness about the protein content in haricot bean. The other possible reason for not giving haricot bean to their children might be produce it in small amount on their farm. They

Table 2: Availability of haricot bean and OFSP on farm and local market.

<table>
<thead>
<tr>
<th>Type of food</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Haricot Bean</td>
<td></td>
</tr>
<tr>
<td>Cooked alone</td>
<td>1 (5.9)</td>
</tr>
<tr>
<td>Cooked with other foods</td>
<td>16 (94.1)</td>
</tr>
<tr>
<td>From OFSP</td>
<td></td>
</tr>
<tr>
<td>Wot</td>
<td>14 (82.4)</td>
</tr>
<tr>
<td>Flat-bread</td>
<td>3 (17.6)</td>
</tr>
<tr>
<td>Haricot bean with OFSP</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0 (0)</td>
</tr>
<tr>
<td>No</td>
<td>17 (100)</td>
</tr>
</tbody>
</table>

Table 4: Preferable foods from haricot bean and OFSP.
might allocate small portion of their land for its production. Similar dispersed and small holding production was reported in most part of Latin America. In most parts of Africa, women farmers who have little access to fertilizer compared to men farmers grow beans. They are commonly incorporating pulses with cereals, roots and tubers [2]. When producing together with other crops, preparation of the land will not target pulse and the output decreases. This is what was happening in the current study area. They were producing little amount of haricot bean when compared to other cereal crops, as they responded. Another study which was conducted in India also showed that the consumption of pulses was very low due to different reasons so that the children were subsisting on inadequate diet.

From the Table 5, it was also seen that the preschool children were given OFSP meal three times in a week, as responded by 65% of the subjects, and two times, as responded by 35% of the respondents. This was also showed that the children were obtaining vitamin A from OFSP in low frequency. The reason for not giving frequently might be due to OFSP was in its emerging age in the study area. CIP and GOAL Ethiopia gave vines of OFSP for 50 households. As a result, there might not be enough production and the children were not able to consume frequently. The consumption of as little as 50 g of OFSP in a day may provide a child's Recommended Dietary Allowance (RDA). According to study conducted in South African's young school children by different scholars, the regular consumption of relatively modest amounts of boiled OFSP significantly improved their VA status [5,20].

Preferable foods from haricot bean and OFSP

Seventeen mothers were interviewed about the foods that prefer to prepare from OFSP and haricot bean to their children. The results are shown in Table 6.

As Table 4 above shows the observed 94% of the respondents gave haricot bean in the form of cooked with other foods. As they responded, they cook haricot bean together with cabbage and provide it to children as side dish with kocha. In other form, they boil it together with cereal grains like wheat, called nifro, and then consume with coffee. The study subjects were also asked about the pretreatments that they apply before cooking or boiling haricot bean. All the respondents did not apply any pretreatment. They simply wash and cook or boil it. They did not know the advantages of pretreatment. They thought pretreatment decreases the quantity of the haricot bean. This is another knowledge gap to be addressed through nutrition education. Many researches confirmed the presence of anti-nutritional factors in pulses. Aisha et al., [21] stated that the bioavailability of nutrients in beans is limited due to presence of anti-nutrients such as phytates and tannins. Pretreatment, like soaking, reduces phytates due to leaching of phytate ions into the soaking water [22]. Water imbibitions also activate phytase enzymes present in the beans, to degrade and reduce phytates [23]. Aisha et al. [21] reported that higher mineral extractability was observed in dehulled beans due to the reduction of phytates and tannins significantly. Lectins can be destroyed by heat treatment; Trypsin inhibitor activity may be reduced to acceptable levels by heating to high temperatures or by prolonged boiling [24]. Since the study subjects were cooking haricot bean before consumption, lectins and trypsin inhibitors might be reduced.

From Table 4, it was also observed that about 82% of the mothers preferred preparing stew (wor) to their children from OFSP. The remaining 18% of the mothers preferred preparing flat bread (kitta) from OFSP. Most of the respondents' preference for preparing stew might be due to it is easy to prepare. They did not prefer preparing flat bread; this might be because the drying of OFSP is very tedious. In addition, drying is also depends on weather condition of days. If the weather is cool, it may take more than three days to dry the OFSP. When the OFSP stays such extended time during drying, it could be contaminated with different contaminants like mad, pests, rodents and even it could be fermented if it is not well scattered on materials placed to be dried. If, fortunately the weather is dry and they are able to dry, they obtain small amount of dried OFSP. This is because OFSP has small amount of dry matter (about 28% as witnessed in this study). The dry matter varies depending on the variety and the season of production. Bengton et al. [25] reported that the dry matter of different varieties of OFSP were between 30-35%. The research was done to evaluate the effects of various traditional processing methods on the all-trans-β-carotene content of orange-fleshed sweet potato in Uganda. Another study conducted in South Africa which was intended to evaluate the nutrient content and consumer acceptability for different cultivars of orange-fleshed sweet potato reported the dry matter of different varieties of OFSP 16-31% [26]. Similarly, study conducted in India to assess the nutritional status of orange fleshed sweet potatoes in alleviating vitamin A malnutrition through a food-based approach, reported the dry matter of different genotype OFSP 21-26% [27].

Assessment of preschool children's consumption of protein and vitamin a containing foods

Mothers who had preschool children were interviewed about how often their children consume foods rich in protein and vitamin A and the result is shown in Table 5.

From Table 5, it is observable that the preschool children were not privileged to consume protein and vitamin A rich foods frequently. The one which they consumed in a better frequency, cabbage, was cooked and so that its water soluble and heat sensitive vitamins may lost. Based on the result, one can judge the preschool children require foods which complement for the daily requirements of protein and vitamin A. Such evidences help strengthening food based strategies to combat vitamin A and protein deficiencies. The current study is bringing useful information to those who have interest in conducting food based intervention and nutrition education researches to address under-nutrition problems.

Consumer oriented sensory evaluation

Mothers who produce OFSP on their farm and have at least one child whose age is in between 3 and 6 years were selected for consumer oriented sensory evaluation. Accordingly, among the fifty mothers who

<table>
<thead>
<tr>
<th>Type of food</th>
<th>Consumption frequency</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Three times in a week</td>
<td>9 (52.9)</td>
</tr>
<tr>
<td></td>
<td>Twice in a week</td>
<td>5 (29.4)</td>
</tr>
<tr>
<td></td>
<td>Once in a week</td>
<td>3 (17.6)</td>
</tr>
<tr>
<td>Carrot</td>
<td>Twice in a week</td>
<td>7 (41.2)</td>
</tr>
<tr>
<td></td>
<td>Once in a week</td>
<td>10 (58.8)</td>
</tr>
<tr>
<td>Egg</td>
<td>Twice in a week</td>
<td>10 (58.8)</td>
</tr>
<tr>
<td></td>
<td>Once in a week</td>
<td>7 (41.2)</td>
</tr>
<tr>
<td>Meat</td>
<td>Once in a week</td>
<td>2 (11.8)</td>
</tr>
<tr>
<td></td>
<td>Once in a month</td>
<td>8 (47.1)</td>
</tr>
<tr>
<td></td>
<td>During holidays</td>
<td>7 (41.1)</td>
</tr>
<tr>
<td></td>
<td>Every day in a week</td>
<td>11 (64.7)</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Three times in a week</td>
<td>6 (35.3)</td>
</tr>
</tbody>
</table>

Table 5: Protein and vitamin A rich foods’ consumption frequency assessment.
were selected for the survey, seventeen of them fulfilled the criteria to carry out consumer oriented sensory evaluation. The results are indicated in Table 6.

The result showed that there is significant difference (p<0.05) between the four samples for color, flavor and mouth feel. It also revealed that there is no significant difference (p<0.05) between sample 202 and 303 for taste and between sample 101 and 202 for overall acceptability. All products were acceptable for all attributes by the consumer oriented sensory evaluators because the least mean score is 3.83 ± 0.47 which is above the median hedonic scale 3, neither lie nor dislike.

Product 404, which was 100% OFSP got the highest mean score for color. This might be due to the orange color of the product. In contrast, product 101 which was 70% OFSP and 30% haricot bean got the least mean score. This might be due to the color of the haricot bean. Since the haricot bean was not dehulled, its bran was visible within the mashed product and it might made the color unattractive when compare to the other products. Product 101, which was 90% OFSP and 10% haricot bean, got the highest mean score for flavor. This might be due to the flavor incorporated from the haricot bean. The study subjects were better accustomed to haricot bean than OFSP so that in the researchers' opinion the prior flavor that they had for haricot bean influenced them.

Product 101 also got the highest mean score for mouth feel. This might be, in the researchers’ opinion, due to the fibrous nature of haricot bean. OFSP is smooth and sticky in its nature due to the starch within it so that it does not be rough in texture in the mouth. Therefore, when the haricot bean proportion increased in the formulated products, the mean score of the mouth feel also increased. Regarding the taste attribute of the formulated foods, the mothers gave the highest mean score for product 101. Even though they knew 100% OFSP is sweeter than the others, they prefer the one which contained more haricot bean. This shows how much the prior taste of haricot bean influenced them. Related finding was reported by Gebremedihin et al. [28], which developed vitamin A enriched bread from wheat and OFSP. In his study, the mothers who carried out sensory evaluation gave the highest score for bread prepared from the whole wheat flour even though they accepted the OFSP incorporated bread. As he stated, the reason for this was OFSP is naturally more colorful and sweet in taste which might be not suitable for the adults’ usual food habit. Likewise in the present study, the mothers gave the highest score for the product which contained the highest proportion of haricot bean. This is because the taste of OFSP differs from the usual (white flesh) sweet potato and they preferred haricot bean's taste over OFSP. This is an important finding, because it can be used as a base-line finding to carry out further researches on product development. This study was the first in its kind; there were many researches on product development from OFSP but most of them were from dried OFSP flours.

Sensory acceptability of OFSP incorporated recipes by consumers depends on its substitution proportion variation in the product. In the current study, all the formulated products were accepted by the mothers of the pre-school children. Many studies support this finding. In west Kenya, OFSP and sweet potato incorporated food products were accepted by both producers and consumers in terms of sensory attributes.

### Acceptability of mashed food from OFSP and haricot bean by pre-school children

Seventeen pre-school children were given the formulated products to test for acceptability and their mothers gave the acceptability value for how they perceived their children's acceptance. The results are shown in Table 7.

Acceptability test was carried out on the target study group (pre-school children) to substantiate the findings. The success of such newly formulated foods depends on whether it is accepted and consumed by the target group. Mothers gave opinion for how they perceived their children's acceptance of the prepared breads. All pre-school children liked all of the formulated foods. This is a promising finding because when the products are accepted by the target group it means that protein deficiency and VAD can be alleviated through such food based interventions. The degree of preference decreased as the proportion of haricot bean increased. They liked most the product 404, which was 100% OFSP. This might be due to the sweet taste and orange color of the OFSP and children obviously like sweet taste. Related result was obtained by Gebremedihin et al. [28], that was preschool children preferred most bread made up of highest proportion of OFSP flour.

From the above result, total yeast and mold count are not affected due to the blending proportion differences of the formulated foods (p<0.05). As the storage time of the foods increased, total yeast and mold counts are increased dramatically, as shown in Table 8. Guidelines for ready-to-eat food of department of medical sciences, ministry of public health, Thailand, define that yeasts per gram must be less than 10,000 (less than 4 log cfu/g) and molds/g must be less than 500 (less than 2.7 log cfu/g). According to this guideline, the formulated foods of the current research would not be safe for consumption after 24 hours.

As it is indicated in Table 9, enterobacteriaceae count is not affected due to the blending proportion differences of formulated foods (p<0.05). Similar to yeast and mold counts, the enterobacteriaceae count showed increment as the storage time increased. The Centre for food safety, food and environmental hygiene department of China classified the enterobacteriaceae count for ready-to-eat foods >10<sup>2</sup> cfu/g unsatisfactory, between 10<sup>1</sup> and 10<sup>2</sup> cfu/g border line and <10<sup>1</sup> satisfactory. According to this classification, the formulated foods are below the border line after 24 hours storage time. In general, the microbial load result indicates that the formulated foods might not be safe for consumption after 24 hours storage. This might be due to the moisture content of the foods is quite higher that favors the growth of microorganisms. In addition, the hygiene of the utensils used for the

<table>
<thead>
<tr>
<th>Sample</th>
<th>Ratio</th>
<th>Color</th>
<th>Flavor</th>
<th>Mouth feel</th>
<th>Taste</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>70:30</td>
<td>3.83 ± 0.46</td>
<td>4.72 ± 0.46</td>
<td>4.77 ± 0.68</td>
<td>4.68 ± 0.44</td>
<td>4.74 ± 0.62</td>
</tr>
<tr>
<td>202</td>
<td>80:20</td>
<td>4.17 ± 0.38</td>
<td>4.47 ± 0.28</td>
<td>4.53 ± 0.42</td>
<td>4.5 ± 0.30</td>
<td>4.61 ± 0.76</td>
</tr>
<tr>
<td>303</td>
<td>90:10</td>
<td>4.33 ± 0.45</td>
<td>4.26 ± 0.38</td>
<td>4.16 ± 0.23</td>
<td>4.46 ± 0.43</td>
<td>4.37 ± 0.46</td>
</tr>
<tr>
<td>404</td>
<td>100:0</td>
<td>4.67 ± 0.48</td>
<td>3.94 ± 0.47</td>
<td>3.89 ± 0.47</td>
<td>3.93 ± 0.48</td>
<td>3.98 ± 0.44</td>
</tr>
</tbody>
</table>

Responses are based on 5-point hedonic scale, 1 for dislike very much and 5 for like very much. Sample 101 = OFSP: Haricot Bean (70:30); Sample 202 = OFSP: Haricot Bean (80:20); Sample 303 = OFSP: Haricot Bean (90:10); Sample 404 (control) = OFSP: Haricot Bean (100:0). Values with different superscripts in the same column are significantly different at p<0.05 (a>b>c>d).

Table 6: Consumer oriented sensory evaluation result of mashed food from OFSP and haricot bean (Mean ± SD).
Table 7: Total yeast and mold count of the formulated foods (log cfu/ml).

<table>
<thead>
<tr>
<th>Formulations (OFSP: haricot bean)</th>
<th>0 hr</th>
<th>24 hrs</th>
<th>48 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>100:00</td>
<td>2.07 ± 0.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.89 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.69 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>90:10</td>
<td>2.10 ± 0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.91 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.70 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>80:20</td>
<td>2.12 ± 0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.91 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.70 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>70:30</td>
<td>2.13 ± 0.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.93 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.72 ± 0.00&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are averages of duplicate readings (mean ± standard deviation). Means followed by different superscripts within the column indicate significant difference (p<0.05). OFSP: orange flesh sweet potato.

Table 9: Enterobacteriaceae count of the formulated foods (log cfu/ml).

<table>
<thead>
<tr>
<th>Formulations (OFSP: haricot bean)</th>
<th>0 hr</th>
<th>24 hrs</th>
<th>48 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>100:00</td>
<td>0.30 ± 0.00&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.86 ± 0.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.64 ± 0.03&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>90:10</td>
<td>0.39 ± 0.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.88 ± 0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.67 ± 0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>80:20</td>
<td>0.50 ± 0.28&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.90 ± 0.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.69 ± 0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>70:30</td>
<td>0.54 ± 0.09&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.90 ± 0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.71 ± 0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are averages of duplicate readings (mean ± standard deviation). Means followed by different superscripts within the column indicate significant difference (p<0.05) (a>b). OFSP: orange flesh sweet potato.
References