




Evaluation of Porridge Made from Composite Flour of Orange-Fleshed Sweet Potato and Enset (Bulla) Flours

Abebe Haile¹ 

Martha Geribo² 

Esayas Kinfe³ 

^{1,2,3}Hawassa University, Awassa College of Agriculture, School of Nutrition, Food Science and Technology, Awassa, Ethiopia
( Corresponding Author)

Abstract

Bulla is the water insoluble starchy product which is separated from Kocho during the decortication process of Enset. However, this extract lacks pro-vitamin A. This study enriched the Bulla with Orange-fleshed Sweet Potato (OFSP) a plant with high levels of β -carotene that can be useful for combating vitamin A deficiency. The porridge was made of composite flours of bulla blended with 30, 35, 40 and 45% OFSP flours were investigated for proximate composition, β -carotene, functional property and sensory acceptability of products using standard methods. The data were analyzed using SAS 1.9 Software. The composite flours percentage moisture, crude (fiber, protein, fat), ash, carbohydrate, gross energy, β -carotene, pH, bulk density and water absorption capacity were found to be in the range of 29.54 to 40.25, (1.66 to 2.05, 2.11 to 2.55, 0.55 to 0.71), 1.76 to 2.11, 53.86 to 63.31, 227.49 to 268.11 Kcal/100 g, 386.68 to 558.05 μ g/100 g, 4.46 to 5.71, 0.58 to 0.80 and 1.70 to 4.87 ml/g, respectively. While, the composite flours porridge percentage moisture, crude fiber, ash, crude protein, crude fat, carbohydrate, gross energy, β -carotene, pH and viscosity content found to be in the range from 43.42 to 58.03, 1.32 to 1.79, 2.39 to 2.78, 2.01 to 2.31, 0.71 to 0.82, 35.21 to 48.63, 155 to 211.11 Kcal/100 g, 201.46 to 301.50 μ g/100 g, 5.71 to 5.82 and 515 to 728 cps, respectively. The porridge OB₄PM₂ (45% OFSP and 55% Bulla) was most preferred due to its color, odor, flavor and overall acceptability with panelist scored value of 4.28, 4.33, 4.39 and 4.45, respectively. Moreover, OB₄PM₂ porridge was found to be good source of ash, energy and β -carotene content.

Keywords: Bulla, Composite flour, Orange-fleshed sweet potato, Porridge, β -carotene, Viscosity.

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1. Introduction

Bulla is a processed starch made from Enset (*Enset ventricosum*). It is obtained when the scrapings and pulps were squeezed, separating of the liquid. Collecting the pulpy white juice and left for one or two days to settle the resultant starch to concentrate into white flour. The starch that separates out from the liquid concentrates into a white powder. This product can be either fermented in pit or directly cooked without fermentation [1, 2]. Bulla is a good source of calories. It can be prepared as pancake, porridge and made into soup. Bulla fulfills both the nutritional requirement and income of the family there by providing household financial security that is by frequent sale of some amounts of fermented Bulla from the storage pit. The price of bulla is higher than Kocho even at local market [1]. Bulla can be stored for a long period of time without spoiling. The shelf life of Bulla depends on the age of the harvested Enset plant and the way of packing system. Proper packaging is needed to protect the spoilage. If there are pockets of air, or exposed to air, molds and other spoilage organisms can grow and soften the product. Due to its moisture content there will be taste and color change happen to the product [3].

Bulla was considered the best quality Enset food. However, it is low in protein, fat content and has no adequate pro-vitamin A for the daily requirement of a normal person. According to the study of Minaleshewa [2] and Tilahun, et al. [4] protein and fat content of Bulla were ranged from 0.4-0.8 and 0.2-0.4g, respectively. The Vitamin "A" content of Enset products record was 0-0.2% [4]. As a result, it is a problem for those people who use Enset product (Bulla) as staple or co-staple food have a chance of being affected by vitamin A deficiency.

Orange-fleshed Sweet Potato (*Ipomoea batatas*) is an important tuber crop grown in the tropics, sub-tropics and warm temperate regions of the world for its edible roots crop. The roots contain significant amount of carbohydrate constitute 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. Beside carbohydrate, it contains high levels of β -carotene and appreciable amount of minerals. Orange-fleshed Sweet Potato (OFSP) varieties are being promoted as food based intervention to combat vitamin A malnutrition [5]. The flesh color of the root varies from various shades of white, cream, yellow to dark-orange depending upon the carotenoids content [6]. Carotenoids have been linked with the enhancement of immune system and decreased risk of degenerative diseases such as cardiovascular problems. Dietary fiber has the potential to reduce the incidence of a variety of diseases in man including colon cancer, diabetes, heart diseases and digestive disturbances [7]. The primary role of enriching the Enset product (Bulla) with Orange-fleshed Sweet Potato was to upgrade the Vitamin A content of the products. It is the intervention falls in the latter category of food based approaches which is particularly suited for rural areas where the Enset products used as a staple food. A food based strategy has the advantage of bringing more nutrients, vitamin "A" and more sustainable approach. Enriching the indigenous root crop Enset product (Bulla) by mixing with orange-fleshed sweet potato can be a good solution to improve the nutritional quality of household diets.

Vitamin A is a fat-soluble vitamin that was needed in small quantities for several metabolic activities in the body. When vitamin A intake is below required levels, a number of manifestations collectively known as vitamin A deficiency (VAD) disorders occur. This vitamin deficiency has manifested as blindness, increased susceptibility to infection and closely associated with increased mortality and morbidity [8]. The causes of VAD occurs when vitamin A intake or liver stores fail to meet daily metabolic requirements and the most common cause is a persistently low intake of vitamin A-rich foods. Therefore, the objective of this study is enriching of Enset product (Bulla) flour with Orange-fleshed Sweet Potato to prepare porridge of having high vitamin A content from the blended flours. Moreover, to determine the physicochemical, β -carotene content and sensory acceptability of the products.

2. Materials and Methods

2.1. Sample Collection

Raw Bulla sample was purchased from Hawassa local market. Raw Orange-fleshed Sweet Potato of Tulla variety (CIP-420027) was collected from Southern Agricultural Research Center of Primary Quality Sweet Potato Vine Multiplication Center (Wondo Genet Farm). All the samples were properly packed and transported to the laboratory of Food Science and Technology, Hawassa University. The OFSP was stored at -18°C (Haier chest freezer Model HCF 588) to protect spoilage. While Bulla was stored at dry and ambient temperature until further processing.

2.2. Bulla Flour Preparation

Bulla sample was prepared according to procedure outlined by Minaleshewa [2]. The semi dried bulk Bulla sample was spreaded on clean dry wood board and the long fibers were removed manually. The sample was then sieved through 500 μm sieve (FRITSCH, test sieve, Made in German) to remove the hard particles and made it uniform size and the contents were mixed. Bulla flour was packed by polyethylene bag and stored at room temperature.

2.3. Orange-fleshed Sweet Potato Flour Preparation

Orange-fleshed sweet potato flour was prepared according to the procedure outlined by Owori, et al. [9]. The OFSP was taken out from deep freezer and kept on the laboratory table for four hours until its temperature was raised to room temperature. The OFSP was washed with potable water to remove any foreign bodies and then the outer skin was peeled by peeling machine (Robot coupé H. Biaugeaup Model CL 30). The remaining unnecessary parts were removed manually and rinsed by clean potable water. The OFSP was chopped to minimize the size for the slicer machine. The chopped sweet potato was then sliced to a uniform size of 3 mm by the slicer machine (H. Biaugeaup Model W1 9901). The slices were soaked in 1% w/v sodium chloride solution for 30 minutes. The function of salt is to inhibit the growth of microorganisms on the slices while drying. The slices were dried on the flat racks of solar dryer. The dried sample was milled by electronic grinder and sieved by 500 μm sieve (FRITSCH, test sieve, Made in German). The flour obtained was double packed by dark polyethylene bags stored in dry and dark place to protect oxidation of β - carotene.

2.4. Preparation of OFSP Added Bulla Composite Flour

The formulation of OFSP with Bulla for porridge making were done based on the recommended dietary intake (RDI) of adult person to maintain a healthy life. It also allows creating unique and delicious recipes based on the acceptability of the users, see [Table 1](#) below.

Table-1. Proportion of OFSP powder used to formulate the composite flour

Bulla composition /Kg					
	OB ₄ PM ₁	OB ₃ PM ₁	OB ₂ PM ₁	OB ₁ PM ₁	B ₁ PM ₁
OFSP	45%	40%	35%	30%	-
Bulla	55%	60%	65%	70%	100%
Total	1Kg	1Kg	1Kg	1Kg	1Kg

Note: * PM₁→ is the code of treatments before cooking

Table-2. Proportion of ingredients used to prepare porridge

Bulla composite flour porridge /kg					
	OB ₄ PM ₂	OB ₃ PM ₂	OB ₂ PM ₂	OB ₁ PM ₂	B ₁ PM ₂
OFSP	45%	40%	35%	30%	-
Bulla	55%	60%	65%	70	100%
Water (mL/kg)	1500	1500	1500	1500	1500
Oil (mL/kg)	20	20	20	20	20

Note: *PM₁→ treatments before cooking, *PM₂→ treatments after cooking.

B₁PM₁=100% of Bulla flour, OB₁PM₁=30% OFSP + 70% of Bulla, OB₂PM₁=35% OFSP + 65% of Bulla, OB₃PM₁=40% OFSP + 60% of Bulla and OB₄PM₁=45% OFSP + 55% of Bulla composite flour; B₁PM₂=100% Bulla porridge, OB₁PM₂=30 % OFSP + 70% Bulla, OB₂PM₂=35% OFSP + 65% of Bulla, OB₃PM₂=40% OFSP + 60% Bulla and OB₄PM₂=45% OFSP + 55% Bulla composite flour porridge.

2.5. Porridge Preparation

Bulla based porridge was prepared using the methods outlined by [Yewelsew, et al. \[10\]](#). One kilogram of composite flours was mixed with 1500 mL/kg of water, kneaded well in the pot, and boiled until all particles became soluble while boiling 20mL oil was added. Then the composite flour porridge was cooked at the temperature of 100 °C for 10 minutes.

2.6. Chemical Analysis

2.6.1. Determination of β-carotene Contents

β-carotene content in the food was determined as the procedure outlined by [Rodriguez, et al. \[11\]](#) based on Spectro-photometric test.

2.6.2. Determination of Proximate Composition

The Proximate composition of flour and composite flour porridge were determined by using the standard method of [Association of Official Analytical Chemists \(AOAC\) \[12\]](#). The total carbohydrate amount in the sample was determined by difference:

$$\text{Total carbohydrate \%} = 100 - (\text{P} + \text{F} + \text{A} + \text{M})$$

Whereas: P = the mass percentage of crude protein,

F = the mass percentage of crude fat

A = the mass percentage of ash,

M = the mass percentage of moisture

2.6.3. Determination of Gross Energy

The energy value was determined by calculation using the relationship from fat, carbohydrate and protein contents of the Atwater's Conversion Factors; (4kcal/g) for protein, (9kcal/g) for fat and (4 kcal/g) for carbohydrates and expressed in calories.

$$\text{Gross energy (kcal/g)} = (4 \times \text{protein}) + (4 \times \text{carbohydrate}) + (9 \times \text{fat})$$

2.7. Determination of Physical and Functional Properties

2.7.1. pH Value

The pH of the samples was determined from 1/10 dilution of sample by glass electrode attached to digital pH meter as their combination ratio before cooking and after cooking of each composite flours samples were done according to the method described by [Yirmaga \[13\]](#). The pH meter (MP 511 Lab. pH meter, China) was calibrated using pH 4.0 and 7.0 buffers prior to determination of the pH of the samples.

2.7.2. Bulk Density

The bulk density of OFSP added Bulla composite flours were determined by using method [\[14\]](#).

2.7.3. Water Absorption Capacity

Water absorption capacity OFSP added Bulla composite flours were determined using the method [15].

2.8. Viscosity

The viscosities of the composite flours porridge were measured using the method of [16].

2.9. Sensory Evaluation

Sixty-two panelists who were the students of the School of Nutrition, Food Science and Technology, Hawassa University did the consumer acceptability of composite flour porridge. The panelists ranked the color, odor, flavor, and overall acceptability of composite flours porridge using a five point hedonic scale (5 Extreme like, 4 Like very much, 3 Like, 2 Dislike and 1 Dislike very much). The composite flours porridge samples were presented in triplicate. Samples were being ordered on the table without providing any information to the panelists. A bottle of tape water with white plastic cups was given to rinse their mouth after each test. They use their observation and sense organ on making decisions, and they interpret the nature of a sample. The results were recorded and analyzed to determine the significance of variations of sensory attributes of the products average scores.

2.10. Ethical Approval

The study protocol was approved by the ethical committee of Hawassa University College of Medicine and Health Science for sensory evaluations.

2.11. Statistical Analysis

The data were analyzing using the SAS 9.1 Software. Analysis of variance (ANOVA) was used for the analysis. Fisher's Least Significance Difference (LSD) test was used to determine the significance of mean differences of the results. The level of statistical significance was set at ($p < 0.05$).

3. Results and Discussions

3.1. Proximate Composition, Physicochemical and Functional Properties

Table-3. Proximate composition (%) of OFSP added Bulla composite flours and porridge.

Treatment	Moisture content	Crud fiber	Ash	Crude protein
Composite flours				
B ₁ PM ₁	48.25±0.01d	0.39±0.01i	1.26± 0.01i	1.06±0.01h
OB ₁ PM ₁	40.38± 0.00g	1.66±0.01e	2.11±0.01g	1.76± 0.01g
OB ₂ PM ₁	33.72± 0.01h	1.81±0.00c	2.24± 0.01f	1.88±0.01e
OB ₃ PM ₁	31.62±0.01i	1.92±0.01b	2.38±0.01e	2.01±0.01d
OB ₄ PM ₁	29.54±0.01j	2.05±0.01a	2.55±0.00c	2.11±0.01c
Porridge				
B ₁ PM ₂	60.30±0.01a	0.12± 0.01j	2.00±0.01h	1.90±0.00f
OB ₁ PM ₂	58.03±0.01b	1.32± 0.01h	2.39±0.01e	2.01±0.00d
OB ₂ PM ₂	50.11±0.01c	1.49± 0.01g	2.51±0.01d	2.12±0.01c
OB ₃ PM ₂	46.75±0.01e	1.62± 0.01f	2.62±0.01b	2.21±0.01b
OB ₄ PM ₂	43.42±0.00f	1.79± 0.01d	2.78±0.01a	2.31±0.01a

Note: *PM₁ → treatments before cooking, *PM₂ → treatments after cooking.

B₁PM₁ = 100% of Bulla flour, OB₁PM₁ = 30% OFSP + 70% of Bulla, OB₂PM₁ = 35% OFSP + 65% of Bulla, OB₃PM₁=40% OFSP + 60% of Bulla and OB₄PM₁=45% OFSP + 55% of Bulla composite flour; B₁PM₂ = 100% Bulla porridge, OB₁PM₂ = 30 % OFSP + 70% Bulla, OB₂PM₂ = 35% OFSP + 65% of Bulla, OB₃PM₂ = 40% OFSP + 60% Bulla and OB₄PM₂ = 45% OFSP + 55% Bulla composite flour porridge. Means ± SD, values within the same column with different superscript letters are significantly different from each other ($p < 0.05$).

Table 3 shows that the moisture content of OFSP and Bulla composite flours and porridges were ranged from 31.62-48.25% and 43.42-60.30 %, respectively. The highest moisture content observed in B₁PM₂ (60.30%) followed by OB₁PM₂ (58.03%) and the least was for the OB₄PM₁ (29.54%). Moisture content of OFSP and Bulla composite flour and porridge were significantly different ($p < 0.05$) to each other. According to Kalekristos [3] the moisture content of Bulla bought from Addis Ababa supper market was found in the range of 44 to 57%, that was contain more moisture than the present study. There were significant differences in moisture content between the treatments, before and after cooking of the porridge. The highest moisture content of composite flours and porridges scores were (OB₁PM₁) 40.38% and OB₁PM₂ (58.03%), respectively. The difference might be due to addition of more water while cooking the porridge. As the amount of OFSP flour increases in the composite flours, the moisture content of flour and porridge were decreased gradually.

Crud fiber contents of Bulla 0.39%, OFSP added Bulla composite flour ranged from 1.66 to 2.05%, while Bulla porridge ranged from 0.12 to 1.79%. There were significant difference ($p < 0.05$) among the treatments. Higher crude fiber (2.05%) content was obtained in Bulla based composite flour OB₄PM₁, while the lowest (0.12%) was obtained for porridge B₁PM₂. According to the previous reported literature, Bulla was the decanted fluid of the decortiations processing of Enset plant and it is very poor in fiber content of recorded values were in the range from 0.6 to 0.8% [3]. As the amount of OFSP flour increases in the composite flours, the fiber content increased gradually. This might be due to the crude fiber content of OFSP more than Bulla flour. However, the fiber content of OFSP added Bulla composite flours were not fulfilling the RDA of fiber for healthy adult. According to FAO Food Standards Program

[17] of the RDA of fiber for healthy person set at 25 to 38 g/day which was significantly different from the present study. Hence, Bulla composite flours porridge needs additional fiber source of food.

Ash actually a much more general term that can refer to a number of substances in the food. The ash is residue that remains after heating and removing water or it refers to any inorganic material present in food [18]. The ash content of OFSP added Bulla composite flour and porridge were ranged from 1.26-2.55% and 2.39 - 2.78%, respectively. According to [Minaleshewa \[2\]](#) and [Yirmaga \[13\]](#) the ash content of Bulla was found 0.2 and 2.39 %, respectively. The highest ash content was observed for OB₄PM₂ (2.78%) whereas the least for B₁PM₁ (1.26%). The ash content of composite flours and porridges were significantly different (p<0.05) to each other. It might be due to the leaching of some minerals from cooking utensils. As the amount of OFSP flour increased in the composite flours, the crude ash content increased. The increment of ash content show that the increasing the density of inorganic material such as minerals present in food.

The protein value for different Bulla based composite flour and porridge were presented in [Table3](#) shows that the highest protein record was for OB₄PM₂ (2.31%) and the least was observed for B₁PM₁ (1.06%). There were significant different (p<0.05) observed among protein content except for OB₄PM₁ and OB₃PM₁. The crude protein content of Bulla was recorded 1.6g/100 g while the protein content of OFSP added Bulla composite flour was in the range of 1.76 to 2.11%. These, value were greater than the crude protein content of Bulla reported values of 0.6 and 0.4-0.8 g/100g by [Tilahun, et al. \[4\]](#) and [Minaleshewa \[2\]](#) respectively. The highest protein content of Bulla composite porridge score was (2.31%) observed in OB₄PM₂. When the percentage of OFSP increases, the protein content of composite flour increased gradually. This might be due to relatively higher protein content of OFSP compared to Bulla. However, protein contents of the composite flours were not enough for daily requirement of healthy person which was in the range of 0.80 to 1.52 g/kg/d [17, 18].

Table-4. Proximate composition (%) of crude fat, carbohydrate, energy and β-carotene of composite flours and porridges

Treatment	Crude fat	Total carbohydrate	Gross energy, Kcal/100gm	β-carotene, µg/100gm
Composite flours				
B ₁ PM ₁	0.26±0.00h	48.78±0.02e	201.07±0.00f	Nil
OB ₁ PM ₁	0.55±0.01g	53.86±0.01d	227.49±0.07d	386.68±0.04d
OB ₂ PM ₁	0.59±0.01f	60.09±0.01c	253.19±0.04c	451.13±0.02c
OB ₃ PM ₁	0.64±0.00e	61.73±0.02b	260.33±0.61b	515.58±0.03b
OB ₄ PM ₁	0.71±0.01d	63.31±0.00a	268.11±0.05 a	558.05±0.00a
Porridges				
B ₁ PM ₂	0.22±0.01i	35.00±0.00h	149.58±0.05 j	Nil
OB ₁ PM ₂	0.71±0.01d	35.21±0.00h	155.27±0.00i	201.46±0.34h
OB ₂ PM ₂	0.74±0.01c	42.71±0.02g	185.98±0.05 h	231.54±0.03g
OB ₃ PM ₂	0.78±0.00b	45.71±0.02f	198.72±0.06g	265.71±0.01f
OB ₄ PM ₂	0.82±0.01a	48.63±0.01e	211.11±0.07e	301.50±0.02e

Note: *PM₁→ treatments before cooking, *PM₂→ treatments after cooking (porridge).

B₁PM₁=100% of Bulla flour, OB₁PM₁=30% OFSP + 70% of Bulla, OB₂PM₁=35% OFSP + 65% of Bulla, OB₃PM₁=40% OFSP + 60% of Bulla and OB₄PM₁=45% OFSP + 55% of Bulla composite flour; B₁PM₂=100% Bulla porridge, OB₁PM₂=30 % OFSP + 70% Bulla, OB₂PM₂=35% OFSP + 65% of Bulla, OB₃PM₂=40% OFSP + 60% Bulla and OB₄PM₂=45% OFSP + 55% Bulla composite flour porridge. Means ± SD, values within the same column with different superscript letters are significantly different from each other (p<0.05).

As it is indicated in [Table 4](#) the fat content of OFSP added Bulla composite flour and porridge were ranged from 0.26 - 0.70 % and 0.22- 0.82%, respectively. The present studied samples were slightly different from [Minaleshewa \[2\]](#) fat content observed value ranged from 0.2 to 0.4 g/100 g. The fat content of the OFSP added Bulla composite flours and porridges were significantly different (p<0.05) to each other. The highest and lowest fat content values were observed for OB₄PM₂ (0.82%) and B₁PM₂ (0.22%), respectively. However, fat content of Bulla composites were not enough to satisfying the daily requirements of adult person. The results indicating that both Bulla and OFSP are poor sources of crude fat.

[Table 4](#) show that the carbohydrate content of OFSP added Bulla composite flour ranged from 48.78 to 63.31%, while that of porridge ranged from 35.00 to 48.63%. The highest and lowest carbohydrate content values were observed for composite flour OB₄PM₁ (63.31%) and porridge B₁PM₂ (35%), respectively. According to [Minaleshewa \[2\]](#) the carbohydrate content of Bulla recorded to be 43.6 to 55.4g/100g, which was less than from the present study finding. There were significant difference (p<0.05) observed between carbohydrate content of the composite flours and porridges. Due to the dilution of more water for porridge processing, the sample contained high amount of water. On the other hand as the percentage of OFSP is increased the carbohydrate content of both the composite flours and porridges were significantly increased. The carbohydrate content of the Bulla composite flour products were somehow enough for satisfying daily requirements of adult person. The findings indicating both Bulla and OFSP were good sources of carbohydrate. The RDA of carbohydrate for healthy person was found to be 130 g/day [18].

The gross energy content of OFSP added Bulla composite flours and porridges were ranged from 201.07 - 268.11 and 149.58-211.11Kcal/100gm, respectively. The highest gross energy content was found for OB₄PM₁ (268.11 Kcal/ 100gm), while the least was for B₁PM₂ (149.58Kcal/ 100gm). The gross energy content were significantly different from each other (p<0.05).

According to the study of [Almaz \[19\]](#) and [Minaleshewa \[2\]](#) the energy content of Bulla was scored 1860 and 1410 -1950 kJ/kg, respectively which were different from present study. The highest energy content of composite flour and porridge were scored for OB₄PM₁ (268.11 Kcal/100g) and OB₄PM₂ (211.11 Kcal/100g), respectively. There were significant difference (p<0.05) between the energy content of composite flour and porridge. When the percentage of OFSP increases in the composite flour, the energy content of composite flour and porridge were

enhanced gradually. This might be due to the relatively higher energy content of OFSP compared to Bulla. The results indicate that the composites are good source of energy.

As mentioned on the previously reported literatures, Bulla was poor in β -carotene content. Therefore, it can be enhanced by the application of β -carotene rich food items to improve the β -carotene of the diet. The effect of addition of OFSP on β -carotene content of Enset (Bulla) based composite flour and porridge is shown in Table 4. The β -carotene content of solar drayed OFSP powder was scored 1280 $\mu\text{g}/100\text{g}$, while the β -carotene content of OFSP added Bulla composite flour values were ranged from 386.68 to 558.05 $\mu\text{g}/100\text{g}$. Similarly, the β -carotene content of the OFSP added Bulla composite porridge values were ranged from 201.46 to 301.50 $\mu\text{g}/100\text{g}$. The highest β -carotene content observed for the composite flour OB₄PM₁ (558.05 $\mu\text{g}/100\text{gm}$) followed by OB₃PM₁ (515.58 $\mu\text{g}/100\text{gm}$) and the least was observed for porridge OB₁PM₂ (201.46 $\mu\text{g}/100\text{gm}$). The β -carotene content of composite flours and porridge were found to be significantly different ($p<0.05$) to each other. According to the study of Stella [6] and Aurélie [20] the β -carotene content of raw OFSP was observed in the ranged values from 1,255 to 2,400 and 1,596 to 2,382 $\mu\text{g}/100\text{g}$ of edible portion, respectively which is different from present study. The β -carotene content of raw OFSP flour comparing with the composite flour was significantly different ($p<0.05$). This might be due to the degradation of β -carotene in the drying process and mixing with food having none β -carotene.

The β -carotene content of composite flour is significantly higher than bulla based porridge ($p<0.05$). This might be due to the effect of cooking temperature on β -carotene content in the preparation of the porridge. On the other hand when the percentage of OFSP increases, the β -carotene content of composite flour and porridge enhanced gradually. This is due to the higher β -carotene content of OFSP compared to Bulla. The results indicate that the composites were good source of β -carotene even though it is less than the one indicated by Stella [6] and Aurélie [20].

According to Kósambo [21] the average β -carotene loss on the finished products of porridge made from OFSP flour was 65%. In the present study the loss of β -carotene content during cooking process of OFSP and Bulla composite flour porridge was 256.55 $\mu\text{g}/100\text{g}$ (45.97%). The finding show that the β -carotene degradation decreased. This might be due to short cooking time, temperature and genetic variation of the crop.

A person who eats 45% OFSP and 55% Bulla composite porridge he/she gain 301.50 μg that was (33.5%) of the daily requirement of adult. The daily requirement of β -carotene of healthy person range between 250 to 900 $\mu\text{g}/\text{day}$ [17, 18].

3.2. Physical and Functional Properties Composite Flours or/and Porridge

Table-5. Physical and functional properties, and pH of bulla based composite flours and porridge

Treatment	pH /100mg	Bulk density, g/ml	WAC, g/ml ³	Viscosity, cps
Composite flours				
B ₁ PM ₁	4.0±0.01c	0.92±0.01a	0.76±0.00e	
OB ₁ PM ₁	4.46±0.01c	0.80±0.01b	1.70±0.10d	-
OB ₂ PM ₁	5.27±0.01b	0.69±0.02c	3.07±0.12c	-
OB ₃ PM ₁	5.64±1.15b	0.61±0.01d	4.00±0.00 b	-
OB ₄ PM ₁	5.71±0.03a	0.58±0.01e	4.87±0.15a	-
Porridge				
B ₁ PM ₂	5.13±0.01c			515±1.00e
OB ₁ PM ₂	5.71±0.00a	-	-	525.67±0.58d
OB ₂ PM ₂	5.73±0.01a	-	-	553.00±1.00c
OB ₃ PM ₂	5.77±0.01a	-	-	624.67±0.58b
OB ₄ PM ₂	5.82±0.02a	-	-	728.00±1.73a

Note: *PM₁→ treatments before cooking, *PM₂→ treatments after cooking.

B₁PM₁=100% of Bulla flour, OB₁PM₁=30% OFSP + 70% of Bulla, OB₂PM₁=35% OFSP + 65% of Bulla, OB₃PM₁=40% OFSP + 60% of Bulla and OB₄PM₁=45% OFSP + 55% of Bulla composite flour; B₁PM₂=100% Bulla porridge, OB₁PM₂=30 % OFSP + 70% Bulla, OB₂PM₂=35% OFSP + 65% of Bulla, OB₃PM₂=40% OFSP + 60% Bulla and OB₄PM₂=45% OFSP + 55% Bulla composite flour porridge. Means ± SD, values within the same column with different superscript letters are significantly different from each other ($p<0.05$). WAC-water absorption capacity, cps-centi pose second.

The pH value of Bulla was 4.00/100mg; OFSP added Bulla composite flour and porridge were found in the range from 4.46-5.82/100mg as presented in Table 5. The highest pH value observed for bulla based porridge OB₄PM₂ (5.82/100mg), while the least value was seen for composite flour B₁PM₁ (4.00/100mg). This might be due to cooking temperature increases the pH value of the samples by denaturing the amino acids in the food. As the percentage of OFSP increases, the pH value of composite flour and porridge were enhanced.

The composite flour pH values were significantly different ($p<0.05$) to each other. While the pH values for porridges were not significantly different ($p>0.05$) to each other. According to the study of Kalekristos [3] Bulla bought from Addis Ababa supper market pH value was 4.9/100mg which was less acidic compared to present study.

As mentioned in previous sections, the bulk density of a powder depends on how closely individual particles packed together and it play important roles during mixing in dough formation [14]. The bulk densities for Bulla was 0.92 g/ml, OFSP added Bulla composite flour were ranged from 0.58-0.91g/ml. The highest bulk densities was observed for B₁PM₁ (0.92g/ml) while the least was for OB₄PM₁ (0.58g/ml). The bulk densities of OFSP added Bulla composite flours were significantly different from each other ($p<0.05$). As the amount of OFSP powder increases in the composite, the bulk density decreased gradually. This is due to particle size of OFSP is less than Bulla.

The water absorption capacity of flour indicates how much water to add during food preparation and interrelated to gelatin properties. Hence, the low water absorption capacity recorded by the flours could explain the less gel formation capacity [16]. The finding of the water absorption capacity of Bulla in this study was 0.76 ml/g, while the

water absorption capacity of OFSP added Bulla composite flours were ranged from 1.70 to 4.87 ml/g as shown in Table 5. As the amount of OFSP flour increases in the composite, the water absorption capacity increased gradually. This might be due to the water absorption capacity of OFSP powder was higher compared to Bulla flour. The highest water absorption capacity of OFSP added Bulla composite was for OB₄PM₁ (4.87 g/ml³) and the least was for B₁PM₁ (0.76 g/ml³). There were significantly different from each other (p<0.05).

The value of viscosity of Bulla porridge was 515.00 c.p.s, OFSP added Bulla composite flours porridge were ranged from 525.67-728.00 c.p.s. (see above Table 5). The highest viscosity value was observed for OB₄PM₂ (728.00 c.p.s) followed by OB₃PM₂ (624.67) and the least for B₁PM₂ (515.67 c.p.s.). There were significantly difference (p<0.05) between each treatment. As the amount of OFSP flour increases in the composite flours, the viscosity of the porridge was also increased. This might be due to the water absorption capacity of the OFSP flour. The higher the viscosity is a desirable quality attribute of flour for cooking purpose. Liquids make up of small molecules have a low viscosity and liquids with long chain molecules have a much higher viscosity [22].

3.3. Sensory Evaluation of Bulla Based Composite Flours Porridge

Table-5. Organoleptic evaluation score of OFSP added Bulla composite flours porridge

Parameters				
Porridge	Color	Odor	Flavor	Overall acceptability
B ₁ PM ₂	1.05±0.12e	1.00±00 e	1.30±1.00 e	1.25±0.30 e
OB ₁ PM ₂	2.63±1.08d	2.62±1.09d	2.60±1.06d	2.58±0.99d
OB ₂ PM ₂	2.80±0.78c	2.84±0.85c	2.83±0.80c	2.89±0.77c
OB ₃ PM ₂	3.36±0.92b	3.36±0.95b	3.37±1.05b	3.53±0.94b
OB ₄ PM ₂	4.28±0.87a	4.33±0.82a	4.39±0.83a	4.45±0.76a

Note: *PM₁→ treatments before cooking, *PM₂→ treatments after cooking.

B₁PM₁= 100% of Bulla flour, OB₁PM₁=30% OFSP + 70% of Bulla, OB₂PM₁=35% OFSP + 65% of Bulla, OB₃PM₁=40% OFSP + 60% of Bulla and OB₄PM₁=45% OFSP + 55% of Bulla composite flour; B₁PM₂=100% Bulla porridge, OB₁PM₂=30 % OFSP + 70% Bulla, OB₂PM₂= 35% OFSP + 65% of Bulla, OB₃PM₂=40% OFSP + 60% Bulla and OB₄PM₂=45% OFSP + 55% Bulla composite flour porridge. Means ± SD, values within the same column with different superscript letters are significantly different from each other (p<0.05).

The porridges were prepared by blending of OFSP and Bulla in different combination were analyzed for various sensorial attributes for their acceptance by using 5 point hedonic scale. When you are offering a new product or changing ingredients of food items, it is important to know what likely the consumer reaction is to be to the characteristics of your product. At the present study all panelists were instructed to make their own individual assessments, according to the evaluation criteria provided for each samples on the basis of, color, odor, flavor and overall acceptability. The organoleptic evaluation of OFSP and Bulla composite flours porridge score values ranged from 1.05-4.28, 1.00-4.33, 1.3-4.39 and 1.25-4.45 for attributes of color, odor, flavor and overall acceptability, respectively as indicated in above Table 6. There were Significant difference (p<0.05) was observed among the treatments. The highest preferences of Bulla composite porridge by color, odor, flavor and overall acceptability were scored 4.28, 4.33, 4.39 and 4.45, respectively. It was observed that the Bulla based porridge sample OB₄PM₂, prepared by addition of 45% OFSP flour was liked most by sensory panelist as compared to the other combinations. The least preferred Bulla composite porridge OB₁PM₂ was scored 1.05, 1.00, 1.30 and 1.25 for color, odor, flavor and overall acceptability, respectively. The evaluation results of the panelist's preferences were increases as the ratio of OFSP increases in the composite flours.

4. Conclusion

As Orange-fleshed Sweet Potato (OFSP) percentage increased in the composite flours and porridge; gross energy, β-carotene content, pH, water absorption capacity and viscosity were enhanced. However, an increased amount of OFSP in Bulla flour and its corresponding products do not made them to be good source of crude fiber, protein and fat. The composite flours porridge OB₄PM₂ was preferred by panelists in terms of the sensory attributes of color, odor, flavor and overall acceptability.

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