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Research Article

Quality, microbiological and sensory properties of "*robo*" supplemented with orange-fleshed sweet potato flour

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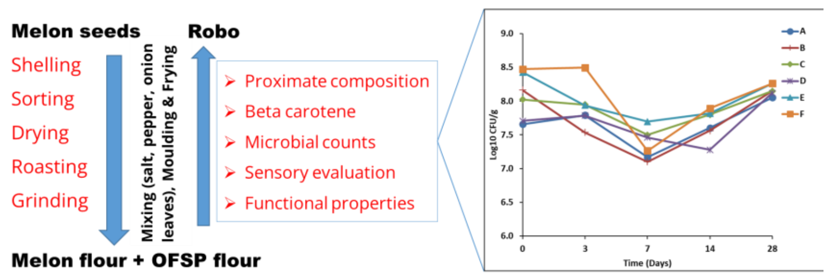
ABSTRACT
This study determined the chemical, microbiological and sensory properties of a traditional snack, *robo*, produced from defatted melon seeds flour supplemented with orange-fleshed sweet potato (OFSP) flour in the proportions of 95:5 (as sample B); 90:10 (C); 85:15 (D); 80:20 (E); and 75:25% (F), respectively, while sample A (100% of defatted melon flour) was the control. The functional properties of the flour samples, as well as the proximate composition, microbial counts, and sensory qualities of the produced "robo" samples were determined using standard methods. The flours exhibited good flow properties in their functionality with the control having the best values. The protein content of the "robo" samples decreased with increasing supplementation of OFSP flour (32.41–29.72%), while the contents of other nutrients, carbohydrate (20.62–27.40%); ash (4.31–6.21%) and crude fibre (2.12–3.79%), increased as the OFSP flour supplementations increase. However, the moisture and fat contents of the samples did not exhibit a definite pattern. There were significant differences in the beta carotene content of the samples, however, it was better retained. The bacterial and fungal counts were within the safe limit after the 28-day storage period. All the samples were acceptable to the panellist. Sample A (100% defatted melon seed flour) was the most preferred in terms of colour, sample E in terms of crunchiness, and sample F in terms of taste, texture, and overall acceptability.



HIGHLIGHTS
- Improved *robo* snacks, containing orange-fleshed sweet potato flour were made.
- The snacks were shelf stable after 28 days of storage period.
- The snacks improve vitamin A content.
- Sensorily, the robo was generally acceptable as snacks.

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1. Introduction

Vitamin A deficiency remains a public health problem in most countries, particularly in Africa where meat intake is very low, which is mostly manifested in young children and pregnant women (Reboul, 2013). Globally, 250 million preschool children and 19 million pregnant women are at risk of vitamin A deficiency. According to WHO 2016, 250,000-500,000 preschool children go blind yearly, while 125,000-250,000 dies yearly after losing sight. In Nigeria, between 34 and 69% of childhood blindness is attributable to vitamin A deficiency (Aghaji, *et al*., 2019). Several adopted strategies to improve vitamin A status include dietary diversification, fortification and supplementation etc. (Akhtar *et al*., 2013), employing strategies which include the promotion of the cultivation of Orange fleshed sweet potato as a nutrition intervention in tackling vitamin A deficiency and food insecurity in many countries (Van and Franke, 2018; Owade *et al*., 2018).

Orange fleshed sweet potatoes have vitamins A (300-1300 µg), C (22.7 mg), E (0.26 mg), and K; several B vitamins and appreciable amounts of magnesium (25mg) and potassium (337 mg) (Bovell-Benjamin, 2010; USDA National Nutrient Database for Standard Reference, 2011). On average, nutritional compositions (dry matter) per 100g fresh weight are 25.09-38.56g protein, 2.03-4.19g fat, 1.74-2.22g carbohydrates, 14.46-22.86g ash, 3.03-4.70g fibre, 2.19-3.00 energy value (kCal) 90.24-153.63, starch (g) 7.840-16.934, reducing sugars (mg) 335-1086, total sugars (mg) 610-24268 (*Sanoussi et al*., *2016*, *Omodamiro et al., 2013; Nabubuya et al., 2012*). Consumption of orange-fleshed sweet potato has been linked to an increase in vitamin A intake, as well as an increase in serum retinol concentrations in children. (Kurabachew 2015; Bonsi *et al*., 2014). It can contribute to the colour, flavour, taste and dietary fibre of processed food

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products such as bread, pasta products, and in other food preparations (Kaguongo, 2012; Ofori *et al.,* 2009).

Several food products have been developed wholely from OFSP or using it as a composite flour in the extrusion process (Olubunmi *et al.,* 2017; Honi *et al.,* 2017; Omodamiro and Ani, 2015), cake, doughnuts and biscuits production (Rangel *et al.,* 2011; Sindi *et al.,* 2013) and bread making (Bibiana *et al*., 2014; Awuni *et al.,* 2017; Owade *et al.,* 2018) while its use in *robo* production has not been reported.

robo is a traditional snack locally produced from defatted melon seeds which are seasoned for a desirable taste and formed into balls or cakes that are then deep fried. It is widely consumed in the western part of Nigeria, mostly with carbohydrate-rich meals like *gari* and *ogi* (Adeyeye *et al.*, 2020).

Several researchers have reported on the production of *robo* from different vegetable sources such as melon seeds (Ejoh and Ketiku, 2013; Aletor and Ojelabi, 2007), groundnut (Osuolale and Olayiwoola, 2014), sesame seeds (Makinde and Ebim, 2015) and watermelon seed (Adeyeye *et al*., 2020). Ejoh and Ketiku (2013) produced defatted fried cake from groundnut and melon to determine the level of vitamin E content which was not significantly different. Osuolale and Olayiwoola, (2014) evaluated the quality of pepper spiced *robo* produced from defatted groundnut and melon having high concentrations of protein, ash and fibre contents. The values for melon *robo* were higher than that from groundnut. Makinde and Ebim (2015), who produced *robo* from melon and sesame seeds reported that they both contained an appreciable amount of protein, ash and fibre contents. Adeyeye *et al*. (2020) reported that the protein, fat, fibre and ash contents of *robo* produced from watermelon seed were lower than that from melon seed, but the moisture and carbohydrate contents were higher. Oladimeji and Kolapo (2008) evaluated the proximate composition of stored defatted residues of some oil seeds and found that defatted melon residue had the highest decrease in protein, ether extract and carbohydrate contents compared with the fresh product.

The major raw material of *robo* is melon, with about 9.30% moisture, 3.33% ash, 42.8% fat, 25.36% protein and 15.31% carbohydrate. It is rich in oil and protein but poor in carbohydrates and vitamin A (Bello *et al*., 2019). Low carbohydrate and vitamin A content could be compensated for when combined with OFSP for the production of *robo*, which formed the focus of the study. The objective of the study, therefore, was to improve the carbohydrate and vitamin A content of *robo* through supplementation of melon flour with orange-fleshed sweet potato flour*.* Standard methods of AOAC (2005), Onwuka (2005), Abbey and Ibeh (2000), Omafvube *et al.* (2004) and Iwe (2003) were used to carry out proximate, functional, microbial and sensory qualities.

2.0 Methodology

2.1 Materials

Melon seeds, dry bell pepper, onion leaves, and salt were purchased from the Ipata market in Ilorin Kwara State, while Orange fleshed sweet potato was sourced from Root Crops Research Institute, Ajasepo, Kwara State.

2.2 Processing of orange-fleshed sweet potato flour

Orange-fleshed sweet potato tubers were washed, peeled, sliced, and dried with a dehydrator (40-50 °C for one hour). Dried tubers were milled with an attrition milling machine, sieved and packaged in an airtight polythene bag until use.

2.3 Production of robo supplemented with OFSP

Melon seeds were shelled and dried; the dried seeds were then roasted in frying a pan for 15 min to obtain a puffy and light brown colouration. The roasted seeds were blended and then mixed with salt, ground dry pepper and onion leaves. The mash was then defatted manually by kneading with the addition of hot water (200ml) for 30 mins until the oil flowed out. The oil was collected and kept for further use.

2.4 Sample formulation

Robo was prepared by substituting defatted melon flour with portions of orange-fleshed sweet potato flour as shown in Table 1. The traditional method described by Sobukola *et al.* (2009) was employed for the preparation of *robo* but with a little modification. All materials were mixed and kneaded into a cake-like mass. The resulting cake was moulded into ball shapes and fried for 10 min, in the oil extracted from the mash, until brown and hard. *robo* samples were then allowed to cool and stored in an air-tight plastic container for analysis.

Table 1: Recipe and formulation for the production of *robo*

Sample	Melon seed (g)	OFSP flour (g)	Spices (pepper, onion leaves and salt) (g)
A(100:0)	200	0	10
B(95:5)	190	10	10
C(90:10)	180	20	10
D(85:15)	170	30	10
E(80:20)	160	40	10
F(75:25)	150	50	10

Source: Osuolale and Olayiwoola (2014)

2.5 Functional properties

The functional properties of the samples were determined. The method of Onwuka (2005) was adopted for bulk density (BD) while water absorption capacity (WAC), oil absorption capacity (OAC) and swelling index of the melon and OFSP blends were determined using the method of Abbey and Ibeh (2000).

2.6 Proximate analysis

The moisture, ash, crude fibre, crude protein, and crude fat contents were determined using the method of AOAC (2005), while carbohydrate was calculated by difference.

2.7 Beta carotene

Beta carotene was determined from dried methalonic extract. 100 mg of extract was added to 10 mL acetone-hexane mixture (4:6), mixed for 1 min and filtered. The absorbance was recorded at three wavelengths (453 and 663 nm). Beta carotene content was calculated as follows according to Eqn. 1.

$$\text{Beta carotene}\left(\frac{\text{mg}}{100\text{ mL}}\right) = (0.216 \text{ x A663}) - (0.304 \text{ x } 0.452 \text{ x A453}) \quad \text{Eqn. 1}$$

2.8 Colour attributes

The colour attributes (Hunter L, a, and b values) of the *robo* were evaluated using a LAB Chroma-meter. The hunter lab colour coordinates system L*****, a***** and b***** values were recorded. The lightness (L*), redness (a*), and yellowness (b*) values were obtained after calibrating the instrument using a white tile and the brown index was calculated. Each sample was measured at three spots using standard L***=**53.44, a*=-24.94 and b*=12.94. The whiteness index was calculated (Chen *et al.*, 2010) and averages of the reading were recorded.

2.9 Microbial analysis

The method enumerated by Omafvube *et al.* (2004) was used to determine the microbial load of the *robo.* Bacteria and fungi counts were expressed as colony-forming unit per gram (cfu/g) of samples. The means of the duplicate plate were recorded.

2.10 Determination of sensory properties of robo

Organoleptic properties (appearance, texture, taste, crunchiness and overall acceptability) of *robo* were carried out using fifty trained panellists who were familiar with the consumption of *robo*. A-9 point hedonic scale was used ranging from 9 (like extremely) to 1 (dislike extremely) (Iwe, 2003).

2.11 Statistical analysis

All experiments were carried out in duplicates. The mean was compared by Duncan's multiple range tests. The data obtained were subjected to analysis of variance (ANOVA) using SPSS (version 20, IBM SPSS Statistics, US).

3.0 Results and Discussion

3.1 Functional properties of robo supplemented with orange-fleshed sweet potato flour

Functional properties are those parameters that determine the application and use of food material for various food products (Adebowale *et al.*, 2012). Table 2 shows the result of defatted melon flour with OFSP. Oil absorption capacity values increased with an increase in the inclusion of OFSP flour. The values ranged from 143% (in sample A) to 175% (in sample F). The value was higher than the 128.8% of melon balls produced by Aletor and Ojelabi (2007) but lower than the 235.30% reported by Osuolale and Olayiwoola (2014). The increase in the oil absorption capacity of the *robo* samples could be due to the affinity of the OFSP flour for oil (169). However, the values were still low; hence, this suggests that it will reduce the vulnerability of *robo* to rancidity and could make the formulation useful in food preparation, where oil incorporation is involved such as in frying, where oil is an important ingredient (Fagbemi and Olaofe, 2000).

Water absorption capacity refers to the water retained by a food product following filtration and application of mild pressure of centrifugation (Kolawole and Chidinma, 2015). The water absorption capacity of sample A (170%) was higher than the 70% from melon ball reported by Aletor and Ojelabi (2007), lower than the 270% reported for melon flour by Osuolale and Olayiwoola (2014) but similar to the 166% reported for maize flour by Ayinde *et al.* (2012). The sample C had the highest water absorption capacity which makes it suitable for the formulation of some foods such as sausages, doughs and soups (Oshodi *et al.*, 1999). Also, higher water absorption of the flour enables freshness in cakes, bread and sausage (Kolawole and Chidinma, 2015).

Bulk density results ranged from 52%-60%, with the control sample having the least value, while sample B had the highest value. The values were lower than the 83% reported by Osuolale and Olayiwoola (2014) and 90% reported by Aletor and Ojelabi (2007). The low bulk density of the samples will be of positive significance for packaging and shipment purposes. The swelling capacity ranged from 16.3g/ml (A) to 3.64g/ml (E). The interaction between protein and starch structure of the formulation could have affected the swelling capacity of other samples. Higher protein content in the flour may cause the starch granules to be embedded within a stiff protein matrix, which subsequently limits the access of the starch to water and restricts its swelling capacity (Akpapunam and Darbe, 1999).

Solubility is an index of the ease of reconstitution of the flour samples in water. The values ranged from 7.17%-15.79%. According to Pomeranz (1991), the solubility value and swelling power of starch may be due to the protein-amylose complex formation in isolated starches. Sample A had the highest value,

Table 2: Functional properties of *robo* supplemented with OFSP flour

Samples	Bulk density (g/ml)	Swelling index (g/ml)	WAC (%)	OAC (%)	Solubility (%)
A	0.52^{d}±0.00	1.63^{d}±0.35	170^{d}±4.24	143^{a}±2.83	15.79^{a}±0.04
B	0.60^{a}±0.00	3.08^{c}±0.00	296^{ab}±1.41	169^{ab}±1.41	7.17^{c}±0.24
C	0.60^{a}±0.00	3.30^{b}±0.00	304^{a}±2.82	169^{ab}±1.41	7.50^{c}±0.01
D	0.57^{b}±0.00	3.57^{a}±0.00	282^{bc}±4.95	170^{ab}±2.12	7.55^{c}±0.04
E	0.55^{c}±0.00	3.64^{a}±0.13	281^{c}±0.71	173^{ab}±2.12	7.58^{c}±0.06
F	0.55^{c}±0.00	3.59^{a}±0.01	283^{bc}±2.12	175^{a}±3.54	9.57^{b}±0.19
G	0.57^{b}± 0.00	3.14^{c}±0.68	309^{a}±2.83	169^{b}±0.71	10.66^{b}±0.03

Value with the same superscripts along the column were not significantly different (p<0.05). The *robo* samples have melon to orange fleshed sweet potato flour ratios thus: A = 100:0; B = 95:5; C = 90:10; D = 85:15; E = 80:20; F = 75:25 and G = 0:100

Table 3: Proximate composition of *robo* supplemented with orange-fleshed sweet potato flour

Samples	Moisture (%)	Crude fat (%)	Ash (%)	Crude Fibre (%)	Crude protein (%)	Carbohydrate (%)
A	$3.34^{e}\pm0.04$	$37.22^{a}\pm0.05$	$4.31^{e}\pm0.01$	$2.21^{f}\pm0.02$	$32.41^{a}\pm0.02$	$20.62^{f}\pm0.10$
B	$4.25^{c}\pm0.00$	$33.55^{b}\pm0.02$	$4.46^{de}\pm0.02$	$2.29^{e}\pm0.09$	$31.18^{b}\pm0.02$	$24.29^{e}\pm0.06$
C	$6.47^{a}\pm0.06$	$29.89^{c}\pm0.01$	$4.64^{cd}\pm0.01$	$3.10^{d}\pm0.01$	$31.04^{c}\pm0.04$	$24.87^{d}\pm0.08$
D	$5.29^{b}\pm0.02$	$30.04^{c}\pm0.02$	$4.76^{c}\pm0.05$	$3.26^{c}\pm0.00$	$30.57^{d}\pm0.01$	$26.10^{c}\pm0.07$
E	$4.07^{d}\pm0.02$	$30.06^{c}\pm0.08$	$5.37^{b}\pm0.24$	$3.51^{b}\pm0.06$	$29.82^{e}\pm0.11$	$27.25^{a}\pm0.04$
F	$3.04^{f}\pm0.02$	$29.85^{c}\pm0.23$	$6.21^{a}\pm0.11$	$3.79^{a}\pm0.01$	$29.72^{f}\pm0.02$	$27.40^{a}\pm0.04$

Value with the same superscripts along the column were not significantly different ($p<0.05$)
The *robo* samples have melon to orange fleshed sweet potato flour ratios thus: A = 100:0; B = 95:5 C = 90:10; D = 85:15; E = 80:20 and F = 75:25.

indicating a high and fast dissolution ability in aqueous solution or during food processing than other samples, and this may be due to the level of protein concentration in the sample.

3.2 Proximate analysis of robo supplemented with OFSP flour.

Proximate compositions of the samples are presented in Table 3. The result showed a significant decrease in the quantity of the protein content ($p\leq0.05$) with an increasing quantity of OFSP in the supplementation. The protein content decreased from 32.41-29.72% with sample F (75:25) having the lowest value, while the control (A) had the highest value. Values obtained were lower than 40.30% reported by Osuolale and Olayiwoola (2014) for *robo* produced with pepper and 41% for *robo* produced without pepper. However, it was in the same range with 32.40% reported by Aletor and Ojelabi (2007) and 30.18- 30.90% reported for *robo* produced from watermelon seed and melon seed by Adeyeye *et al.* (2020). The low protein content may be due to the denaturation of proteins during frying and the inclusion of orange-fleshed sweet potato flour.

The fat content of *robo* produced from the control had the highest value (37.22%) and was higher than 17.10% reported in *robo* produced with pepper and 17.73% in that without pepper as reported by Osuolale and Olayiwoola (2014). The value was equally higher than 19.2% in the snacks produced from the defatted residue of melon (Oladimeji and Kolapo, 2008). However, the values were lower than 40.5–45.6% reported in the *robo* samples reported by Makinde and Ibim (2015) but were in the same range as the 37.52–39.24% reported for *robo* produced from watermelon seed and melon seed (Adeyeye *et al.*, 2020). The high-fat content and the fluctuation in values could be a result of the deep frying method of processing *robo*.

Crude fibre content increased from 2.21% to 3.79% in the samples. The values were similar to the value of 3.19% obtained in the melon cake sample produced by Bello *et al.* (2018) but lower than the range of 5.97-6.31% reported by Adeyeye *et al.* (2020), 5.39% for traditional cake reported by Udoidem and Enwere (2012) and 4.5% for defatted residue reported by Oladimeji and Kolapo, (2008). Crude fibre aids the digestive system in human (Ayinde *et al.*, 2012) and according to Lattimer and Haub, 2010, a correlation exists between fibre consumption and the risk of coronary heart disease and general types of cancer.

The ash content increased from 4.31- 6.21%. The values were lower than the 7.1% reported by Osuolale and Olayiwoola (2014) in peppered *robo,* but comparable to 5.04-5.82% reported for *robo* produced by Adeyeye *et al.* (2020); melon cake snacks reported by Bello *et al.* (2018) and 5.39% in melon cake sample reported by Udoidem and Enwere (2012). Increased ash content could be attributable to the addition of OFSP flour.

The carbohydrate content increased with an increase in OFSP flour supplementation, with values increasing from 20.62-27.40%, which could be due to the high carbohydrate content of sweet potato 90mg/100g (Rodrigues *et al.*, 2016). Moisture content (MC) of *robo* samples is found to be in the range of 3.04-6.47%. The sample with 10% OFSP has the highest value of 6.47% while the control *robo* has 3.34%, which was lower than the value reported by Osuolale and Olayiwoola (2014), but similar (6%) to that reported by Aletor and Ojelabi (2007). The moisture content does not exhibit a definite pattern; this may be due to the frying temperature which was not automated.

3.3 Beta carotene content of robo supplemented with OFSP flour.

The beta carotene content of samples A, B, C, D, E and F ranged between 363.2-2210 µg/100 g, with sample A having the lowest value (363.2 µg/100 g) and sample F, the highest value (2210µg/100g), as shown in Table 4. There were significant differences among the samples; however, retention in the β-

Table 4: Beta carotene content of *robo* supplemented with OFSP flour

Samples	Beta carotene (µg/100 g)	*Vitamin A(µg RAE)
A	$363.2^{c}\pm0.06$	-
B	$2160^{ab}\pm0.28$	180
C	$1965^{b}\pm0.35$	163.8
D	$2025^{ab}\pm0.50$	168.8
E	$2205^{a}\pm0.21$	183.8
F	$2210^{a}\pm1.56$	184.2

Value with the same superscripts along the column are not significantly different ($p<0.05$). The *robo* samples have melon to OFSP flour ratios thus: A = 100:0; B = 95:5 C = 90:10; D = 85:15; E = 80:20 and F = 75:25.

carotene content of the *robo* samples. The beta carotene is converted to the active form of vitamin A in the body. As a standard, 12 µg β-carotene is equal to 1 µg Retinol Activity Equivalent (RAE) (Tadesse *et al.,* 2015). The high values of vitamin A retained in the *robo* will be of positive and significant importance to the consumers of the snacks and thereby reduce the prevalence of vitamin A deficiency.

3.4 Colour analysis of robo supplemented with OFSP flour

The Colour of food samples generally is one of the factors used in determining the acceptability of food products. L* indicates lightness (0 to 100) with 0 being black and 100 being white. The coordinate a∗ is for red (+) and green (−), and b∗ is for yellow (+) and blue (−). The limits for a∗ and b∗ are approximately ±80. For the L* value, the control sample had the highest value of 47.93 which tended towards whiteness/lightness, while sample F had the least value of 40.71, which tended towards darkness. The values decreased with increasing quantities of OFSP flour from 47.93 (A) to 40.71 (F), with significant differences noticed among the supplemented samples. With increasing supplementations of the OFSP flour, the *robo* sample became darker, and this could be due to the Maillard reaction that occurs between amino acids in melon and the carbohydrates of OFSP flour.

Table 5: Colour of *robo* supplemented with OFSP flour

Samples	L*	a*	b*
A	$47.93^{a} \pm 0.34$	$7.28^{a}\pm0.48$	$16.47^{a}\pm0.62$
B	$42.04^{b} \pm 0.52$	$4.79^{bc}\pm0.53$	$10.30^{b}\pm0.85$
C	$41.58^{bc} \pm 0.47$	$4.10^{c}\pm0.12$	$8.94^{c}\pm0.30$
D	$42.19^{b} \pm 0.66$	$5.10^{b}\pm0.51$	$10.30^{b}\pm0.73$
E	$41.13^{cd} \pm 0.35$	$4.40^{bc}\pm0.39$	$9.47^{bc}\pm0.44$
F	$40.71^{d} \pm 0.41$	$3.91^{c}\pm0.65$	$8.84^{c}\pm0.74$

Value with the same superscripts along the column are not significantly different ($p<0.05$). The *robo* samples have melon to OFSP flour ratios thus: A = 100:0; B = 95:5 C = 90:10; D = 85:15; E = 80:20 and F = 75:25.

The results show that a* for the control sample had the highest value (7.28), which tended towards redness, while sample F had the least value (3.91) which tended towards green. This could be due to the high sugar content of the OFSP flour. The values of the colour parameters were significant among the supplemented samples.

The results show that the b* of the control (A) sample was the highest (16.47), and tended towards yellowness while sample F had the least value (8.84), which tended towards blueness or darkness of the sample. Significant colour differences were noticed among the samples supplemented with OFSP flour.

3.5 Microbial analysis

The bacterial and fungal counts of the various *robo* samples were determined for 4 weeks (Figure 1). It was observed that the bacterial counts initially reduced but later began to rise after Day 7, except for samples A, D and F, which had an initial surge in the bacterial population. Sample A, which was the control, had the lowest bacterial population at production with a Log10 value of 7.6 and remained low till the end of the experiment. Contrary to the above statement, the highest bacterial count of 8.5 was observed in sample F, which has the highest OFSP flour inclusion level of 25 %. These values were higher than those reported by Sobukola *et al.* (2009) and Osuolale and Olayiwoola (2014). The microorganisms could have been introduced into the *robo* snack during various post-frying stages such as during the cooling, handling and packaging stages. The general trend of the bacterial population is A<D<C<B<E<F. This trend suggests that increasing the content of OFSP flour supports bacterial colonization of the *robo* at the production stage. This could be due to the native microorganisms in the OFSP flour and high starch content which encourage the proliferation of amylolytic bacteria. The reasons for the disparate, lower counts in sample D are not immediately obvious but could be due to their higher moisture contents (Table 3), which means less *robo* material was sampled. By the 28th day, however, the counts were relatively similar, indicating that the OFSP flour inclusion level did not considerably impact the *robo* samples over a long period. The dip in counts by day 7 suggests the replacement of the native microorganisms with another class, likely the osmophiles, which are tolerant of low moisture content and water activity environments in a succession.

The fungal population of all the samples follows the typical growth curve. The counts rise steadily after an initial lag phase

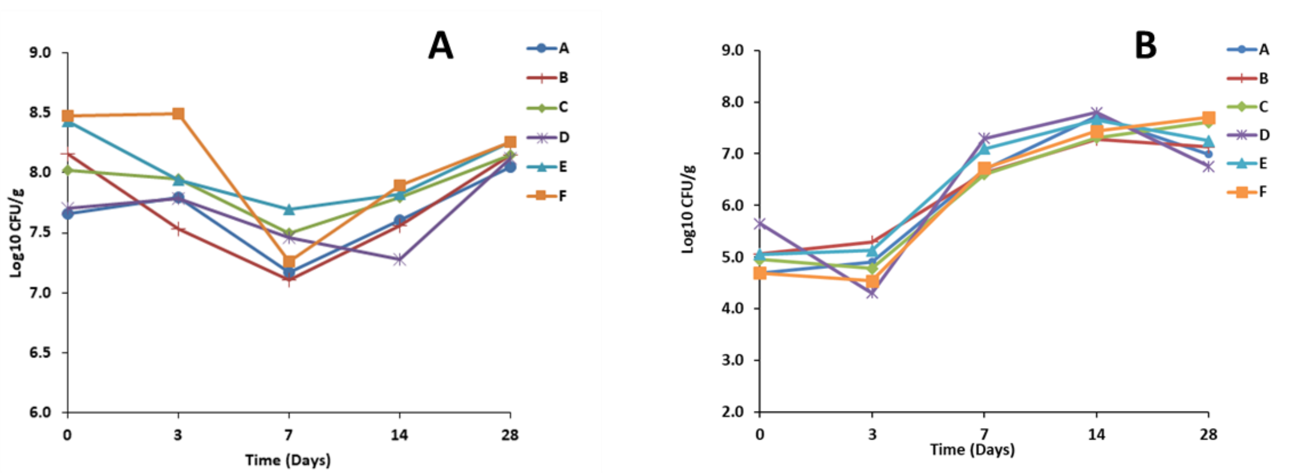

Figure 1: (A) Log10 values of bacterial counts of *robo* samples held at room temperature over 28 days. (B) Log10 values of fungal counts of *robo* samples held at room temperature over 28 days. The *robo* samples have melon to OFSP flour ratios thus: A = 100:0; B = 95:5 C = 90:10; D = 85:15; E = 80:20 and F = 75:25.

Table 6: Mean sensory scores of *robo* supplemented with OFSP flour

Samples	Appearance	Crunchiness	Taste	Texture	Overall acceptability
A	$7.70^{a}±0.95$	$5.67^{b}±1.97$	$6.25^{a}±1.47$	$6.33^{a}±1.67$	$6.77^{a}±1.72$
B	$6.03^{bc}±1.97$	$6.37^{ab}±1.47$	$6.23^{a}±2.11$	$6.40^{a}±1.83$	$6.73^{a}±1.89$
C	$6.43^{b}±1.22$	$5.83^{ab}±2.25$	$6.30^{a}±1.56$	$6.23^{a}±1.33$	$6.43^{a}±1.46$
D	$4.53^{d}±2.08$	$6.47^{ab}±1.81$	$6.00^{a}±2.05$	$6.20^{a}±1.75$	$6.50^{a}±1.48$
E	$5.43^{cd}±2.14$	$6.80^{a}±1.16$	$6.70^{a}±1.06$	$6.57^{a}±1.52$	$6.47^{a}±1.61$
F	$5.30^{cd}±2.35$	$6.63^{ab}±1.79$	$6.80^{a}±1.61$	$6.90^{a}±1.57$	$6.97^{a}±1.67$

Values with the same superscripts along the column were not significantly different (p<0.05). The *robo* samples have melon to orange fleshed sweet potato flour ratios thus: A = 100:0; B = 95:5 C = 90:10; D = 85:15; E = 80:20 and F = 75:25.

from Log10 values of 4.7 - 5.0, then plateaus at a Log10 value of 7.6 before declining. This was due to the low moisture content of the samples, and the environment which supports fungal growth. Generally, the inclusion of the OFSP flours did not seem to considerably affect the fungal population of the *robo* samples.

3.6 Mean sensory scores

The appearance of the control *robo* sample was rated best (7.70). Appearance provides information about the formulation and quality of the product (Hussain *et al.,* 2006). The mean score of the appearance decreased from 7.70 to 4.53. With increasing levels of OFSP flour in the formulation, *robo* became darker likely due to the Maillard reaction that occurs between amino acids protein in melon seeds flour and the sugar content of the OFSP flour during frying. The supplementation of the defatted melon flour with OFSP flour showed a significant difference when compared with the control sample. This indicated that when sample appearance was considered, melon seed flour supplemented with OFSP flour will have low acceptability for *robo* production.

Taste is the main factor to determine the acceptability of the product (Banureka and Mahendran, 2009). There were no significant differences in the taste of the samples at (p≤0.05) but the *robo* containing 25% (F) of OFSP flour had the highest mean score of 6.80.

The crunchiness of *robo* of the sample with 20% (E) OFSP flour had the highest mean score of 6.80 which was the most acceptable. The crunchiness increases with an increase in orange-fleshed sweet potato, suggesting that the crunchiness of *robo* was accepted with an increase in the OFSP flour addition. This could be due to the high starch content of OFSP. There were no significant differences among the samples at 5% level for overall acceptability. Samples with 5 and 25% were generally accepted by the consumers.

4.0 Conclusions

The study revealed that *robo* supplemented with orange-fleshed sweet potato (OFSP) flour is a nutritious snack for its protein, fat, carbohydrate, energy and Vitamin A nutrients. The increase in carbohydrate content can contribute to the daily energy requirement. It also has the potential to increase the vitamin A status of *robo* consumers because the beta-carotene content was converted to Retinol Activity Equivalent. Functional properties of the blend of melon–OFSP flour revealed that the combination can be used for other frying products because of the low oil absorption capacity. The values for the swelling index also revealed that the flour blends can be used in dough formation. The microbial investigation showed that bacterial counts in all blends declined within a week, but long-term storage encouraged the proliferation of both fungi. All the samples had high microbial counts but were within safe limits. The sensory evaluation shows that all the samples were acceptable to the panelists. However, the control sample (A) was the most preferred in terms of colour, sample E was the most preferred in terms of crunchiness, and sample F was the most preferred in terms of taste, texture, and overall acceptability.

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