

## **INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & MANAGEMENT**

### **NOVEL FOOD PRODUCT FROM BLENDS OF OFSP, MAIZE AND EDIBLE AGRO WASTE (OKARA): IMPLICATION FROM WASTE TO WEALTH**

**OMODAMIRO\*<sup>1</sup>, R.M AND ANI<sup>2</sup>, J.C**

<sup>1</sup> National Root Crops Research Institute, Umudike, Abia State. Nigeria

<sup>2</sup> University of Nigeria, Nsukka, Enugu State. Nigeria.

---

#### **ABSTRACT**

Okara is a huge (35%) by-product generated from soymilk processing. It contains about 24% protein (dry weight) among other nutrients. The huge quantities of okara produced annually pose a significant disposal problem in Nigeria due to increase in soymilk production. Hence the aim of this study is to research into its food use. Composite blend made up of okara, residue from Orange-Fleshed Sweetpotato (OFSP) beverage processing and maize flours were evaluated for suitability in snack preparation. Simplex Centroid Design (SCD) - experimental software package was used to formulate blends of fourteen (14) runs, each was mixed to obtain dough of 45.88g/100g moisture content and then extruded using a single screw extruder. Proximate compositions of the flour were analyzed. The white maize flour had moisture content 9.47, crude protein 1.17, fat 0.00, ash 2.22, and carbohydrate 81.14%; OFSP flour had moisture content 11.55, crude protein 5.14, fat 8.35, ash 2.55, and carbohydrate 72.42%, okara had moisture content 8.85, crude protein 23.58, fat 20.00, ash 2.21, and carbohydrate 45.36% while the extruded snacks had moisture content 12.15, crude protein 20.83, fat 15.43, ash 2.51, and carbohydrate 49.05%. The extrudates (Nobel snacks) were subjected to sensory evaluation. Blend ratio of 80:10:10 and 67:17:17 (OFSP: okara: white maize) were mostly acceptable and were not significantly different ( $p > 0.05$ ) from each other in term of colour and aroma. However snack from 67:17:17 (OFSP: okara: white maize) was mostly acceptable and significantly different ( $p < 0.05$ ) from all other extrudates in terms of texture, taste, mouth feel and general acceptability. Four of the extrudates (E181, E055, E161, and E066) were not generally acceptable. The under mentioned were the pasting properties of the flour used for the blend formulation: peak viscosity was 422.00, 229.0 and -29.00 RVU; trough 353.67, 130 and -31.0 RVU; break down 100, 68.33 and 2.0 RVU; final viscosity 1091.7, 227 and -26.0 RVU; set back 738, 97 and 5 RVU; peak time 7.6, 3.33 and 4 RVU; pasting temperature 87.3, 85.1 and 81.50°C for maize flour, OFSP flour and Okara in all cases. It can be concluded that Snack processing using OFSP: Okara : Maize in ratio 67:17:17 is feasible.

**Key words: okara, orange-fleshed sweetpotato, extruder, maize flour, novel and sensory evaluation**

---

#### **INTRODUCTION**

A snack is a portion of food or drink often smaller than a regular meal, generally eaten between meals (Anon, 2013a). A healthy snack is one that is high in nutritional value like protein, vitamins, minerals, fibre but relatively low in calories, totals fat, saturated fat (no trans-fat). Snack foods have become an integral part of the eating habits of the majority of the world's population (Anon, 2013b).

Orange-fleshed sweetpotato (OFSP) as a staple food has an advantage over most vegetables in that it can supply significant amounts of pro- vitamin A and energy simultaneously thus helping to address both VAD and under nutrition (Bouis, 2002; Low *et al*, 2009; Jaarsveld *et al*, 2005 and Jaarsveld *et al* 2006). Beta-carotene is the dominant carotenoid in orange-fleshed sweetpotato (OFSP) (McLaren and Frigg, 2001). Simplex Centroid Design (SCD) is software for experiential design used to determine the relationship between a variable that impacts the process and resulting response, with each variable altered in a systematic approach. Food extrusion technology is a form of food processing where food materials is subjected to heat and shear energy results in cooked food. It is high temperature short time method of cooking. In recent times extrusion has found a wider application in food industry and as one of the major processes for producing varieties of food such as breakfast cereals, snack foods with modified starches and flours to sweet (Meuser, and van Lengerich, 1992 ; Mukund and Yogesh, 2007).

Okara (soy pulp) is a by-product generated from soymilk production. Okara is low in fat, high in fiber, and also contains protein, calcium, iron and riboflavin. It contains 76 to 80% moisture, 20 to 24% solids and 3.5 to 4.0% protein. On a dry weight basis okara contains 24% protein, 8 to 15% fats, and 12 to 14.5% crude fiber. It contains 17% of the protein from the original soybeans (Wickramarathna and Arampath, 2003). Okara is rich in nutrients content

but majority of it is still being discarded, causing environmental problems (Wickramaratna and Arampath, 2003). The huge quantities of okara produced annually pose a significant disposal problem in Nigeria. However, okara has been used in the vegetarian cuisines of Western nations since the 20th century (Shurtleff and Akiko, 1979).

Vitamin A deficiency (VAD) remains a global public health challenges, particularly in developing countries (Ruel, 2001 and WHO, 1995). Prevention and reduction of VAD can be achieved through biofortification of staple crop such as orange-fleshed sweetpotato. Study has shown efficacy of OFSP in the reduction of VAD (Institute of Medicine, 2001). However due to low dry content of OFSP and Africa consumers prefer sweetpotato that has high dry matter (Tomlink, et al 2004). It is therefore necessary to research into other food forms, such as snack made from OFSP to enhance high consumption of the crop. Therefore, the use of okara in production of snacks would not only add value to this waste product but will enhance the nutrient quality of carbohydrate based snacks prevalent in our society.

Objective of the study is therefore to find food use for waste and by product from OFSP juice and Soy milk processing thereby reducing environmental pollution, produce nutritive snacks and create job opportunity for income generation when the technology is transferred to food processors in particular rural women and youth.

## **MATERIALS AND METHODS**

White maize and soy bean were procured from Umuahia central market while the OFSP was obtained from sweetpotato programme of National Root Crops Research Institute (NRCRI), Umudike. The white maize was chosen for its starch and fiber potential as well as to enhance gelatinization, that is conversion of raw starch to a cooked and digestible material by the application of water and heat, which is one of the effects that extrusion has on the starch component of foods (Anderson et al., 1969). The okara is for protein and OFSP for its pro-vitamin A potential.

### **Preparation of okara, maize flour and OFSP flour**

The methods of Onyibe *et al.*, (2009) and Olusola and Morton (1996) were adopted for the preparation of the okara flour and maize flour respectively, as shown in Figure 1 and 2. The method described by Omodamiro *et al.*, (2010) shown in Figure 3, was used to obtain OFSP mash (a waste product from the preparation of OFSP juice/extract) to produce OFSP flour used in the preparation of the novel snack.

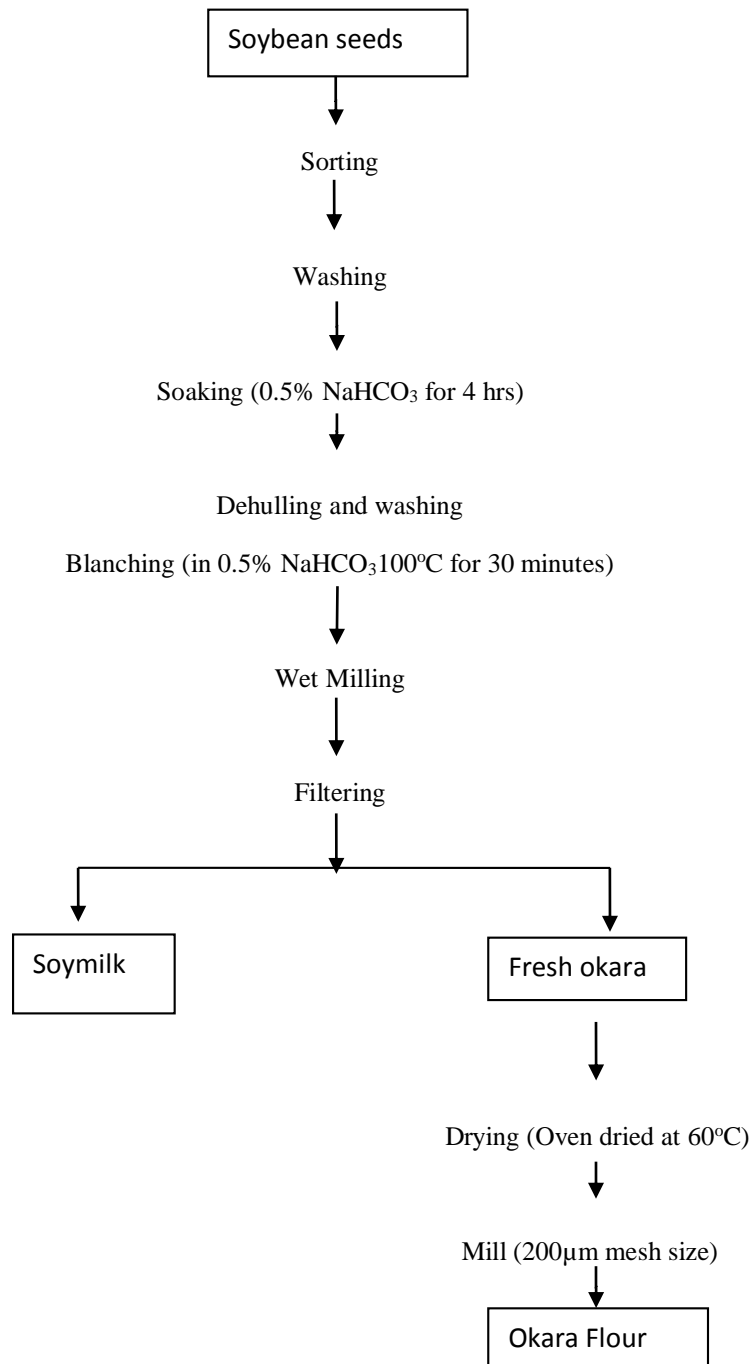


Figure 1: Flow chart for the production of okara flour. Source: (Onyibe et al., 2009)

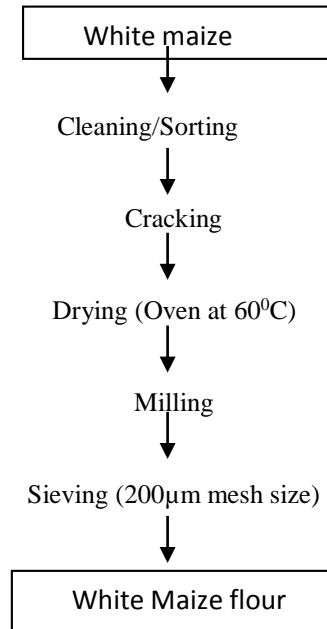


Fig. 2 Flow chart for the production of maize flour Source: Olusola and Morton (1996).

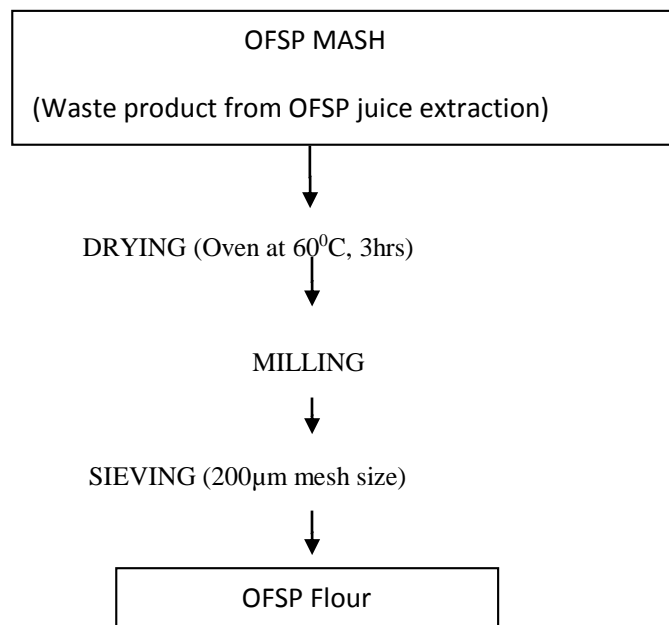


Figure 3: Flow chart for the production of OFSP mash Flour Source: Omodamiro et al, (2010)

### PREPARATION OF SNACK FROM OFSP: OKARA: MAIZE FLOUR BLENDS

Moisture content of the flour (OFSP, okara and maize flour) were evaluated with the aid of moisture analyzer S/N P-1023603 made in Japan. Simplex Centroid Design (SCD- experimental software package) was used to formulate blends of fourteen (14) runs from the flour to form feed for extrusion. Four of the runs were center points, as shown in Table 1. Top loading balance was used to weigh the quantity of added water for accuracy. The water was added to obtained dough which was extruded immediately. Uniform quantity of water (45.88g) was used to form dough of an average moisture content of 45% for each run.



A



B



C



D



E



F

Plate 1: A= Fresh OFSP extract B = Drying of OFSP residue in cabinet dryer, C = 14 Blends from OFSP: Okara: Maize flour, D = Processed OFSP: Okara: Maize flours, E= Extrusion runs and F= Drying of the fresh extrudates

Table 1: Simplex Centroid Design with three components

Design point	OFSP Flour (X <sub>1</sub> ) g/100g	Okara flour (X <sub>2</sub> ) g/100g	W. maize flour (X <sub>3</sub> ) g/100g
1	80	10	10
2	10	10	80
3	10	80	10
4	50	0	50
5	0	50	50
6	50	50	0
7	33.3	33.3	33.3
8	67	17	17
9	17	17	67
10	17	67	17
11	50	0	50
12	33.3	33.3	33.3
13	0	50	50
14	80	10	10

Where  $X_1 + X_2 + X_3 = 100\%$ , maize = white maize

### EXTRUSION OF OFSP: OKARA: MAIZE COMPOSITE FLOUR.

A fabricated single screw extruder moderate shears cooking ( $20-100s^{-1}$ ) and maximum product temperature  $125-175^{\circ}C$  was used for the extrusion of each blends. The extruder was operated at constant temperature ( $80^{\circ}C$ ), and dough was extruded at screw speed (70rpm) based on the pilot trials, cylindrical die was used to obtained cylindrical shape extrudates. The cylindrical shaped extrudates (5mm diameter) were collected and aseptically cut with the aid of kitchen knife into uniform length (average of 6cm) and dried at  $60^{\circ}C$  for 2 hours in a cabinet drier to obtain dried extruded snack of average moisture content (6.5 to 7.3%) after which it was cooled to room temperature and then packaged with food grade poly ethylene till use.

### LABORATORY ANALYSIS

Analysis for proximate composition of the white maize, okara, OFSP flours and extruded snacks was done using AOAC (2010). The pasting properties of the flour were analyzed to ascertain its fitness for extrusion.

### SENSORY EVALUATION

Organoleptic quality of the snacks was conducted in the Product Development Programme of (NRCRI), Umudike. A twenty-member sensory panel drawn from NRCRI and post graduate students of Food Science and Technology, Michael Okpara University of Agriculture (MOUAVU) was used for the sensory evaluation. The formulated snacks was subjected to sensory evaluation for colour, taste, mouth feel, aroma and general acceptability quality attributes using nine point Hedonic scale, where 1- dislike extremely, 2-dislike very much, 3-dislike moderately, 4- dislike, 5- neither like nor dislike, 6-like, 7-like moderately, 8-like very much, and 9-like extremely) was used to rate the evaluation. The panelists tasted the extrudate samples and chose among the nine points of the scale one that best matched their opinion of the product (Iwe, 2002).

### RESULTS AND DISCUSSION

The orange colour of the OFSP which implies presence of carotene was retained as shown in plates 1 (A to F) in its flour as well as the snacks Plate 2. Table 2 shows the pasting properties of the flours. Peak viscosity was 422.00, 229.0 and -29.00 RVU; trough 353.67, 130 and -31.0 RVU; break down 100, 68.33 and 2.0 RVU; final viscosity 1091.7, 227 and -26.0 RVU; set back 738, 97 and 5 RVU; peak time 7.6.33 and 4 RVU; pasting temperature 87.3, 85.1 and 81.50 RVU for maize flour, OFSP flour and Okara in all cases. The pasting property results revealed that maize flour had highest viscosity (1091.7 RVU) and significantly different ( $P < 0.05$ ) from others. Hence it is responsible for

the binding together of other materials to form snack. The constant moisture content of the dough is needed for uniformity of the snack colour, shape and uniformity in texture.

Table 2: Pasting properties of raw materials used for the extruded snack

SAMPLE	PEAK VISC (RVU)	TROUGH (RVU)	BREAK DOWN (RVU)	FINAL VISC (RVU)	SET BACK (RVU)	PEAK TIME (Min)	PASTING TEMP (°C)
MAIZE FLOUR	422 <sup>a</sup>	353.67 <sup>a</sup>	100 <sup>a</sup>	1091.7 <sup>a</sup>	738 <sup>a</sup>	7.00 <sup>a</sup>	87.3 <sup>a</sup>
OFSP FLOUR	229 <sup>b</sup>	130 <sup>b</sup>	68.33 <sup>b</sup>	227 <sup>b</sup>	97 <sup>b</sup>	6.33 <sup>b</sup>	85.1 <sup>b</sup>
OKARA FLOUR	-29 <sup>c</sup>	-31 <sup>c</sup>	2.0 <sup>c</sup>	-26 <sup>c</sup>	5 <sup>c</sup>	4.07 <sup>c</sup>	81.5 <sup>c</sup>
LSD(P>0.05)	9.967	8.785	0.86	18.543	0.011	10.033	0.156

### PROXIMATE ANALYSIS

The mean values of the proximate composition of the formulated snack as well as its raw materials and commercial OFSP based snack (control) are shown in Table 3. The moisture content range from 8.51-10.34% these values are within recommended moisture levels for flour. Moderately lower with significant difference ( $p < 0.05$ ) value was observed in sample OEP (OFSP based extruded snack). Such snacks are expected to have low moisture for good keeping quality. Idowu *et al.*, 1996 reported low moisture cookies. The ash content ranged from 1.52 to 4.098% with the highest value observed in sample OCC (control). Crude fibre ranged from 0.05 to 4.00%. Formulated snack has the highest value, which makes it a potential functional food snack. The results of lipid content were significantly different ( $p > 0.05$ ). The values ranged from 9.83-22.48 %. The fat content of the extrudate was lower compare to the commercial, which also make it healthy snack for adults. These values were in line with various composition flour cookies formulated by other researchers (Okpala, 2010; Giwa and Ikuje, 2010). There was no significant difference ( $p > 0.05$ ) in the values of sulphited and unsulphited samples in term of moisture and ash contents but different in term of crude fiber and fat contents.

Table 3: Proximate composition of snack and its raw materials

Samples	Moisture content (%)	Crude protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
ESNACK	12.15b	20.83b	15.43b	2.51a	49.05d
OFSPR	11.55c	5.14c	8.35d	2.55a	72.42b
OKARA	8.85e	23.58a	20.00a	2.21b	45.36e
WMF	9.47d	1.17e	0.00e	2.22b	81.14a
LSD (0.05)	0.157	0.171	0.0178	0.0513	0.2360

WMF = white maize flour, OFSPR = orange-fleshed sweetpotato flour, ESNACK = extruded snacks.

### SENSORY EVALUATION

The results of sensory evaluation are shown in Table 4. Blend ratio of OFSP- 80: okara-10: white maize-10 and blend ratio OFSP- 67: okara-17: white maize-17 were mostly acceptable and are not significantly different ( $p > 0.05$ ) from each other in term of colour and aroma. However snack from OFSP- 67: okara-17: white maize-17 was mostly acceptable and significantly different ( $p < 0.05$ ) from all other exudates in terms of texture, taste, mouth feel and general acceptability as shown in Table 4. Four of the exudates (E181, E055, E161, and E066) were not generally acceptable among the 14 samples presented to the sensory panel.

Correlations among the sensory attributes are shown in Table 4. All the attributes were positive and strong (0.5385 to 0.9146). Taste and mouth feel had the highest value of 91.46%, this shows that taste of food has a lot to do with mouth feel.

Table 4: Correlations (Pearson) Weighting Variable Panelist

	AROMA	COLOUR	G/ACCEPT	MOUTHFEEL	TASTE
COLOUR	0.8426				
G/ACCEPT	0.6892	0.7659			
MOUTHFEEL	0.7890	0.7996	0.8734		
TASTE	0.8240	0.7968	0.8394	0.9146	
TEXTURE	0.7540	0.6860	0.5385	0.6218	0.6617

Cases Included 280 Missing Cases 0

Table5: Mean Sensory Scores of Multiple Comparison Test on Extruded Snacks

Samples	COLOUR	AROMA	TEXTURE	TASTE	M/FEEL	G/ACCEPT
E811	8.05 <sup>a</sup>	7.95 <sup>b</sup>	7.25 <sup>a</sup>	8.45 <sup>a</sup>	8.00 <sup>a</sup>	8.65 <sup>a</sup>
E118	3.95 <sup>gh</sup>	2.15 <sup>f</sup>	3.95 <sup>f</sup>	5.05 <sup>e</sup>	5.10 <sup>d</sup>	5.00 <sup>e</sup>
E181	2.90 <sup>i</sup>	2.25 <sup>f</sup>	3.85 <sup>f</sup>	2.05 <sup>h</sup>	1.20 <sup>b</sup>	2.20 <sup>b</sup>
E505	6.14 <sup>d</sup>	6.15 <sup>c</sup>	6.00 <sup>c</sup>	6.50 <sup>cd</sup>	5.05 <sup>d</sup>	6.00 <sup>c</sup>
E055	3.00 <sup>i</sup>	2.10 <sup>f</sup>	3.85 <sup>f</sup>	2.30 <sup>h</sup>	2.15 <sup>f</sup>	3.05 <sup>g</sup>
E550	6.65 <sup>c</sup>	3.95 <sup>e</sup>	5.80 <sup>c</sup>	4.10 <sup>f</sup>	3.25 <sup>f</sup>	5.05 <sup>e</sup>
E333	4.25 <sup>fg</sup>	5.00 <sup>d</sup>	5.20 <sup>d</sup>	5.10 <sup>e</sup>	4.00 <sup>e</sup>	5.00 <sup>e</sup>
E677	7.75 <sup>ab</sup>	7.90 <sup>ab</sup>	6.85 <sup>ab</sup>	7.55 <sup>b</sup>	7.00 <sup>b</sup>	7.90 <sup>ab</sup>
E117	4.30 <sup>f</sup>	2.05 <sup>f</sup>	3.95 <sup>f</sup>	5.05 <sup>e</sup>	4.95 <sup>d</sup>	5.10 <sup>e</sup>
E161	3.75 <sup>h</sup>	2.00 <sup>f</sup>	3.95 <sup>f</sup>	3.20 <sup>g</sup>	2.05 <sup>g</sup>	3.85 <sup>f</sup>
E606	6.15 <sup>d</sup>	6.10 <sup>c</sup>	6.65 <sup>b</sup>	6.20 <sup>d</sup>	6.00 <sup>c</sup>	5.30 <sup>e</sup>
E444	5.10 <sup>e</sup>	3.95 <sup>e</sup>	5.05 <sup>de</sup>	5.10 <sup>e</sup>	4.00 <sup>e</sup>	5.05 <sup>e</sup>
E066	2.95 <sup>i</sup>	2.20 <sup>f</sup>	4.75 <sup>e</sup>	3.25 <sup>g</sup>	3.05 <sup>f</sup>	4.95 <sup>e</sup>
E822	8.00 <sup>a</sup>	7.85 <sup>a</sup>	7.20 <sup>a</sup>	8.15 <sup>b</sup>	7.80 <sup>a</sup>	8.75 <sup>a</sup>

**KEYS:** E811 = 80.10.10, E118 = 10.10.80, E181 = 10.80.10, E505 = 50.0.50, E055 = 0.50.50, E550 = 50.50.0, E333 = 33.33.33, E677 = 67.17.17, E117 = 17.17.67, E161 = 17.67.17, E606 = 50.0.50, E444 = 33.33.33, E066 = 0.50.50 and 822 = 80.10.10 of OFSP: Okara : White maize flour in all case. (E606 = E505, E444 = E333, E066 = E055 and E822 = E811 are the center points)



(A)





(B)

Plate 2: A = Extruded 67:17:17 blends and B = Dried and packaged OFSP based nutritive snacks

## CONCLUSION

Wastes from OFSP beverage preparation and okara from soymilk preparation can be used to produce acceptable pro-vitamin A snack. The best combination level is ratio 67:17:17 or 80: 10:10 of OFSP, Okara and maize flours respectively. The ratios received the best ratings as indicated by their overall acceptability. Okara inclusion up to 17% can be chosen owing to higher okara inclusion and yet its acceptability is not significantly different from that of 10%.

## RECOMMENDATION

The novel Orange-fleshed sweetpotato based snack can form part of what is use for tea break in hospitality industries such as hotels, social gathering-cocktails parties. Agricultural Engineers should design and construct machine for manual extraction of OFSP extracts so as to separate the residues with ease. Soymilk processor can add up section for proper dispensing and drying of okara to create an avenue for additional income generation to their industries.

## ACKNOWLEDGMENTS

The author deeply acknowledged and appreciate Prof Iro Nkama, Unuversity of Nigeria Nsukka for his contributions. Executive Director Dr. J.C Okonkwo NRCRI, Umudike for their various contributions. Dr Shobukola, Mr. Femi Cooker, Dr. Shitu, Dr (Mrs) Fetuga and Mr Tayo of Federal University of Agriculture, Abeokuta for their technical support.

## REFERENCES

- I. Anderson,R.A,Conway, H.F, Pfeifer, V. F and Griffin, E.L (1969). Gelatinization of corn grits by roll and extrusion cooking. *Cereal science Today*14,4-12.
- II. (Anon, 2013a). [recipes.wikia.com/wiki/category: Nigerian\\_snacks](http://recipes.wikia.com/wiki/category:Nigerian_snacks). Accessed on 27-03-2013.
- III. Anon, 2013b). [www.ncsoy.org/ABOUT-SOYBEANS:Uses-of-soybeans.asix](http://www.ncsoy.org/ABOUT-SOYBEANS:Uses-of-soybeans.asix). Accessed on 27- 03-2013.
  - a. AfrAOAC (1990). *Official methods of Analysis of the Association of Official Analytical Chemists*, Washington D.C., USA.
- IV. Bouis, H. (2002). A New Tool for Fighting Micronutrient Malnutrition. *J.of Nutr.* 132 (3) :491S- 516S.
- V. Giwa E.O. and Ikujenlola Abiodun Victor (2010). Quality characteristics of biscuits produced from composite flours of wheat and quality protein maize. *African Journal of Food Science and Technology* Vol.1 (5).Pp116-119.*African Journal of Food Science and Technology* Vol. 1(5), pp.116-119
- VI. Institute of Medicine. (2001). *Dietary reference intakes for vitamin A, vitamin K, arsenic, boron,chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc*.Washington D.C., National Academy Press.
- VII. Iwe MO (2002). *A handbook of sensory methods and Analysis*. First edition. Rejoint Communication Service Ltd. 65, Adelabu St. Uwani Enugu. p.71.

- VIII. Jaarsveld, P.J. v., Faber, M., Tanumihardjo, S.A., Nestel, P., Lombard, C.J., and Benade, A.J. (2005). Beta-carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test. *American Journal of Clinical Nutrition* 81: 1080-1087.
- IX. Jaarsveld, P.J., Marais, D.W., Harmse, E. and Rodriguez-Amaya, D. (2006). Retention of  $\beta$ -carotene in boiled, mashed orange-fleshed sweet potato. *Journal of Food Composition and Analysis* 19: 321-329.
- X. Laura Okpala, Eric Okoli, and Emelem Udensi (2013)  
a. Physico-chemical and sensory properties of cookies made from blends of germinated pigeon pea, fermented sorghum, and cocoyam flours. *Food Sci Nutr.* 1(1):8-14.
- XI. Low, J. Kapinga, R. Donald, C., Cornelia L., John L. and Maria, A. (2009). Challenge Theme Paper 3: Nutritional Impact with Orange-Fleshed Sweetpotato (OFSP). Unleashing Potential of OFSP in Sub-Saharan Africa. CIP Social Science Working Paper. Colombia Pp73-105
- XII. McLaren, D. and Frigg, M. (2001). Manual on vitamin A deficiency disorders (VADD)  
a. Sight and Life Publisher. 2: Pp 103.
- XIII. Meuser, F and van Lengerich, B (1992). System Analytical Model for extrusion of starches. In Kokini, J. L, Ho, C and Larwe M.V 9EDS). *Food Extrusion Science and Technology.* Pp 619-630. New York:Marcel Dekkar Inc.
- XIV. Montgomery, D.C (1984). *Design and Analysis of experiments* (second ed) New York. John Wiley and sons. Pp 445-474.
- XV. Mukund V. Karwe and Yogesh Jaluria (2007). Numerical simulation of fluid flow and heat transfer in a single-screw extruder for non-newtonian fluids. *An International Journal of Computation and Methodology.* Vol.17 (2) Pp 167-190
- XVI. Olusola, O and Morton, I.D. (1996). Development by extrusion of soyabean snack sticks: a nutritionally improved soya-maize snack (Kokoro). *Int. J. of Food Sci. and Nutr.* 47:5-13.
- XVII. Onyibe, J.E., Ojeniyi, S., Bankole, A.O., Teniola, D.O., Ugokwe, P.U., Mordi, J.I. and Etoamaibe, M (2009). Production and Quality evaluation of Probiotic soy milk. *Nig. Fd. Journal.*27(1): 66-74.
- XVIII. Omodamiro, R. M., Oti, E., Afuape, S and Ettudaiye, H.A (2010) Sensory Evaluation of Orange-Fleshed Sweetpotato Extract Drinks. In: Proceedings of the 34th Annual Conference and AGM of Nigeria Institute of Food Science and Technology. River State University of Science and Technology, Port Harcourt. 18<sup>TH</sup>-22<sup>ND</sup> October, 2010. Pp171-172.
- XIX. Ruel, M. T. 2001. Can food-based strategies help reduce vitamin A and iron deficiencies? International Food Policy Research Institute; Washington, USA.  
[<http://www.ifpri.org/pubs/fpreview/fpreview05.htm>]
- XX. Shurtleff William and Akiko Aoyagi(1979). Tofu and soymilk production. Vol.2. The book of Tofu.
- XXI. Tanumihardjo, S. A (2011) Vitamin A: Biomarker of Nutrition for Development. *Journal of Clinical Nutri.* 94 (2): 6585-66856
- XXII. Tomlins, K., Rwiza, E., Nyango, A., Amour, A., and Ngendello, T. (2004). The Use of Sensory Evaluation and Consumer Preference for the Selection of Sweet Potato Cultivars in East Africa. *Journal of the Science of Food Agriculture,* 84, 791-799.
- XXIII. Wickramarathna, G. L. and Arampath, P. C. (2003). Utilization of okara in bread making. *Cey. J. Sci. (Bio.Sci.)*.31:29-33
- XXIV. WHO (2009) Global prevalence of vitamin A deficiency in populations at risk 1995-2005. WHO Global Database on Vitamin A Deficiency Pp 55 ISBN: **978 92 4 159801 9**
- XXV. Woolfe, J.A. (1992). Sweetpotato: an untapped food resource. Cambridge Uni. Press, Cambridge UK. Pp 5-10.