

## **Quality Evaluation of Chinchin Produced from Wheat Flour and Orange-Fleshed Sweet Potato Puree**

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### **ABSTRACT**

Chinchin is a fried or baked snack commonly consumed in West Africa. The crunchy product is often prepared using wheat flour. This study was conducted to explore the possibility of adding orange-fleshed sweet potato puree (OFSP) to wheat flour to produce chinchin. In this study, different proportions (30%, 40%, and 50%) of OFSP were added to wheat flour and the pasting properties of the formulated doughs, nutritional composition, colour attributes and the sensory characteristics of the formulated chinchin products were tested. One way-analysis of variance was performed at a significant level of 95% on the investigated parameters. Regarding the pasting properties of the dough, there was a decrease in the peak viscosity as the concentration of OFSP was increased. However, chinchin produced with the addition of 30% OFSP had the highest break down viscosity. The compositional analyses of the formulated chinchin products showed that there were significant differences in moisture, ash and the protein contents of the OFSP chinchin products. In addition, the water activity of the dough increased with increases in the content of OFSP. With respect to the colour, the chinchin products, the clarity ( $L^*$ ) of the products increased as the proportions of the OFSP was decreased, but with an increase in the proportion of OFSP, red ( $a^*$ ) and yellow ( $b^*$ ) colouration increased. The overall acceptability of the chinchin product decreased when the proportion of OFSP was increased. Thus, to incorporate OFSP into wheat flour for chinchin preparation, 30% of the OFSP should be considered for consumer acceptability.

**Keywords:** Orange-fleshed sweet potato puree, chinchin, pasting properties, nutritional composition, water activity

### **INTRODUCTION**

Chinchin is a fried golden-brown crunchy snack produced from wheat flour and commonly consumed in West Africa. It is a cookie-like product prepared using wheat flour, margarine, egg and other ingredients. It is normally kneaded and cut into small sizes before frying (Akubor, 2004) and as a snack, it is consumed between breakfast and lunch (Chapli and Smith, 2011). Eating snack prevents individuals from becoming ravenously hungry (Lemchi *et al.*, 2016). In-order to ensure one is

eating a healthy snack, the snack should contain protein, fat, fiber and water (Lemchi *et al.*, 2016). According to Hinton (2018) snack can be a healthy part of one's diet, since it provides energy for daily activities. Besides, it can provide valuable nutrients such as vitamins, minerals, protein and fiber.

Snacks that are commonly consumed include cake, chinchin, doughnut, buns, turn over and biscuits among others. These snacks are usually produced from wheat flour, which is low in protein and other macro nutrients (Lemchi *et al.*, 2016). However, the cost of importation of wheat flour continues to increase with increasing demand for wheat flour base products (Lemchi *et al.*, 2016). Wheat flour has become a major raw material on which the bakery industry depends. This has led to the need for the utilization of other flours to partially replace wheat flour for the production of bakery products. This will help increase the nutritional quality and reduce the cost of wheat importation.

Orange-fleshed sweet potato (OFSP) is a unique variety of sweet potato which is high in pro-vitamin A and can contribute significantly to vitamin A, C and mineral nutrition in humans (Satheesh and Solomon 2019). It is a good source of antioxidants noted to be able to scavenge free radicals (Widodo *et al.*, 2015). Moreover, the sweetness of products may increase if OFSP is used partially to replace cereal based wheat flour (Samuel and John, 2014). OFSP is recognized as crop that has a wide range of uses and can be used to improve the nutritive content of food (Oti and Aniedu, 2010). OFSP root can be used to prevent vitamin A deficiency because is high in  $\beta$ -carotene content (Ofori *et al.*, 2009). The addition of OFSP in chinchin production to partially replace wheat flour will reduce postharvest loses, increase the income of farmers and reduce the importation of wheat flour (Oti and Aniedu, 2010).

This study was conducted to investigate the potential of OFSP to enhance the nutritional composition of chinchin when used as a substitute for wheat flour. The consumer acceptability of the wheat flour-OFSP chinchin was also evaluated.

## **MATERIALS AND METHODS**

### **Source of raw materials**

Wheat flour, eggs, nutmeg, milk powder (Nestle, Ghana), baking powder, white sugar, and margarine (80% fat cook brand, Holland) were obtained from Tamale central market in the Northern Region of Ghana. The OFSP root was obtained from a farm in Cape Coast in the Central Region of Ghana.

### ***Preparation of OFSP puree and OFSP- wheat flour composite dough***

About 5 kg of orange-fleshed sweet potato (OFSP) roots were sorted and washed with running water to remove all the soil particles. after which it was boiled for 30 min. The cooked root was cooled for 15 min, peeled with a knife, and then pounded in mortar with a pestle until a smooth puree was formed (Fig. 1). The puree was

instantly used for the preparation of the orange-fleshed sweet potato puree (OFSP)-wheat flour composite dough. In all, four different types of dough formulations were made, A (100% wheat flour), B (70% wheat flour:30% OFSPP), C (60% wheat flour: 40% OFSPP) and D (50% wheat flour: 50% OFSPP).

### ***Preparation and production of OFSPP-wheat chinchin***

In a medium sized-bowl, milk powder (100 g), margarine (350 g), (egg 30 mL), (nutmeg 2 g) baking powder (12.5 g) and sugar (100 g) were mixed using a liquidizer except sample A (100% wheat flour), in which 100 mL of water was added. The mixture of margarine, wheat flour and the other ingredient was added to the OFSPP in a separate bowl and thoroughly mixed to form soft dough. The formulated dough was kneaded and cut with knife into cubes. The cubes were then placed in an oiled pan and baked in a preheated electric oven (Robert Bosch Hausgerate GmbH carl-strabe 34 81739 Munched, Germany) at a temperature of 150 °C for 45 min to obtain the chinchin product. This was allowed to cool for 30 min and then packaged in zipped plastic bag for further studies. Similar processes were used for the production of wheat flour chinchin (Fig. 1).

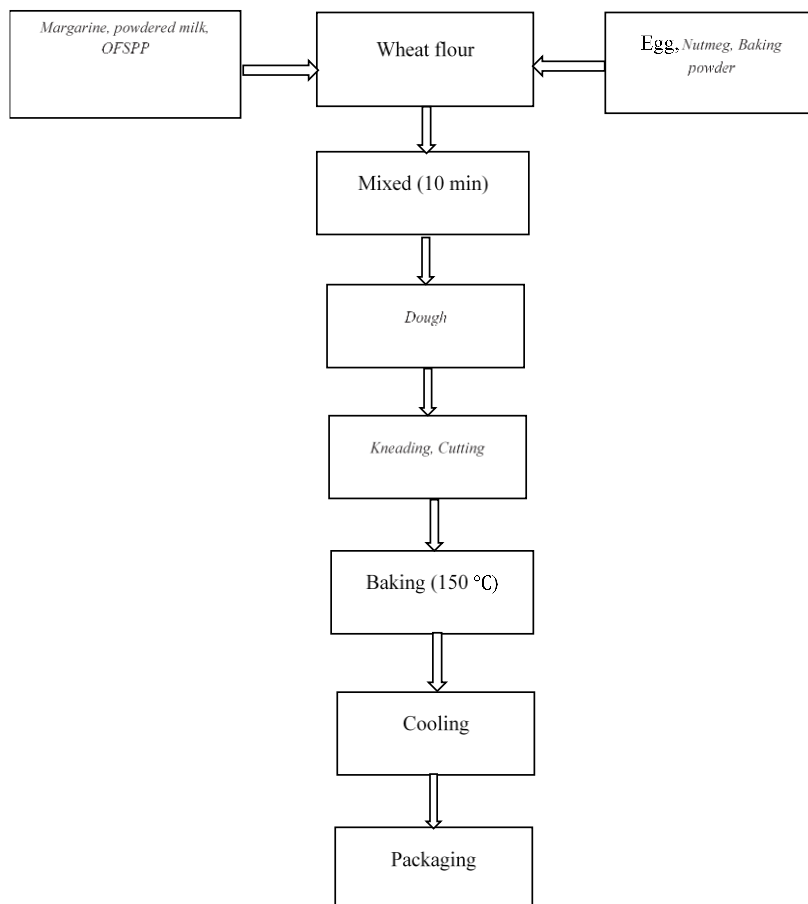


Figure 1: Flow chart for the production of chinchin

### ***Proximate analyses***

The moisture, fat, protein (N×6.25) and ash contents of all the formulated chinchin were determined according to the AOAC method (2005). To determine the total ash content, samples were ashed in a muffle furnace at 550 °C for 4 h. The carbohydrate content was estimated by calculating the difference between 100 and the sum total of percent moisture, percent protein, percent fat and percent ash (Amagloh and Rafia, 2017). The total energy of the chinchin was determined as described by Adeola and Ohizua, (2018) using the Atwater factor where the energy value of the chinchin was expressed in kcal using the formular: Energy (kcal) = (Protein x 4) + (Fat x 9) + (Carbohydrate x 4). Again, the water activity of the samples were measured using a digital water activity meter (model: H-ms2100Wa 190106x).

### ***Pasting profile of the wheat- OFSP dough***

The pasting characteristics of the wheat- OFSP dough samples were determined using a Rapid Visco Analyzer (RVA 4500 Perten instrument). Three and half grams of the sample containing distilled water were carefully mixed to avoid lump formation. The canister was fixed into the rapid visco analyzer and the paddle was then placed into the canister after which the test was conducted instantly for 13 min. Indices measured were peak viscosity, setback viscosity, final viscosity, trough, breakdown viscosity, pasting temperature and time to reach peak viscosity.

### ***Colour attributes of the product***

Using the techniques as described by Greene and Bovell-Benjamin, (2004), a hand held chromameter (Model: Konica Minolta CR-410) was used to determine the colour of the samples. The colour measurements recorded were L\* (clarity), a\* (redness), and b\*(yellowness). Chroma (C\*), hue angle (h\*) and colour differences ( $\Delta E$ ) were then calculated:

$$C^* = \sqrt{((a^*)^2 + (b^*)^2)} ; h^* = (\tan^{-1} b^* / a^*) ; \Delta E = \sqrt{((\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2)} \text{ (Pathare } et al., 2013).$$

### ***Sensory evaluation***

The sensory characteristics of the formulated products were determined using the method of Kemp et al. (2010). The chinchin product was coded and presented together with questionnaires to fifty (50) untrained panelist. The product was evaluated on, colour, taste, appearance, crispiness and overall acceptability on a 5-point hedonic scale, where: 5 = Like extremely and 1 =Dislike extremely. Drinking water was provided to the panelist to rinse their mouth after evaluating each sample to prevent carryover taste.

### ***Statistical analysis***

All the experiments were done in triplicate and the data were analyzed using one-way analysis of variance (ANOVA). Kruskal-Wallis Friedman at  $P < 0.05$  was used to determine the significant differences between the treatments using XLSTAT 2016. The results were expressed as means and standard deviations, and were presented in tables.

## **RESULTS AND DISCUSSION**

### ***Pasting properties of the formulated dough***

Table 1 shows the pasting characteristics of OFSPP-wheat dough. The peak viscosity, which is an index of the capacity of starch-based food to swell prior to their physical degradation (Adebowale *et al.*, 2008) were investigated and this varied from 354.00 to 478.00 RVU. There was a decrease in the values of peak viscosity as the fraction of OFSPP increased. Besides, no significant difference was observed in the peak viscosities of the blended doughs. The high peak viscosity observed may be attributed to the high starch content of the dough.

The least viscosity rate (trough) of the RVA pasting profile was studied. This measures the capacity of the paste to tolerate breakdown throughout cooling. This property decreased with an increased in OFSPP content (Table 1). The value of the trough viscosity ranged from 246.00 to 327.00 RVU. The product which contained 30% OFSPP had the highest value of 327.50 RVU, while product, which was made of 50% OFSPP gave the least trough viscosity of 246.00 RVU. There was no significant difference ( $P < 0.05$ ) in the trough viscosities. The result obtained showed higher values than the result reported in an earlier research in millet-wheat composite chinchin (Adegunwa *et al.*, 2014). The break down viscosity measures the capacity of paste to endure breakages during cooling. There were no significant differences in the breakdown viscosities as the replacement of OFSPP increased. The breakdown viscosity ranged from 108.50 to 150.50 RVU. The formulation with 30% OFSPP had the maximum breakdown viscosity whereas wheat flour replaced with 50% OFSPP had the least breakdown viscosity.

The final viscosity is the measure of steadiness of the granules, which in this study ranged from 494.50 to 711.00 RVU. The final viscosity describes the quality of a specific starch-based flour, since it shows the capacity to form viscous paste after cooling or gel after cooking and cooling, as well as, the resistance of the paste to shear force during stirring (Adeyemi and Idowu, 1990). There was no significant difference in the final viscosity. The change in the final viscosity might be due to the products kinetic effect of cooling on viscosity and the re-association of starch molecules in the samples (Nwokeke *et al.*, 2013). Also, the setback viscosity ranged

from 248.500 to 392.006RVU. A significant difference was observed in the setback viscosity of wheat flour and OFSPP composite dough at ( $P < 0.05$ ). The greater the setback, the lesser the retrogradation of the dough paste during cooling and the lesser the staling rate of the flour product (Adeyemi and Idowu, 1990).

Peak time, which indicates the cooking period, was examined, and it ranged between 5.30 to 5.37 min. The formulation with 70% wheat flour showed a maximum value of 5.37 min, signifying more processing time. However, when the wheat flour was replaced with 50% OFSPP, a peak time of 5.30 min was obtained. Again, the pasting temperature ranged between 90.90 °C to 92.08 °C. It was observed that there was a significant difference in the pasting temperatures among the dough samples. The sample with 100% wheat flour had the greatest pasting temperature. The pasting temperature offers a clue on least temperature necessary for cooking the samples, the pasting temperature attained for the composite flours were quite close.

### ***Water Activity***

Results on water activity is presented in Table 2. The water activity of the dough increased with an increased in the OFSPP content. The water activity values ranged from 0.85 to 0.94. A decreased in the water activity could possibly reduce the rate at which spoilage will occur in the formulated dough. With regard to the water activity of the chinchin product, formulation, the 50% OFSPP had the least value of 0.48 for water activity, while the 30% OFSPP product obtained the highest value of water activity (0.58). Formulation with 50% OFSPP had the least value for water activity. This product could have an extended shelf life as compared to the other formulations, since less moisture could be available for spoilage microorganism to use to cause spoilage of the chinchin product. Generally, the decreased in water activity of the chinchin product could be as a result of the rate at which moisture was lost during the baking process.

Table 1: Pasting properties of the dough

Sample	Peak Viscosity (RVU)	Trough (RVU)	Breakdown (RVU)	Final Viscosity (RVU)	Setback (RVU)	Peak time (min)	Pasting tempt (°C)
100% wheat flour	447.00±16.97 <sup>a</sup>	300.00±8.49 <sup>a</sup>	147.00±8.49 <sup>a</sup>	692.00±15.56 <sup>a</sup>	392.00±7.07 <sup>a</sup>	5.37±0.05 <sup>a</sup>	92.08±0.04 <sup>a</sup>
70% wheat flour:30% OFSPP	478.00±1.41 <sup>a</sup>	327.50±2.12 <sup>a</sup>	150.50±3.54 <sup>a</sup>	711.50±14.85 <sup>a</sup>	384.00±12.73 <sup>a</sup>	5.37±0.05 <sup>a</sup>	91.28±0.04 <sup>ab</sup>
C60% wheat flour :40% OFSPP	400.00±77.78 <sup>a</sup>	280.00±45.25 <sup>a</sup>	120.00±32.53 <sup>a</sup>	581.00±104.65 <sup>a</sup>	301.00±59.34 <sup>a</sup>	5.30±0.04 <sup>a</sup>	90.90±0.57 <sup>b</sup>
50% wheat flour: 50% OFSPP	354.50±30.41 <sup>a</sup>	246.00±18.38 <sup>a</sup>	108.50±12.02 <sup>a</sup>	494.50±44.55 <sup>a</sup>	248.50±26.16 <sup>b</sup>	5.30±0.04 <sup>a</sup>	91.25±0.7 <sup>ab</sup>

Values are means ± standard deviation. Values with different superscripts within the same column are significantly different (P < 0.05). OFSPP (orange-fleshed sweet potato puree)

Table 2: Water activity of the formulations

Sample	a <sub>w</sub> Dough	a <sub>w</sub> Chinchin
100% wheat flour	0.85±0.00 <sup>a</sup>	0.53±0.01 <sup>b</sup>
70% wheat flour :30% OFSPP	0.88±0.03 <sup>a</sup>	0.58±0.00 <sup>a</sup>
60% wheat flour :40% OFSPP	0.86±0.06 <sup>a</sup>	0.55±0.00 <sup>ab</sup>
50% wheat flour :50% OFSPP	0.94±0.01 <sup>a</sup>	0.48±0.00 <sup>c</sup>

Values are means±standard deviation. Values with different superscripts within the same column are significantly different (P>0.05). a<sub>w</sub> (water activity), OFSPP (orange-fleshed sweet potato puree)

### ***The energy value of the products***

The energy values are shown in Table 3. Formulation containing 30% OFSPP recorded the highest kcal/100g of 466.04, while formulation, which is made up of 50% OFSPP recorded the least value of 437.02 kcal/100g. These results are comparable to the result reported by Tangkanakul *et al.* (1999) with values ranging from 420.2 to 544.3 kcal/100g.

### ***Moisture***

Concerning the moisture content of the samples, it was found that it ranged from 5.44% to 10.64%. Generally, there was a rise in the moisture content as the quantity of puree was increased. Sanni and Adebawale (2006) stated that the lesser the amount of moisture in a product to be stored, the longer the shelf life of such products, therefore a decrease in the OFSPP substitution may lead to a longer shelf life of the chinchin product.

### ***Ash***

In this study, the percent ash increased with the higher rate of OFSPP. Products formulated with 30% OFSPP had the least value or the 1.38% ash content, while sample containing 50% OFSPP had the maximum ash content of 1.84% (Table 3). This result is similar to the results obtained when Ugu and Indian spinach vegetables were used to produce chinchin (Oyedele and Adebooye, 2017).

### ***Crude Fat***

In terms of the crude fat content, there was no significant difference, even though there was marginal differences among the chinchin formulations. Sample made of 40% OFSPP had the least percent of 17.19 fat, while the 30% OFSPP product gave the highest percent value of fat (18.66%). These values are similar to values

obtained by Oyedele and Adebooye, (2017) who recorded 17.34% crude fat content for chinchin produced from 95% wheat and 5% ugu.

### ***Crude Protein***

With regards to the protein content, there was an increase in crude protein content when the content of OFSPP was increased in the formulation. It was found that the 50% OFSPP product obtained the highest protein (10.16%) and 100% wheat flour chinchin had the least value of 9.28% protein. The values obtained in this study were lower compared to the chinchin produced from 95% wheat flour: 5% ugu (Oyedele and Adebooye, 2017).

### ***Carbohydrate***

In this experiment, the products were found to decrease in carbohydrate contents as the fraction of wheat flour was decreased. This agrees with the findings of Akubor (2004) who reported that chinchin produced from wheat and tiger nut flour were low in carbohydrate as the concentration of tiger nut flour was increased. Formulation made up of 100% wheat flour obtained the highest carbohydrate content of 66.66%. The decreased in the percent carbohydrate could be as a result of the increase in the content of OFSPP, which probably decreased the carbohydrate content in the dough (Table 3).

Table 3: Proximate composition of the processed chinchin

Sample	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Ash (%)	Carbohydrate (%)	Energy (kcal)
100% wheat flour	5.51±0.09 <sup>c</sup>	9.28±0.12 <sup>b</sup>	17.36±5.44 <sup>a</sup>	1.20±0.08 <sup>c</sup>	66.66 ±5.56 <sup>a</sup>	459.95±27.27 <sup>a</sup>
70% wheat flour: 30% OFSPP	5.44 ±0.85 <sup>c</sup>	9.54 ±0.12 <sup>b</sup>	18.66±0.35 <sup>a</sup>	1.38± 0.02 <sup>c</sup>	64.98 ±3.34 <sup>a</sup>	466.04±8.66 <sup>a</sup>
60% wheat flour: 40% OFSPP	8.11±0.12 <sup>b</sup>	9.85 ±0.19 <sup>ab</sup>	17.19 ±0.79 <sup>a</sup>	1.59 ±0.02 <sup>b</sup>	63.27 ±0.47 <sup>a</sup>	447.20±4.50 <sup>a</sup>
50% wheat flour: 50% OFSPP	10.64 ±0.09 <sup>a</sup>	10.16 ±0.12 <sup>a</sup>	17.38 ±5.44 <sup>a</sup>	1.84 ±0.08 <sup>a</sup>	59.99 ±5.56 <sup>a</sup>	437.02±1.42 <sup>a</sup>

Table4: Colour quality of the chinchin

Sample	L*	a*	b*	C*	ΔE*	
100% wheat flour	67.28±0.07 <sup>a</sup>	1.80±0.02 <sup>d</sup>	18.54±0.01 <sup>c</sup>	18.63±0.01	84.44±0.04 <sup>a</sup>	
70% wheat flour: 30% OFSPP	63.22±0.55 <sup>b</sup>	4.31±0.04 <sup>c</sup>	21.75±0.27 <sup>b</sup>	22.17±0.25 <sup>b</sup>	78.79±0.26 <sup>b</sup>	5.76± 0.41 <sup>c</sup>
60% wheat flour: 40% OFSPP	59.57±0.10 <sup>c</sup>	5.73±0.06 <sup>b</sup>	22.53 ±0.05 <sup>ab</sup>	23.25±0.04 <sup>a</sup>	75.72±0.18 <sup>c</sup>	9.50± 0.12 <sup>b</sup>
50% wheat flour: 50% OFSPP	58.50±0.26 <sup>d</sup>	6.62±0.12 <sup>a</sup>	22.84±0.57 <sup>a</sup>	23.78±0.55 <sup>a</sup>	73.82±0.49 <sup>d</sup>	10.91±0.311

Values are mean±standard deviation. Values with different superscripts within the same column are significantly different (P>0.05). Clarity (L\*), Red colour (a\*), yellow colour (b\*) Chroma(C\*), Hue angle = (h\*) and Total colour difference (ΔE\*)

### ***Colour attributes of the formulated chinchin***

Colour of a developed food product may determine whether it may or may not be accepted by consumers (Pathare *et al.*, 2013). The results of the colour measurement is presented in Table 4. It was evident that, the higher the percent incorporation of wheat flour the higher the clarity ( $L^*$ ) value for the chinchin product. Also, it was evident that the higher the content of the OFSPP, the lesser the  $L^*$  value of the product. It was also observed that the  $L^*$  of the product increased as the proportions of OFSPP was reduced. The control (100% wheat Chinchin) recorded the highest value  $L^*$  value of 67.28, while 50% OFSPP chinchin had the least  $L^*$  value of 58.50. The results obtained in this study is similar to that reported by Brandy *et al.* (2009).

In terms of the redness ( $a^*$ ) of the product, it was observed that redness increased as the OFSPP content was increased. Chinchin with 50% OFSPP, had redness value of 6.62, while 100% wheat chinchin gave 1.80. The red colour component of the product could be associated to the high concentration of the OFSPP.

The result for the yellow colouration ( $b^*$ ) was similar to the redness because as the OFSPP concentration increased, the  $b^*$  of the product increased. Adding 50% OFSPP in the chinchin gave the highest value of 22.84 for the  $b^*$  attribute of the product. Chinchin made of 100% wheat had the least  $b^*$  value of 18.54. These values are quite higher than those reported by Brandy *et al.* (2009).

With regards to the Chroma ( $C^*$ ) of the formulated chinchin products, there was a slight difference in the values obtained for  $C^*$ . The  $C^*$  increased with an increase in the content of the OFSPP (Table 4). The total colour difference ( $\Delta E^*$ ) shows the magnitude of colour difference between a formulated product and the control product (Patras *et al.*, 2011). There was high colour change in the product as the content of OFSPP was increased in the formulations. The highest (10.91) change in colour was recorded in the 50% OFSPP chinchin. This may be due to that fact that it had the highest OFSPP concentration, and probably its carotene pigment concentration was higher.

### ***Sensory characteristics of the products***

As presented in Table 5, the scores obtained for colour on all the chinchin products showed no significant difference ( $P > 0.05$ ). Products containing 40% OFSPP had the highest mean ranking of 107.66 for colour, while the product with 100% wheat flour had the least mean ranking of 87.49 for colour. In terms of taste of the product, significant differences ( $P > 0.05$ ) were observed among the chinchin products. The 100% wheat flour chinchin had the highest mean ranking of 119.03. This was followed by the 30% OFSPP, which gave a mean rank value of 114.74.

Concerning the appearances of the product, the mean rank ranged from 95.75 to 109.55 (Table 5). Formulation with 30% OFSPP had the highest mean rank; while

formulation with 50% OFSPP obtained the least score. There were no significant differences observed for the appearance of the different chinchin products. The variation in the mean rank of the formulations could be as a result of the composition of the product, since the score decreased with increases in the OFSPP content with the exception of the 30% OFSPP. As regards the crispiness, the 100% wheat flour chinchin gave the highest mean rank of 111.21, while formulation with 50% OFSPP had 70.53 mean rank value indicating the least mean rank (Table 5). It was observed that the crispiness of the formulations decreased with an increase in the OFSPP concentration. There were significant differences ( $P < 0.05$ ) in the crispiness of the products.

In terms of the overall acceptability (Table 5) of the formulations, it ranged from 115.79 to 85.44.

In this study, it was clear that the mean rank for the overall acceptability reduced with increases in the content of OFSPP. The panelist preferred the chinchin product produced with 30% OFSPP over the other formulations.

Table 5: Sensory qualities of the formulated chinchin.

Sample	Colour	Taste	Appearance	Crispiness	Overall Acceptability
100% wheat flour	87.49	119.03 <sup>c</sup>	98.39	111.21 <sup>b</sup>	110.11 <sup>ab</sup>
70% wheat flour:30% OFSPP	103.98	114.74 <sup>bc</sup>	109.55	122.64 <sup>b</sup>	115.79 <sup>b</sup>
60% wheat flour:40% OFSPP	107.66	83.21 <sup>a</sup>	98.31	97.62 <sup>ab</sup>	90.66 <sup>ab</sup>
50% wheat flour:50% OFSPP	102.87	85.02 <sup>ab</sup>	95.75	70.53 <sup>a</sup>	85.44 <sup>a</sup>
p-value	0.253	0.000	0.585	0.0001	0.010

Values are means of rank. Values with different superscripts in the same column are statistically different ( $P < 0.05$ ); OFSPP (orange-fleshed sweet potato puree)

## CONCLUSION

Chinchin produced from OFSPP and wheat flour blend was developed and compared with chinchin produced from wheat flour alone. The physicochemical and sensory properties of the chinchin products were significantly influenced by the incorporation of the OFSPP. The pasting properties of the formulated dough did not show significant difference with the exception of setback and pasting temperature that showed significant differences. The water activity of the chinchin products was

lower than that of the dough. The protein composition of the chinchin product improved as the OFSPP content was increased, whereas the carbohydrate content declined with respect to the increased in the OFSPP content. All the colour attributes indicated significant difference. Formulation containing 30% OFSPP consistently had the best values with respect to appearance, crispiness and overall acceptability by panelists.

## REFERENCES

- Adegunwa, M., Ganiyu, A., Bakare, H and Adebowale, A. (2014). Quality evaluation of composite millet-wheat Chinchin. *Agriculture and Biology Journal of North America*, 5(1), 33–39.
- Adeola, A. A., and Ohizua, E. R. (2018). Physical, chemical, and sensory properties of biscuits prepared from flour blends of unripe cooking banana, pigeon pea, and sweet potato. *Journal of Food Science and Nutrition*, 3:1–9.
- Adeyemi, I.A. and Idowu, M. A. (1990). The evaluation of pregelatinized maize flour in the development of maissa, a baked product. *Nigeria Food Journal*, 8: 63-73.
- Akubor, P. I. (2004). Protein contents, physical and sensory properties of Nigerian snack foods (cake, chin-chin and puff-puff) prepared from cowpea - wheat flour blends. *International Journal of Food Science and Technology*, 39:419–424.
- AOAC. (2005). Official Methods of Analysis. (12th eds), Association of Official Analytical Chemistry, Washington DC, USA, AOAC International.
- Brandy, M. Howard, Kay, H. Mcwatters, and Firibu Saalia, A. I. (2009). Formulation and evaluation of snack crackers made with peanut flour. In *Cereal foods world* 54, 2–7.
- Chapli, K., and Smith, A. P. (2011). Definitions and perceptions of snacking, *Journal of Food Science and Nutrition*, 9(1), 53–59.
- Greene, J. L., and Bovell-Benjamin, A. C. (2004). Macroscopic and Sensory Evaluation of Bread Supplemented with Sweet-potato Flour. *Journal of Food Science*, 69(4),167–173.
- Hinton, F. (2018). Food Fact Sheet. Retrieved May 9, 2019, from [www.bda.uk.com/foodfacts](http://www.bda.uk.com/foodfacts)
- Lemchi, S. N, Mbah, C. A. and Obi-Anyanwu, J. N. (2016). Sensory evaluation of use of maize and yam flour in composition with wheat flour. *International Journal of Advanced Academic Research*, 2(2), 1–11.
- Nwokeke, B., Adedokun, I. and Osuji, C. (2013). Effect of blending on the proximate, pasting and sensory attributes of cassava-african yam bean fufu flour. *International Journal of Scientific and Research Publications*, 3(8),1-7.

- Ofori, G., Oduro, I., Ellis, W. O., and Dapaah, K. H. (2009). Assessment of vitamin A content and sensory attributes of new sweet potato genotypes in Ghana, *Journal of Food Science and Nutrition*, 3(7), 184–192.
- Oti, E and Aniedu, C. (2010). Potentials of sweetpotato for confectionaries: implications for food security. *Journal of Agriculture and Social Research*, 10(2), 17–23.
- Oyedele, D. J., and Adebooye, C. (2017). Proximate, mineral, sensory evaluations and shelf stability of chinchin enriched with ugu and indian spinach vegetables. *International Journal of Biochemistry*, 18(4), 1–14.
- Pathare, P. B., Opara, U. L., and Al-said, F. A. (2013). Colour measurement and analysis in fresh and processed foods. (pp. 36–60). South African: Springer Science Business Media.
- Patras Patras, A., Brunton, N. P., Tiwari, B., and Butler, F. (2011). Stability and degradation kinetics of bioactive compounds and colour in straw- berry jam during storage. *Journal of Food and Bioprocess Technology*, 4:1245–1252
- Rafia, S. (2017). development and quality assessment of gari from dried cassava chips. university for development studies, Tamale.
- Satheesh, N. and Solomon W. F. (2019). Review on nutritional composition of orange-fleshed sweet potato and its role in management of vitamin A deficiency. *Food Science and Nutrition* 7: (6) 1920–1945.
- Samuel, A., and John, O. (2014). Evaluation of nutritional and sensory properties of cookies produced from sweet potato- maize flour blends. *Journal of Researcher*, 6(9), 61–70.
- Sanni, L.O., and Adebowale A. A. (2006). Proximate, functional, pasting and sensory qualities of instant yam flour. A paper presented at the 14 ISTRC Symposium, central tuber crops research institute, Trivandrum. Kerala State, India.
- Tangkanakul, P., Tungtrakul, P., and Mesomya, W. (1999). Nutrient contents of commercial snack food products. *Journal Food Science and Nutrition*, 276: 270–276.
- Widodo, Y., Wahyuningsih, S., and Ueda, A. (2015). Sweet Potato Production for Bio-ethanol and Food Related Industry in Indonesia: Challenges for Sustainability. *Journal of Procedia Chemistry*, 14: 493–500.