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NUTRITIONAL ASSESSMENT AND CONSUMER ACCEPTABILITY OF SNACKS (CHINCHIN AND COOKIES) ENRICHED WITH UNDERUTILIZED INDIGENOUS VEGETABLES

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Indigenous vegetables have grossly remained underutilized. Enriching snacks with Underutilized Indigenous Vegetables (UIVs) will improve the nutritional quality of the products. This study investigated the effect of some Nigerian UIVs on the quality of chinchin and cookies. Fresh leaves of *Solanum macrocarpon (igbagba), Telfaria occidental (ugwu) and Amaranthus viridis (tete abalaiye)* were dried and incorporated at different levels (0.55-3.50%) into the dough. The dough was cut into pieces, fried to chinchin and baked to cookies. Proximate, mineral and sensory evaluations of the snacks were carried out, and the data obtained were subjected to statistical analysis. The inclusion of the UIVs increased the protein, ash, fibre, energy and mineral content of the snacks. Sensory evaluation revealed that 2 g vegetable enriched snacks were acceptable to the tasters than other addition levels. The results suggest that vegetable addition enhanced the nutritional and mineral enrichment of the cookies and *chinchin* snacks.

Keywords: Underutilized indigenous vegetables, Enrichment, Snacks, Physicochemical characteristics, Sensory acceptability

INTRODUCTION

Snacks are popular and consumed by a wide range of population across all age groups. They are consumed primarily for pleasure rather than for nutritive purpose (Matz, 1993). Sustainability of energy throughout the day is one of the benefits of snacking. Snacks can provide what may be missing from meals. *Chinchin* is a fried snack, not highly nutritive but with good economic value, and readily affordable. It has a good shelf life of five to six months (Hussain *et al*., 2006). *Chinchin* is sweet to taste, slightly hard, might contain cowpeas and may be prepared by baking instead of frying (Akubor, 2004). Cookies are flat, dry, sweet biscuits. They have been produced from blends of wheat and cowpea (McWatters *et al*., 2003; and Akubor, 2004).

Vegetables are very vital to the human diet. They are cheap and good nutritional sources of protein, vitamins, minerals, dietary fibre, and water to aid digestion. Green leafy vegetables are rich sources of essential vitamins and minerals (Gupta *et al*., 2005). Varieties of indigenous vegetables found in Africa (Odhav *et al*., 2007) are important food security crops, with more vitamins and micronutrients than the exotic vegetables. Vegetables are highly perishable due to their high moisture content and are sold at throwaway prices during the peak season. This is because of non-availability of sufficient storage, and proper processing facilities at the production point (Pande *et al*., 2000). Drying can prevent such huge wastage and increase their availability during off seasons. Dehydrated vegetables are

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simple to use and have longer shelf life than fresh vegetables (Chauhan and Sharma, 1993).

Karva (2008) reported that there was a substantial increase in the essential amino acid content of snack foods incorporated with *rajagira* (green leafy vegetable). Singh and Awasthi (2003) also reported 15% acceptable level of powdered vegetable incorporated in some food products such as biscuit. Attempt to increase the nutritional qualities of snack foods with the use of dehydrated under-utilized vegetables have not been reported. Hence, the study investigated the use of dried Under-utilized Indigenous Vegetables (UIVs) in Nigeria in the enrichment of snacks (*chinchin* and cookies).

MATERIALS AND METHODS

Sample Collection

The fresh vegetable leaves of *igbagba* (*Solanum macrocarpon*), ugwu (*Telfairia occidentali*) and tete abalaiye (*Amaranthus viridis*) were obtained from the Teaching and Research farm of the ObafemiAwolowo University, Ile-Ife, Nigeria. The snack ingredients (wheat flour, margarine, egg, baking powder, milk, nutmeg, salt and sugar) were purchased from the central market in the same university. All chemicals used were of analytical grade.

Processing of the Vegetables

The method of Ojo *et al*. (2015) was employed in the processing of the vegetables. The vegetables were washed to remove sand and other unwanted matters and thinly chopped. The leaves were spread on clean stainless steel trays and sundried for three days. The leaves were turned intermittently to avert fungal growth. Weight was monitored until the vegetables were brittle and no more change in weight recorded. The dried leaves were then pulverized to a coarse powder using a laboratory mill, sieved through a 500 µm screen wire mesh and stored in air-tight containers until further use.

Production of Chinchin and Cookies

The ingredients and proportion for the *chinchin* and cookies production are shown (Table 1). The production of the snacks was adapted from all Nigerian recipes (2014) and culinary arts (2014) (Figure 1).

Table 1: Recipe Used for the Preparation of Chinchin and Cookies

Ingredients (g)	*Chinchin*	Cookies
Flour	200	130
Baking powder	-	7.4
Sugar	40	20
Salt	0.5	1.5
Butter	25	25
Milk	15	15
Nutmeg	2	-
Water	80	80
Total	362.5	278.9
Egg	-	1 egg yolk
Sundried Vegetables		
(*Igbagba, Ugwu and Tete*)	2 (0.55%)	2 (1.00%)
	5 (1.40%)	5 (1.76%)
	10 (2.70%)	10 (3.50%)

Source: http://www.allnigerianrecipes.com/snacks/chin-chin (2014); http://culinaryarts.about.com/od/bakingdesserts (2014)

Proximate Analyses of the Samples

The samples were evaluated for crude protein, crude fat, crude fibre, moisture, % brix and ash content according to AOAC (2002). The content of total carbohydrate was determined by difference. The energy value was determined using combustion calorimeter (Model, e2K) according to AOAC (2002).

Mineral Analyses of the Samples

The mineral contents (Manganese, Magnesium, Iron, Calcium and Copper) were determined using a modification of the sequential digestion procedure described by Akinremi *et al.* (2003). The digested samples were introduced at 2.0 ml/minute with nebulizer gas flow of 0.70 l/min. Calcium and magnesium were determined by reading their absorbance at 393.37, 766.49, 279.55 and 213.62 nm wavelengths respectively while Iron, Manganese, and Copper were measured at 259.94, 257.61, 324.75 and 213.856 nm wavelengths respectively (Martin*et al.*, 1994).

Sensory Evaluation of the Samples

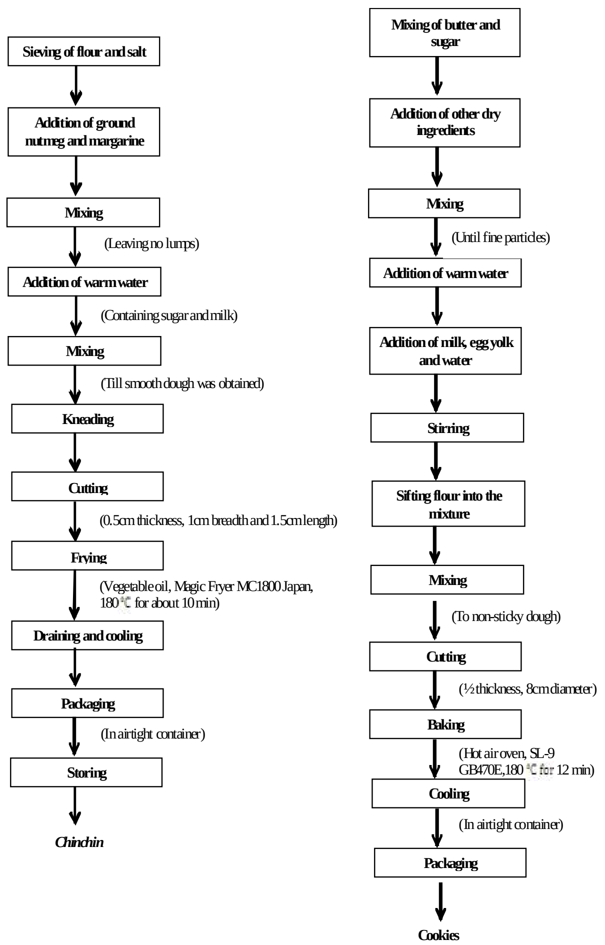
Twenty-four hours after preparation, the sensory evaluation of the snacks was carried out. The samples were served in clean white plates to 15 trained panelists. The panelists

Table 2: Proximate Compositions of the Fresh and Sundried Vegetables

Vegetable	% Protein	% Moisture	% Crude Fibre	% Crude Fat	%Ash	CHO
Fresh *Tete*	11.81±0.39	87.79±0.47	0.48±0.04	0.04±0.00	20.39±0.83	0.00±0.00
Fresh *Igbagba*	5.24±0.59	87.20±0.33	0.57±0.03	2.81±0.35	15.27±1.02	0.00±0.00
Fresh *Ugwu*	8.12±0.64	85.30±0.22	0.89±0.01	1.21±0.03	7.22±0.96	0.00±0.00
Sundried *Tete*	35.18±0.82	13.25±0.35	0.87±0.01	0.03±0.01	9.21±0.78	41.47±1.93
Sundried *Igbagba*	20.34±0.66	16.17±0.35	1.71±0.01	0.07±0.02	7.16±0.38	54.56±0.65
Sundried *Ugwu*	33.28±0.41	14.25±0.35	2.28±0.04	0.78±0.03	10.89±0.72	38.73±0.24

Note: CHO-Carbohydrate; Mean ± S.D. of three determinations.

Figure 1: Production of Chinchin and Cookies



scored the samples for taste, colour, smell, texture, general appearance and overall acceptability using the seven point Hedonic scale, where 7 represents 'like extremely' and 1 represents 'dislike extremely'.

Statistical Analysis

Experiments were carried out in triplicates. Data obtained were subjected to Analysis of Variance (ANOVA), followed by mean separation using Duncan Multiple Range Test (Statistical Package for the Social Science [SPSS], 2011). Significance was accepted at $p < 0.05$.

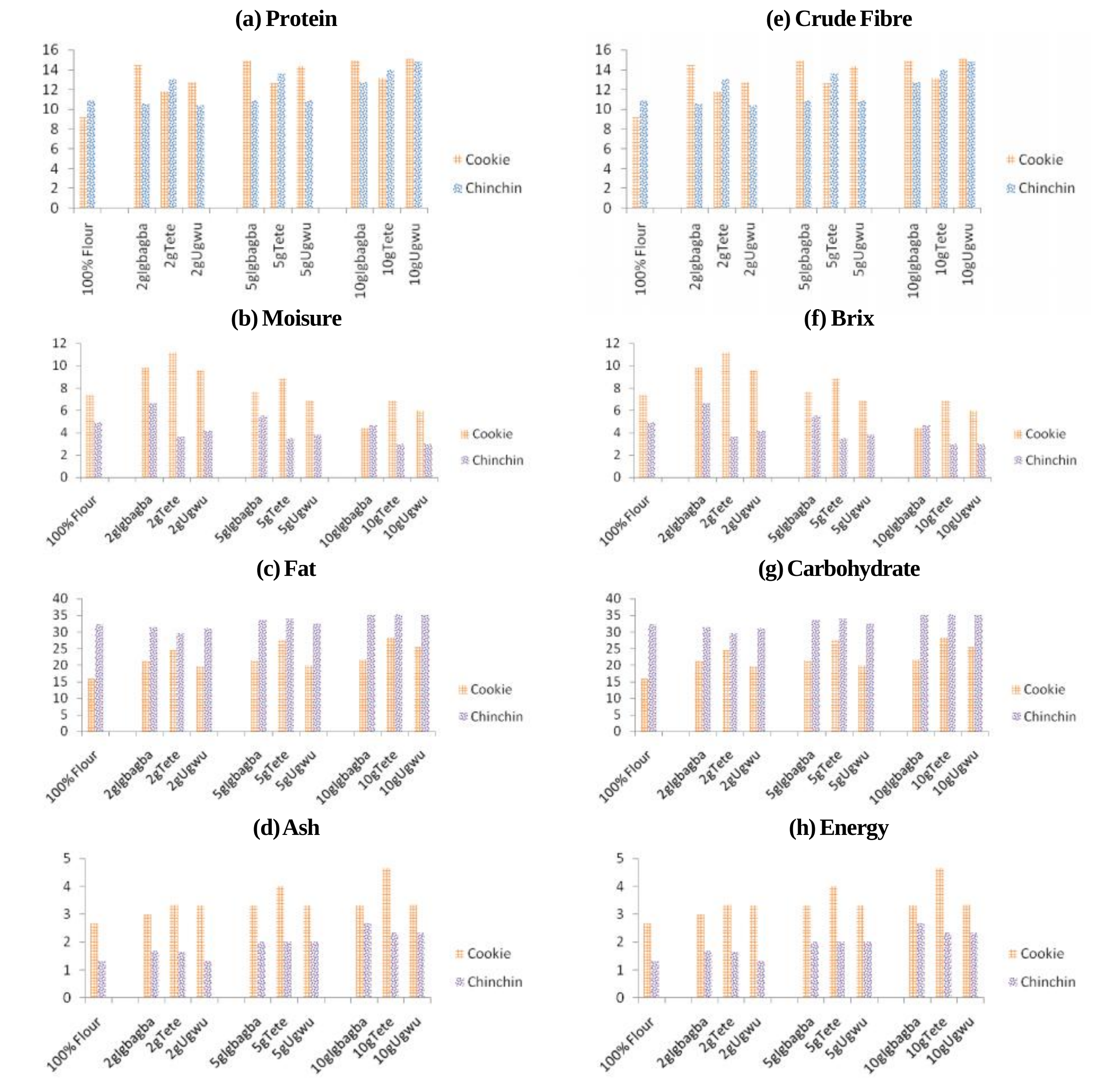
RESULTS AND DISCUSSION

The proximate compositions of the fresh and dried vegetables were analysed and the result is presented (Table 2). The result showed that drying reduced the moisture, crude fat and ash content of the vegetables, but increased the protein, crude fiber and carbohydrate. Higher protein contents were recorded for *tete* (35.18%) and *ugwu* (33.28) than *igbagba* (20.34%) vegetable. The moisture content (wet basis) of *igbagba* (16.17 %) was higher than that of *tete* (13.25%) and *ugwu* (14.25%). *Ugwu* had the highest crude fibre (2.28%) followed by *igbagba* (1.71%) and followed by *tete* (0.87%). The fat contents of the dried vegetables are low ranging from 0.03 to 0.78%. *Ugwu* vegetable had the highest ash content (10.89%), followed by *tete* (9.21%), and *igbagba* (7.16%).

Proximate Composition of Chinchin and Cookies

Results of the proximate composition of the snacks showed (Figures 2a-2h) that the addition of the dried vegetables increased the protein content of the enriched cookies significantly $(p < 0.05)$. The protein content of the three vegetables enriched cookies ranging between 11.82 and 15.10%, which amounted to about 29-65% increase in protein content. The enriched cookies have higher protein compared to the 9.15% protein of the 100% flour cookies. Increasing the vegetable concentration increased the protein

Figures 2a-h: Proximate Composition of *Chinchin* and Cookies



content of *tete and ugwu* enriched cookies up to 10 g but no increase was noticed beyond 5 g of *igbagba* addition. Of the three vegetables, 10 g *ugwu* enriched cookies had the highest protein value (15.10%). Protein content of the *chinchin* samples increased as the amount of vegetable increased. *Chinchin* enriched with *tete* vegetable had values (13.07-13.94%) which are significantly $(p > 0.05)$ higher than the 100% flour *chinchin* (10.95%). Increasing the quantity of *tete* from 2 g to 10 g significantly $(p > 0.05)$ increased the protein content (about 19-27% increase). Protein content of *igbagba* and *ugwu* enriched *chinchin* did not increase with 2 g to 5 g vegetable addition but increased at 10 g addition (16 and 35% protein increase respectively).

Cookies generally appeared to have higher protein values than the *chinichin* samples. It should be noted that although the formulations of both snacks are quite similar (Table 1), no egg was added in the formulation of *chinchin* and a higher percentage of vegetables were incorporated in the cookies. Both snack foods showed a steady increase in the protein content with increasing level of vegetable addition. The enriched snacks had higher protein content than the 100% flour snacks. The high protein content in the enriched snacks would be of nutritional importance in Nigeria and other developing countries where proteinous foods are of high cost. These values are within range of biscuits incorporated with vegetables (11.6-23.8%) reported by Singh and Awasthi (2003) and those reported by Singh *et al.* (2004) for biscuits and cake prepared from dried spinach leaves (9.60-16.62%).

Moisture content for the cookies ranged between 4.43 and 11.19%. Cookies enriched with 2 g vegetables had higher moisture (9.59 -11.19%) than 100% flour cookies (7.41%) with a percentage increase of 33, 51, and 29% for *igbagba*, *tete*, and *ugwu* respectively. The moisture content of the *chinchin* samples ranged between 3.00 and 6.58%. *Igbagba* enriched *chinchin* retained more moisture than the other two vegetables, with 2 g and 5 g enriched *chinchin* retaining about 34 and 12% moisture content respectively. The moisture content of *chinchin* was lower than that of the cookies. This is expected because frying is a process of dehydration (Bordin *et al.*, 2013). The moisture content of the snacks decreased significantly as the amount of vegetable increased. It is probable that the vegetables absorbed the moisture in the dough for rehydration. More water may be required for rehydration as vegetable quantity increased, thus lowering the final moisture content of the snack foods. The low moisture content of the snacks is an indication that the products would not favour spoilage by microorganisms, thereby increasing the storage stability of the products. This result revealed that increasing the quantity of the vegetables incorporated in the snacks can result in a more shelf stable product due to its lower moisture content.

The fat content of all the enriched cookies (19.77-28.29%) were significantly higher when compared to 100% flour cookies (15.84%). This might be due to the oil absorption capacity of the vegetables added. This result correlate with the report of Agbede *el al.* (2012), Sharoba *et al.* (2013) and Borja *et al.* (2013), that vegetable have high oil absorption capacity. The enriched *chinchin* had higher fat (29.52-35.27%) content than the cookies. This increase may be associated with oil absorbed during frying. Two gramme vegetables addition did not significantlyaffect the fat content of the *chinchin*. A slight increase (1-10%) was observed in the fat content of *chinchin* when the vegetables were increased from 5-10 g. The result revealed that increasing the quantity of the vegetables did not significantly affect the fat content of the snack foods. Fat content was retained mostly in the *tete* enriched snacks.

The ash contents of the vegetable enriched cookies (2.98-4.65%) are significantly higher than that of 100% flour cookies (2.66%). The result revealed that vegetables addition amounts to about 12-75% increase in ash content. Increasing the *igbagba* and *ugwu* vegetables beyond 5 g did not significantly affect the ash content of the cookies. *Tete* enriched cookies had the highest ash content, and increased at all level of vegetable addition. The ash contents of the enriched *chinchin* samples (1.67-2.67%) are significantly higher than that of 100% flour *chinchin* (1.33%). Increasing the quantity of the three vegetables slightly increased the ash contents. *Chinchin* enriched with 10 g *igbagba* vegetable had the highest ash content. Ash contents of enriched cookies are higher than the *chinchin* samples. This might be because of difference in the formulation of each snack.

Crude fibre was not detected in the 100% flour snacks. The flour was sifted prior to usage, and the fibre might have been removed during this operation. The crude fibre of the enriched cookies ranged between 0.33 and 0.67%. No significant difference in the crude fibre content of the enriched cookies. Increasing the vegetable quantity from 2 g to 5 g did not significantly increase the crude fibre of cookies but the value doubled at 10g vegetable inclusion. Crude fibre of enriched *chinchin* ranged between 0.33 and 0.8%. The 10 g *ugwu* enriched *chinchin* had highest crude fibre. This may be because of the high crude fibre content of the dried *ugwu* (2.28%) incorporated in the sample, but the value was not significantly different from other enriched *chinchin* samples. This result revealed that the vegetables are good sources of low fibre essential for human nutrition, and can be incorporated in high carbohydrate snacks for healthy living.

Degree brix of the enriched cookies ranged between 4.60 and 8.20 while that of 100% flour cookie was 6.7 °brix. *Tete* enriched cookies had the highest value and the % increase in ° brix was observable at all levels of vegetable addition. °Brix for enriched *chinchin* ranged between 4.10 and 10.00. The value increased with increase in vegetable addition. Percentage increase in the value at 2 g and 5 g addition level was significantly lower than at 10 g addition level. *Igbagba* enriched *chinchin* had the highest value with about 55% °brix increase at 10 g addition. °Brix (soluble solids concentration) increased with increase in vegetable. This is an indicator that the quality of the vegetable snacks improved (Rane *et al.*, 2016). Vegetable enriched cookies had lower carbohydrate content (46.54-49.17%) when compared to the control (58.24%). Increase in the vegetable addition did not significantly increase the carbohydrate content of the cookies. *Chinchin* enriched samples decreased in carbohydrate with increase in vegetable addition. This reduces the emergence of protein-energy malnutrition. Vegetable enriched cookies had higher energy values (445.49-492.61 kcal/g) when compared to the 100% flour cookies (438.92 kcal/g). Increasing the quantity of all the three vegetables increased the energy content of the cookies (2-12% energy increase). Cookies enriched with *tete* vegetable had higher values than other vegetables. Energy values of the enriched *chinchin* (522.03-563.13 kcal/g) are higher when compared to the 100% flour *chinchin* (535.93 kcal/g) but not significantly different. As the vegetable quantity increased from 2 g to 10 g, the energy content also increased (0.5-5%). *Chinchin* enriched with *ugwu* vegetable had the highest value at 5 g to 10 g incorporation level.

Mineral Composition of Chinchin and Cookie Samples

Mineral compositions of the UIV's have been reported on a dry basis (IDRCProject, 2014). Mineral compositions of the cookies and *chinchin* samples are presented (Figures 3a-3e). Copper (Cu) content of the enriched cookies ranged between 6.3 and 11.2 mg/kg. Increasing the vegetable quantity increased the Cu in the cookies. *Igbagba* enriched cookies had the highest Cu (8.6-11.2 mg/kg) with about 41% increase at 10 g addition level. Cu composition of *chinchin* samples increased from 6.4 to 12.1 mg/kg with an increase in vegetable addition. *Igbagba* enriched *chinchin* had the highest Cu. About 80% increase was obtained at 10 g addition level. No significant increase was noticed in the Cu content of the cookies and *chinchin* samples enriched with 2 g to 5 g *tete* and *ugwu* vegetables.

The iron (Fe) content of the cookies increased with increase in vegetable from 163.5 to 932.8 mg/kg. *Igbagba* enriched cookies at 10 g addition had the highest Fe, followed by 10 g *tete* enriched cookies. This account to about 133% and 31% increase in Fe when compared to the 100% flour cookies. Fe content of the *chinchin* samples increased (111.8-282.4 mg/kg) with an increase in vegetable addition. The 10 g *tete* enriched *chinchin* had the highest Fe. Values of the enriched *chinchin* are lower than those of the enriched cookies. The values are higher than those reported by Singh and Awasthi (2003) for biscuits incorporated with vegetables (2.16-5.62 mg/kg). This may be as a result of the differences in the types of vegetables and also the processing methods.

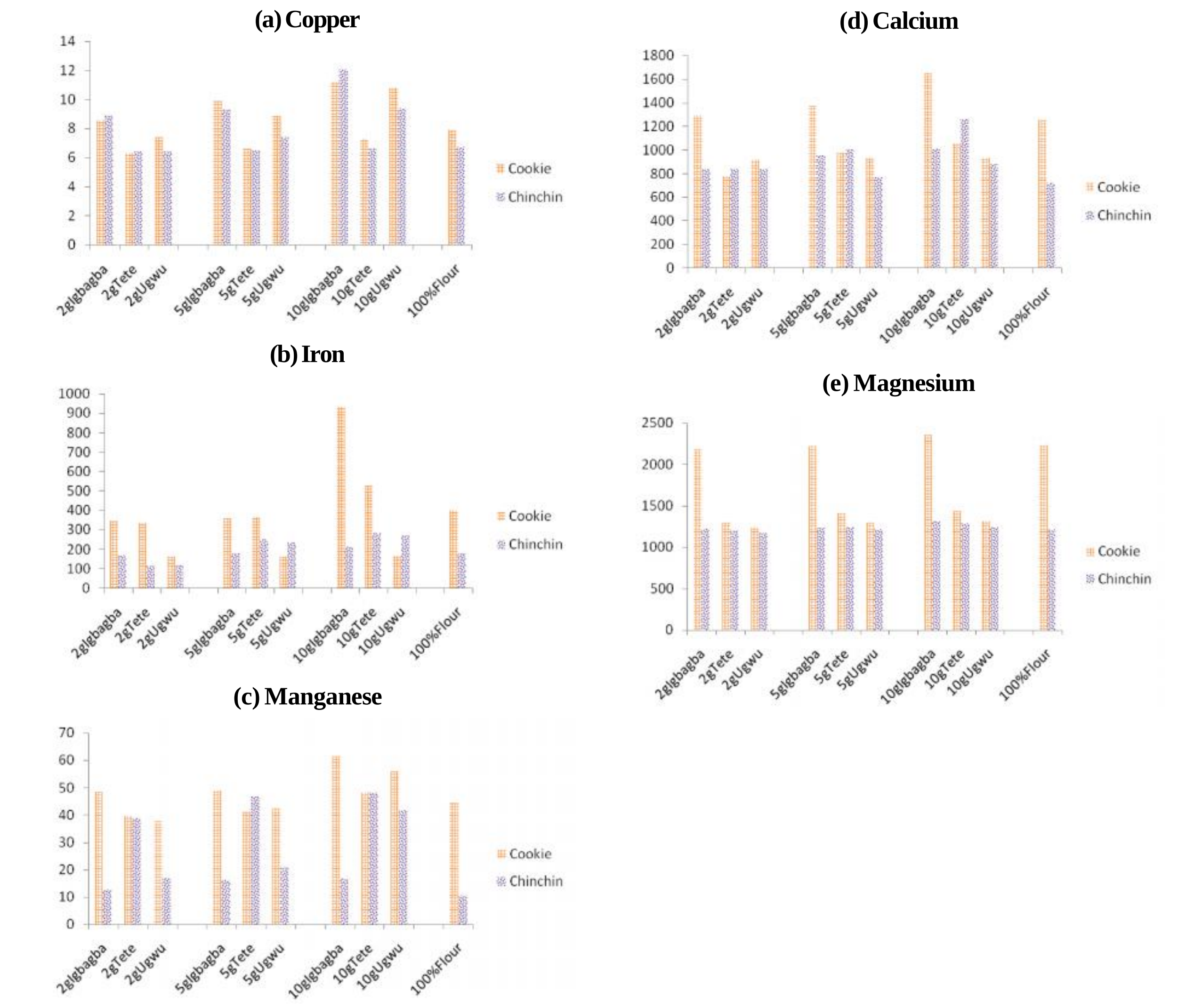
Manganese (Mn) values of the cookies were higher than those of the *chinchin* samples. Increasing the vegetable quantity increased the Mn content of cookies significantly (37.7-61.5 mg/kg). *Igbagba* enriched cookies had the highest value. Mn content of the *chinchin* samples increased from 12.6 to 48.1 mg/kg. The values were higher than 10.5 mg/kg of the 100% flour *chinchin*. *Tete* enriched *chinchin* had the highest Mn which significant increased from 2 g to 10 g vegetable inclusion level (269-358%).

Calcium (Ca) content of the snack foods increased with increase in all the vegetable addition. Ca content of the enriched cookies ranged between 777.8 and 1649.6 mg/kg. *Igbagba* enriched cookies had the highest value (1292.4-1649.60 mg/kg) which is significantly higher (3-32% increase) than the 100% flour cookies (1254.40 mg/kg) and other vegetable enriched cookies (777.80-1055.30 mg/kg). Ca contents of enriched *chinchin* samples are significantly higher (738.60-1262.60 mg/kg) than 100% flour *chinchin* (718.80 mg/kg). Percentage Ca increase in enriched *chinchin* ranged from 3 to 76%. Magnesium (Mg) values were higher than the other minerals studied. Mg increased with increase in all the vegetables for snack samples, with *igbagba* enriched snacks having the highest value. Mg content of the cookies ranged between 1240.3 and 2361.9 mg/kg, while that of the *chinchin* samples ranged between 1182.51 and 1311.1 mg/kg. The results of the proximate and mineral composition of the snack foods revealed that cookies had higher values than *chinchin*. This may bedue to differences in the formulation and method of preparation. Frying process has been reported to considerably affect the proximate and mineral contents of rainbow trout than baking and grilling (Gokoglu *et al.*, 2004).

Sensory Evaluation of Chinchin and Cookies

Mean sensory scores of the cookie and *chinchin* samples are presented (Table 3). Plate 1 showed the cookie and *chinchin* samples prepared with and without the vegetables. The results revealed that increasing the quantity of each vegetable significantly ($p<0.05$) decreased all the sensory attributes measured. The 100% flour cookie had the highest score while 10 g *ugwu* cookie had the least score in all

Figure 3a-e: Mineral Composition of *Chinchin* and Cookies

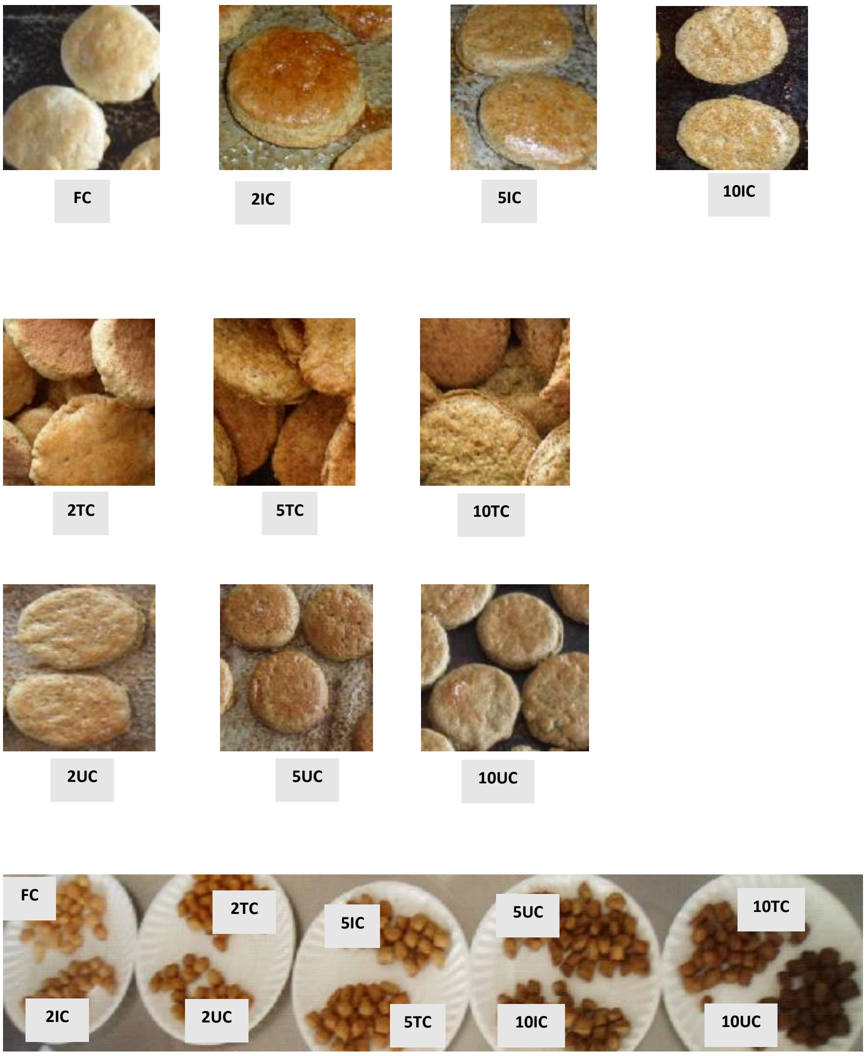


attributes. The 2 g enriched cookies were highly scored after the 100% flour cookie in all the sensory attributes evaluated.

In terms of taste, all the 2 g vegetables and 5 g *igbagba* cookies were not significantly (p>0.05) different from the 100% flour cookie. Among the vegetable enriched cookies, 2g *tete* cookie had the highest scores (5.53) in taste. There were significant (p<0.05) differences in the colour of the enriched cookies and the 100% flour cookie. Among the enriched samples, all the 2 g vegetables and the 5 g *tete* cookies were not significantly (p>0.05) different from each other. In terms of smell and texture, all the 2 g vegetables and 5 g *igbagba* cookies were not significantly (p>0.05) different from the 100% flour cookie. The 2 g *tete* cookie was highly scored in smell (5.87) and texture (6.13) among the enriched samples. There was no significant (p>0.05) difference in the general appearance and overall acceptance of the 2 g vegetable enriched cookies and 100% flour cookie. Among the enriched samples, 2 g *tete* cookie had the highest score in general appearance (5.80) and overall acceptance (6.00).

Among all the 2 g vegetable cookies, 2 g enriched *tete* cookie had the highest score in all the sensory attributes evaluated. Among all the 5 g vegetable cookies, 5 g *igbagba* cookie was highly scored in all attributes except in colour and general appearance. The 10 g *ugwu* enriched cookie had the least score among the 10 g vegetable enriched cookies. This result, therefore, revealed that 2 g *tete* enriched cookies are more acceptable to the tasters.

Plate 1: Cookies and *Chinchin* Samples



Results of the sensory evaluation showed that increasing the quantity of each vegetable significantly ($p<0.05$) reduced the scores of all the attributes evaluated for the *chinchin* samples. The 100% flour *chinchin* had the highest score while 10 g *ugwuchinchin*had the least score in all attributes evaluated. Among the 2 g enriched *chinchin*, 2 g *igbagba chinchin* had the highest score in all variables except colour, where 2 g *tete* enriched *chinchin* was rated highest (6.13) but the two samples are not significantly ($p>0.05$) different from each other in colour. The 5 g *tetechinchin* had the highest score among the 5 g vegetable enriched *chinchin* samples in all variables except overall acceptance. The 10 g *ugwu chinchin* had the least score in all variables among the 10 g vegetable enriched *chinchin*.

There were no significant ($p>0.05$) differences in the taste of the 2 g *igbagba*, 2 g *tete* and the 100% flour cookie. Among the enriched *chinchin* samples, 2 g *igbagba chinchin* had the highest score (6.33) in taste while 10 g *ugwu chinchin* had the least score (2.87). The enriched *chinchin* samples were significantly ($p<0.05$) different from the 100% flour cookie. All the 2 g vegetable enriched *chinchin*are not significantly ($p>0.05$) different from each other, with 2 g *tete* having the highest score (6.13), i.e., the least green in colour. There was no significant ($p>0.05$) difference in the smell and texture of the 2 g *igbagba*, 2 g *tete* and the 100% flour cookie. The 2 g *igbagba* and 100% flour cookie are not significantly ($p>0.05$) different from each other in terms of general appearance and overall acceptability. Among the enriched *chinchin*s amples, 2 g *igbagba chinchin* is not significantly different from the 100% flour cookie in all attributes except colour. The sample was also rated higher among all the vegetable enriched *chinchin*. This result therefore revealed that 2 g *igbagba* and *tete* vegetable enriched *chinchin* are more acceptable than *ugwu* enriched *chinchin* to the tasters.

CONCLUSION

This study showed that some UIV's in Nigeria can be incorporated in some food products like snacks (cookies and *chinchin*). The result revealed a substantial increase in the proximate and mineral content of the snacks when compared to 100% flour snacks. The energy content of the snacks increased with increase in the vegetable. The addition of vegetable increased the mineral content but the extent of the increase varies with the different snack foods. *Igbagba* enriched snacks had higher values of Ca, Mn and Fe.

Generally, cookies had higher nutrient values than *chinchin*. Two grammeUIV's enriched snacks are more acceptable to the tasters than all other enriched snacks. Vegetable addition at higher level provoked significant differences in the colour, with intense green colour in *ugwu* enriched snacks. UIVs can significantly provide additional nutrients when incorporated in snacks.

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APPENDIX

Table 3: Mean Sensory Scores of the Cookies and *Chinchin* Samples

Samples	Taste	Colour	Smell	Texture	General Appearance	Overall Acceptance
FC	$5.73\pm1.34_{a}$	$6.47\pm0.64_{a}$	$5.93\pm0.79_{a}$	$6.60\pm0.51_{a}$	$6.33\pm0.98_{a}$	$6.47\pm0.74_{a}$
2IC	$5.20\pm1.42_{abc}$	$5.07\pm1.10_{bc}$	$5.47\pm0.92_{a}$	$5.73\pm0.79_{ab}$	$5.53\pm1.13_{ab}$	$5.67\pm1.11_{ab}$
2TC	$5.53\pm1.06_{ab}$	$5.33\pm1.18_{b}$	$5.87\pm1.13_{a}$	$6.13\pm1.25_{a}$	$5.80\pm0.86_{a}$	$6.00\pm1.00_{a}$
2UC	$5.40\pm0.74_{ab}$	$5.07\pm1.10_{bc}$	$5.13\pm0.99_{ab}$	$5.60\pm0.99_{abc}$	$5.60\pm1.12_{ab}$	$5.73\pm0.79_{ab}$
5IC	$4.93\pm1.34_{abcd}$	$4.13\pm1.13_{cde}$	$5.07\pm1.03_{ab}$	$5.67\pm1.05_{abc}$	$4.53\pm1.06_{c}$	$5.07\pm0.88_{bc}$
5TC	$4.60\pm0.99_{bcd}$	$4.47\pm1.06_{bcd}$	$4.33\pm1.35_{bc}$	$4.87\pm1.06_{bcd}$	$4.87\pm0.83_{bc}$	$4.93\pm0.79_{bc}$
5UC	$4.27\pm1.16_{cde}$	$4.00\pm1.31_{de}$	$4.13\pm1.06_{c}$	$4.73\pm1.53_{bcd}$	$4.00\pm0.85_{cd}$	$4.20\pm1.32_{cd}$
10IC	$4.13\pm1.36_{de}$	$2.80\pm1.47_{f}$	$3.67\pm1.39_{cd}$	$4.60\pm2.23_{cd}$	$3.47\pm1.55_{de}$	$3.27\pm1.67_{e}$
10TC	$4.27\pm1.58_{cde}$	$3.27\pm1.49_{ef}$	$3.67\pm1.23_{cd}$	$4.40\pm1.50_{d}$	$3.60\pm1.40_{de}$	$3.53\pm1.64_{de}$
10UC	$3.53\pm1.55_{e}$	$2.67\pm1.35_{f}$	$3.07\pm1.49_{d}$	$3.93\pm1.83_{d}$	$3.07\pm1.39_{e}$	$3.27\pm1.44_{e}$
FCH	$6.47\pm0.83_{a}$	$6.87\pm0.35_{a}$	$6.40\pm0.63_{a}$	$6.13\pm0.64_{a}$	$6.80\pm0.41_{a}$	$6.67\pm0.49_{a}$
2ICH	$6.33\pm0.82_{a}$	$6.00\pm0.76_{b}$	$6.07\pm0.70_{ab}$	$6.00\pm0.85_{ab}$	$6.27\pm0.59_{ab}$	$6.27\pm0.59_{a}$
2TCH	$5.67\pm0.72_{ab}$	$6.13\pm0.74_{b}$	$5.93\pm0.79_{abc}$	$5.53\pm1.06_{abc}$	$5.80\pm0.68_{bc}$	$6.00\pm0.85_{ab}$
2UCH	$5.13\pm1.25_{bc}$	$5.47\pm0.83_{bc}$	$5.33\pm1.29_{bcd}$	$5.60\pm0.99_{abc}$	$5.47\pm0.74_{c}$	$5.47\pm0.74_{bc}$
5ICH	$5.27\pm0.88_{bc}$	$4.87\pm0.74_{cd}$	$5.07\pm0.59_{de}$	$5.13\pm1.06_{bc}$	$5.13\pm0.83_{c}$	$5.20\pm0.86_{cd}$
5TCH	$5.40\pm0.99_{bc}$	$5.07\pm0.88_{c}$	$5.13\pm0.92_{cde}$	$5.67\pm1.11_{abc}$	$5.13\pm0.99_{c}$	$5.07\pm1.03_{cde}$
5UCH	$4.60\pm1.24_{c}$	$4.33\pm1.11_{de}$	$4.53\pm1.46_{de}$	$4.93\pm0.96_{c}$	$4.20\pm1.27_{d}$	$4.47\pm1.30_{def}$
10ICH	$4.53\pm1.13_{c}$	$3.73\pm0.96_{e}$	$4.47\pm1.25_{de}$	$4.87\pm1.13_{c}$	$3.60\pm0.83_{d}$	$4.33\pm1.11_{ef}$
10TCH	$4.60\pm1.40_{c}$	$3.93\pm1.16_{e}$	$4.40\pm1.24_{e}$	$4.80\pm1.37_{c}$	$3.73\pm1.34_{d}$	$4.20\pm1.32_{f}$
10UCH	$2.87\pm1.55_{d}$	$2.47\pm1.30_{f}$	$2.93\pm1.58_{f}$	$4.00\pm1.60_{d}$	$2.40\pm1.24_{e}$	$2.73\pm1.44_{g}$

Note: Means with the same alphabets within a column were not significantly different from each other at ($p<0.05$). FC-100% (Flour) Cookies, 2IC-2 g *Igbagba* Cookies, 5IC-5 g *Igbagba* Cookies, 10IC-10 g *Igbagba* Cookies, 2TC-10 *Igbagba* Cookies, 5TC-5 g *Tete* Cookies, 10TC-10 *Tete* Cookies, 2UC-2 g *Ugwu* Cookies, 5UC-5 g *Ugwu* Cookies, 10UC-10 *Ugwu* Cookies, FCH-100% (Flour) *Chinchin,* 2ICH-2 g *Igbagba Chinchin,* 5ICH-5 g *Igbagba Chichin,* 10ICH-10 g *Igbagba Chichin,* 2TCH-2 g *Tete Chichin,* 5TCH-5 g *Tete Chinchin,* 10TCH-10 g *Tete Chinchin,* 2UCH-2 g *Ugwu Chinchin,* 5UCH-5 g *Ugwu Chinchin,* 10UCH-10 g *Ugwu Chinchin.*