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CHARACTERISTICS OF COOKIES PRODUCED FROM WHEAT AND EGG SHELL FLOUR

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Abstract: Cookies are popular snacks commonly consumed by children and adults to provide energy. Quality evaluation of cookies from composite flour of wheat-egg shell powder was assessed. Egg shell was made into powder and fortified in ratios (100:0%, 97.5:2.5%, 95:5%, 92.5:7.5%, 90:10%) for wheat and egg shell flour respectively). The different flour blends was processed into cookies. The cookies produced were then evaluated for proximate composition, mineral composition and sensory attributes using laboratory standard methods. The result of the proximate analysis showed that ash, fibre and protein contents of the cookies sample increased significantly with increase in the level of egg shell powder incorporated with values ranging from 1.70-4.92%, 3.10-6.60%, and 6.52-15.32% respectively. Sample with 10% egg shell powder had the highest value for each of the parameters while control sample (100% wheat) had the least value. The result of the mineral composition also showed that calcium, magnesium and iron content of the samples increased significantly with increased level of egg shell powder with values ranging from 131-514mg/100g, 48.55-96.26mg/100g and 0.248-1.060mg/100g respectively. The aroma, texture, crispiness, and taste of the fortified cookies had mean scores of 4.7-8.3, 5.4-7.8, 5.4-7.7 and 5.1-8.2 respectively. Cookies fortified with egg shell powder were generally accepted by the panelist up to 10% egg shell powder. Inclusion of egg shell powder up to 10% level is found to improve the nutritional and sensory attributes of the cookies.

Keywords: Cookies, Egg Shell, Proximate Composition, Mineral Composition.

INTRODUCTION

Cookies otherwise known as biscuits are popular cereal foods commonly consumed by the populace especially among the pre-school and school age children (Okaka 2009). Cookies are ready-to-eat, convenient and inexpensive food snacks provided from unpalatable dough that is transformed into a porous readily digestive and appetizing product through the application of heat. They are rich source of fat, protein and carbohydrate hence they provide energy and are a good source of minerals (Kure et al. 1998). Wheat flour is considered `unique as the basic raw materials for the production of bakery product such as bread, biscuits and cookies because of its special gluten development properties as compared to those of other cereal grain (Chu 2004). Cookies have been suggested as a better use of composite flour than bread due to their ready to eat farm whole consumption, relatively long shelf life and good eating quality (Mcwatters 2003). Eggshells are waste materials from hatcheries, homes and fast food industries (Amu et al. 2005). Egg shell waste disposal contributes to environmental pollution; challenges associated with disposal of eggshells include cost availability of disposal sites, odor, flies and abrasiveness (Phil and Zhihong 2009). Eggshells contain calcium and trace amounts of other micro element i.e magnesium, boron, copper, manganese, molybdenum, sulphur, silicon and zinc (Bee 2011). Eggshell calcium is probable the best natural source of calcium and has been reported to increase bone mineral density in people and animals with osteoporosis (Schaafsma et al. 2002). Since eggshells contain more calcium, the mixture of its flour and wheat flour is

mainly a form of fortification of calcium which will therefore help to improve the nutritional quality of the cookies. Nigeria is a developing country where malnutrition is common to both adult, children, pregnant and breast feeding woman who need calcium supplement to nourish their body and also for the formation of strong bone and teeth. It is therefore recognized that a very low calcium intake can contribute to the development of rickets, in infants and children especially those consuming restricted diets, so adequate calcium should be maintained during childhood and it is necessary for the development of a maximal peak bone mass. Increasing peak bone mass may be an important way to reduce the risk of osteoporosis in later adulthood. Eggshell is a cheap source of calcium and will be used to supplement wheat flour in producing cookies that are high in calcium. This work is aimed at evaluating the characteristics of cookies produced from wheat and eggshell flour.

MATERIALS AND METHODS

Source of Materials

Wheat flour, eggshell and other baking ingredients such as butter, sugar, corn starch, milk, egg and vegetable shortening were purchased from Kuto Market in Abeokuta, Nigeria.

METHODOLOGY

Preparation of Eggshell Flour

The eggshells obtained were washed in water and was boiled in hot water for 10mins to kill pathogens. After boiling the eggshells was air dried and ground into powdery form. The product was then packed in polyethylene bags and stored prior to analysis (Figure 1)

Formulation of Blends

Wheat and egg shell flour were mixed at different proportion (97.5:2.5%, 95.0:5.0%, 92.5:7.5%, 90.0:10.0%) while 100% wheat flour served as standard.

Preparation of Cookies

Cookies were prepared according to the method of Apotiola and Fashakin (2013). Recipe: flour (100g), sugar (40g), whole egg, milk (200mls), vanilla flour 1 teaspoonful and baking powder. The fat and sugar were mixed until fluffy. Egg and milk were added while mixing continued for about 40minutes. Approximate amount of flour, baking powder, vanilla flavoring were slowly introduced into the mixture. The dough was rolled and cut into circular shapes of 5cm diameter. The cookies were placed on baking trays and baked in charcoal oven until it was fully baked after baking the cookies were cooled at ambient temperature, packed in polyethylene bags and stored for later analysis.

Determination of Proximate Composition

Proximate analysis of the cookies was carried out using the method of Association of Official Analytical Chemist (AOAC 2000).

Determination of Mineral Composition

AOAC (2005) methods were used to determine the mineral compositions of the samples.

Sensory Properties of Cookies

Sensory properties of cookies were determined using 20 members of panelist consisting of students of Moshood Abiola Polytechnic, Abeokuta, Ogun state. Cookies samples from each flour blend were presented in coded white plastic. The order of presentation of samples to the panelist was randomized. The panelists were instructed to evaluate the coded samples for

aroma, taste, colour, texture, crispiness and overall acceptability. Table water was provided to rinse the mouth after each taste. Each sensory attribute was rated on a 9 point hedonic scale. 1 representing the least score while 9 the highest score.

STATISTICAL ANALYSIS

All data obtained were subjected to statistical analysis of variance (ANOVA) using SPSS (Statistical Package for the Social Science or Statistical Product and service Solution) version 15.0. Means were separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Proximate composition is a partitioning of compounding in a feed into six categories based on chemical properties of the compounds. The result for the proximate composition of cookies incorporated with egg shell powder is presented in Tables 1. The values for ash, moisture, crude fiber, fat, protein, and carbohydrate contents of the cookies ranged from 1.70-4.92%, 2.56-9.10%, 3.01-6.60%, 3.65-9.80%, 6.52-15.32% and 60.80-76.02% respectively. Moisture content is the amount of water in a material or substance. It was observed that the moisture content of the fortified cookies and the control sample were significantly different from one another. 100% wheat cookies had the highest value of 9.10% while sample with 10% egg shell powder had the least value of 2.56%. This shows that the fortified cookies have higher shelf stability. Tyagi et al. (2006) also reported that slight increase in moisture content of mustard fortified biscuit might be due to water binding capacity of mustard flour used. A significant increase ($p \leq 0.05$) was observed in the ash content of the cookies fortified with egg shell powder. Sample containing 10% egg shell powder had highest value of 4.92%, closely followed by cookies sample with 7.5% and 5% egg shell powder with the value of 3.98 and 3.02% respectively.

This is similar to the work reported by Olaoye et al. (2007) where there was observed increase in the ash content of breadfruit flour and wheat flour cookies. The significance increase in the ash content of egg shell powder fortified cookies may be due to high amount of ash content (27.2%) present in shell membrane (Macneil 1997). The high ash content of cookies with egg shell powder may be indicative that the cookies contain minerals element in abundance since ash is an indicative of the amount of mineral contained in any food sample (Olaoye *et al.,* 2007). The fat content of the cookies was observed to be significantly different from one another ($p \leq 0.05$) when compared to control. The fat content ranges from 3.65-9.80%. Sample with 10% egg shell powder had the highest value while 100% wheat flour had the least score. The slight increase in fat content may be due to the fat egg shell powder in trace amount (2.7%) (Macneil 1997). Tyagi et al. (2006) reported decrease in fat content of mustard biscuit as it was largely due to protein content of the cookies. It can be observed from the result that sample with 10% egg shell powder had highest value of protein powder. The significant increase in the protein content of the fortified cookies may be due to high amount of protein (69.2%) in the egg shell powder (Macneil 1997). Padmaja (1995) reported that the high protein content of cassava/cucurbita seed flour is due to the level of ccucrbita seed flour. The high protein content in the fortified cookies will be of nutritional importance in most developing countries like Nigeria where many people can hardly afford high proteinous food because of their high cost. The crude fiber content of the cookies sample increased with increase in the level of egg shell powder. Sample with 10% egg shell powder had the highest value while 100% wheat cookies had the least value. 100% wheat flour had the highest carbohydrate content of (76.02). This was expected as the principal ingredient used (wheat flour) is composed of mainly carbohydrate rich materials. This value is significantly different ($p \leq 0.05$) from composite cookies. The

carbohydrate content of the cookies sample decreases due to the increase in the protein content of the sample. The mineral composition values ranged from 131.40-514.40mg/100g, 48.55-96.26mg/100g, 135.10-138.65mg/100g, 0.93-0.96mg/100g and 0.248-1.060mg/100g for Ca, Mg, P, Zn, and Fe respectively as shown in Table 2. Calcium plays essential role in blood clotting, muscle contraction, nerve impulse transmission, bone and tooth formation. A deficiency of calcium can lead to disorders such as osteomalcia, osteoporosis, rickets, increased neuromuscular irritability, tachycardia, impaired blood clotting and increased carcinoma of the colon. The values of calcium obtained in this research work are within the recommended daily allowance (RDA) of 1000mg. It was observed from the results that significant difference ($p \leq 0.05$) occurred in the calcium content of the samples. The calcium content of the samples increased with increase in the level of egg shell powder addition with highest value obtained at 10% level (514.40mg/100g). The increase in the calcium content of cookies sample could be due to the high calcium content egg shell powder (calcium carbonate) as reported by (Macneil 1997). Magnesium is essential for all biosynthetic processes including glycolysis, formation of cyclic AMP, energy dependent membrane transport and transmission of the genetic code. Greater than 300 enzymes are known to be activated by magnesium ion. The magnesium content of cookies samples increased significantly with increase in the level of egg shell powder incorporation.

These values however, fall within the range for the recommended daily allowance (the RDA for Magnesium is 400mg and the maximum allowable intake is 120mg). The phosphorus content of the cookies decrease slightly with increase in the level of egg shell powder incorporated. The slight decrease might be due to low phosphorus content (0.9%) in egg shell powder. This result is in close agreement to the findings of Salem et al. (2012) where they reported that there was decrease in calcium content of fortified cake with egg shell powder. Zinc is involved in 200 enzymatic reactions. It positively influences tissue growth and healing and participates in insulin formation and spermatogenesis. Zinc deficiency causes growth retardation, impaired immune functions, loss of appetite and skin, nail and hair change (white spots on nails), acrodermatites enteropathica (hair loss, diarrhea, anorexia). The recommended daily allowance for zinc is 15mg with maximum allowable intake of 11mg (RDA 2011). The zinc content of the cookies increase slightly with increase in the level of egg shell powder. The cookies sample fortified with egg shell powder shows no significant difference among each other when compared with the control sample. Iron has several functions in the human body; it serves as a carrier of oxygen to the tissue from the lung by the red blood cells, as a transport medium for electrons within the cells, and as a integrated part of important enzyme system in various tissue. The iron content of the cookies shows significant difference among each other. The values however, increase with increase in the level of egg shell powder incorporated.

The values for aroma, texture, colour, crispiness, taste and general acceptability ranged from 4.70-8.30, 5.40-7.80, 6.45-7.50, 5.35-7.70, 5.10-8.20, and 7.30-8.05 respectively. Aroma is the main criterion that makes the product to be liked or disliked. Addition of egg shell powder was shown to improve aroma of the cookies with increase in the mean scores of the samples. Significantly difference occurred among the sample with sample with 10% egg shell powder having the highest mean score of 8.30. The texture of the cookies containing egg shell powder in their formulation was significantly affected with increase in the level of egg shell powder. Cookies prepared from 10% egg shell powder got highest (7.80) significant ($p \leq 0.05$) score while lowest score was obtained in the cookies prepared from 100% wheat flour (5.40). With respect to the texture, judges accepted cookies prepared from all the treatments of composite flour with egg shell powder as none of the samples score below 5 which is the minimum acceptable

score on a 9-point hedonic scale. Color is an important sensory attribute of any food because of its influence on acceptability. It is an important parameter in judging properly baked cookies as brown colour resulting from Maillard reaction is always associated with baked goods. It also shows the suitable raw material used for the preparation, provides information about the formation and quality of the product (Falola et al. 2011). The colour of the cookies samples with 100% wheat flour has the highest mean score of 7.20 with sample with 2.5% egg shell powder having the least value of 6.5. Crispness is a desirable quality of cookies. There was significant difference among the samples as the mean score of the samples increases with increase in the level of egg shell powder from 5.35-7.70. Sample with 10% egg shell powder has the highest score while sample with 100% wheat had the least score. This shows that incorporation of egg shell powder in the cookies increase its crispness. The taste of the cookies refers to the sweet sensation caused in the mouth by contact with the cookies due to the sweetening agent. There was significant difference in the taste of the cookies as the mean scores of the cookies increased with increase in the level of egg shell powder incorporated. The mean scores ranged from 5.10-8.20. Sample with 10% egg shell powder has the highest score while 100% wheat cookies has the least score.

In terms of overall acceptability, all cookies samples were generally accepted and show no significant difference among each other when compared with the control sample with score ranging from 7.30-8.05. Sample with 2.5% egg shell powder had the highest score of 8.05 while sample with 7.5% egg shell powder had the least score of 7.30. The result obtained for sensory parameters in this study is in close agreement with the findings of Salem et al. (2012) where they reported that no statistically significant difference were observed between unfortified cake "control sample" and cake fortified with 10% and 20% egg shell for colour and overall acceptability, but texture, taste, taste, odour and appearance was significantly difference. It can be concluded that incorporation of egg shell powder up to 10% was judged to be acceptable by the panelist in all sensory parameters as none of the sample scored below five, which is considered the minimum acceptable on a 9-point hedonic scale.

CONCLUSION

From the result obtained in this study, it can be concluded that incorporation of egg shell powder into cookies up to 10% level is acceptable with improved nutritional and sensory qualities. The protein, ash and fiber contents of the composite cookies were improved with highest values obtained at 10% level inclusion of egg shell powder. The mineral composition of the composite of the composite cookies was also improved as significant increase was observed in calcium, magnesium and iron contents of the composite cookies samples. The sensory analysis of the cookies also shows that colour, crispness and texture of the composite cookies was improved by inclusion of egg shell powder up to 10%. Also, the panelist judged the cookies samples to be acceptable generally at all levels of inclusion.

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Table 1: Proximate Composition of Cookies made from Wheat Flour Incorporated with Egg-Shell Powder

Parameters	Ash (%)	Moisture (%)	Crude fiber (%)	Fat (%)	Protein (%)	Carbohydrate (%)
100%WF	1.70[d]	9.10[a]	3.01[d]	3.65[a]	6.52[e]	76.02[a]
97.5%WF + 2.5%ESP	1.82[d]	4.34[c]	4.88[c]	7.05[d]	7.12[d]	74.79[b]
95%WF + 5% ESP	3.02[c]	4.52[b]	5.52[b]	8.75[b]	9.60[c]	68.59[c]
92.5%WF + 7.5%ESP	3.98[b]	4.60[b]	5.54[b]	9.35[c]	10.08[b]	66.45[d]
90%WF + 10%ESP	4.92[a]	2.56[d]	6.60[a]	9.80[b]	15.32[a]	60.80[e]

A-D different letter superscripts in the same column indicate statistical difference ($p<0.05$).

Keys:
WF = Wheat Flour
ESP = Eggshell Powder

Table 2: Mineral Elements of Cookies Made from Wheat flour Incorporated with Egg-Shell Powder

Parameters	Ca (mg/100g)	Mg (mg/100g)	P (mg/100g)	Zn (mg/100g)	Fe (mg/100g)
100%WF	131.40±5.52[e]	48.55±1.34[e]	138.70±1.56[a]	0.93±0.03[a]	0.248±0.007[e]
97.5%WF + 2.5%ESP	213.19±11.75[d]	58.55±1.49[d]	138.65±1.63[a]	0.93±0.03[a]	0.351±0.008[d]
95%WF + 5% ESP	321.67±8.80[c]	72.36±1.47[c]	135.65±1.20[a]	0.95±0.04[a]	0.508±0.008[c]
92.5%WF + 7.5%ESP	417.62±8.56[b]	82.62±1.67[b]	135.65±1.63[a]	0.96±0.04[a]	0.810±0.016[b]
90%WF + 10%ESP	514.40±12.17[a]	96.26±0.78[a]	135.10±1.56[a]	0.96±0.05[a]	1.060±0.042[a]

A-E Different Letter Superscripts in the same Column Indicate Statistical Difference ($p<0.05$).

Keys:
WF = Wheat Flour
ESP = Egg Shell Powder

Table 3: Sensory Attributes of Cookies from Wheat Flour Incorporated with Egg-Shell Powder

Parameters	Aroma	Texture	Colour	Crispiness	Taste	General Acceptability
309	4.70±0.87^{d}	5.40±1.23^{c}	7.50±1.19^{a}	5.35±0.75^{c}	5.10±0.55^{d}	7.60±0.99^{a}
211	6.50±0.61^{c}	6.70±0.66^{b}	6.45±0.83^{b}	6.65±0.59^{b}	6.80±0.52^{c}	8.05±0.89^{a}
417	7.15±0.93^{b}	6.60±0.88^{b}	7.05±1.54^{ab}	7.10±0.85^{b}	7.20±1.36^{bc}	7.45±1.32^{a}
527	7.50±1.00^{b}	7.55±0.67^{a}	7.15±1.27^{ab}	7.10±0.85^{b}	7.55±1.05^{b}	7.30±1.13^{a}
219	8.30±0.92^{a}	7.80±0.95^{a}	7.20±1.51^{b}	7.70±0.80^{a}	8.20±0.62^{a}	7.55±1.09^{a}

A-D Different Letter Superscripts in the same Column Indicate Statistical Difference ($p<0.05$).

Keys:
309 = 100% Wheat Flour (Control)
211 = 97.5% Wheat Flour and 2.5% Egg Shell Powder
417 = 95% Wheat Flour and 5% Egg Shell Powder
527 = 92.5% Wheat Flour and 7.5% Egg Shell Powder
219 = 90% Wheat Flour and 10% Egg Shell Powder

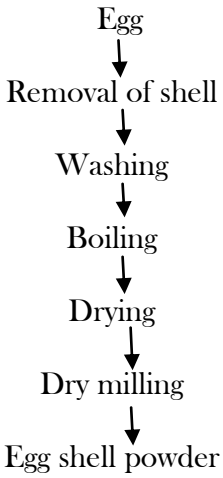

Fig. 1 Production of Eggshell flour
Source: Bee (2011)

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