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Sensory evaluation and nutritional analysis of samples of cake and cookies made with millet flour enriched with yeast and calcium

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Abstract
Refined wheat flour, a key ingredient in cookie and cake is mainly composed of starch which is devoid of nutrients particularly minerals. This study was designed to determine the possibility of using enriched millet as a replacement for refined wheat flour in cookie and cake preparation. Experimental research design was employed in the study. Millet seeds were processed into flour using standard procedure. The cakes and cookies samples were analysed in the laboratory for proximate composition while data on sensory qualities of the products was collected using a 9 point hedonic scale. Enriched millet flour as a replacement for refined wheat flour in the preparation of cakes and cookies were effective in enhancing its nutritional and sensory attributes. Nutritive value of the cookies improved in terms of protein, ash and mineral content after replacing refined wheat flour with enriched millet. Out of the products, millet flour enriched with yeast and calcium had the highest protein content. Quantitative Descriptive Analysis (QDA) method was adopted to assess the sensory qualities of products, which revealed that cakes and cookies prepared with 50:50 wheat + wheat + millet had better sensory profile compared to other combinations. In addition, texture perceived in 50:50 wheat + millet cake and cookie samples further enhanced their sensory appeal making them palatable. This study indicated the prospects for utilization of millet flour in preparing cookies and cakes which enhanced nutritional qualities and sensory attributes.

Keywords: Millet, wheat flour, cakes, cookies, calcium and yeast

Introduction
According to the Institute of Food Technologists (IFT), sensory evaluation is a scientific method used to evoke, measure, analyse and. interpret those responses to products as perceived through the senses of sight, hearing, touch, smell and taste (IFT, 2007) [10].
Millet is gluten free and has been found to be a healthy food choice for people with celiac disease (the most common disease caused by cereal protein ingestion) (Dicko *et al*., 2005) [4].
Refined wheat flour is a key ingredient in cookies and cakes and is mainly composed of starch which is devoid of nutrients particularly minerals. Millet is gluten free and has been found to be a healthy food choice for people with celiac disease (the most common disease caused by cereal protein ingestion) (Dicko *et al*., 2005 [4]. Nutrition analysis refers to the process of determining the nutritional content of foods and food products. Nutritional analysis of foods allows the nutritional composition to be scientifically determined and measured. This is important as the nutritional composition of food is of major significance to the consumer and to authorities. Nutritional analysis is use to test the percentage of carbohydrate, fat, ash, protein and moisture content in snacks such as cakes, cookies etc. (Kwaw and Sackey, 2013) [14].
Cakes are soft bakery products produced by baking a batter containing flour, baking powders and beaten eggs with or without shortenings (IFIS, 2005). According to the final products desired, other ingredients such as flavorings, nuts, chocolate and dried fruits are also included. Cakes are a major snack in the fast food industry and highlight of many celebrations. They are highly cherished by women and children. It is a complete food, rich in fat and proteins. There are literally millions of cake recipes and can be classified based on their accompaniment such as coffee cakes, occasion cakes or based, primarily on ingredients and cooking techniques (Eke *et al.*, 2008) [5, 8]. Cake may be small and intended for individual consumption such as queen cake while longer cakes are cut, sliced and served as part of a meal or social functions.

Apart from using wheat flour in baking, millet flour provides high nutrition quality in baking especially in cakes and cookies.

Cookies are nutritive snacks produced from unpalatable dough that is transformed into appetizing product through the application of heat in an oven Anozie *et al.*, 2014 [2].

They are ready-to-eat, conveniences and inexpensive food product, containing digestive and dietary principle of vital importance Olaoye *et al*., 2007 [17]. Cookies contribute valuable quantities of iron, calcium, protein, calorie, fibre and some of the B-vitamins to our diet and daily food requirement (Ferial & Azza, 2011). It has been reported that millet enriched with yeast and calcium has many nutritious and medical functions such as increase better sight and reduces risk of rheumatism (Obilana and Manyasa, 2002; Yang *et al*., 2012) [16, 10].

Yeast is used to enrich the cake and cookies for better eyesight. Yeast are rich in carbohydrates, protein, vitamins, water energy, fat and minerals such as iron, magnesium, phosphorus, potassium, sodium, zinc and calcium (Young and Cauvain, 2007) [23]. Calcium is an important mineral in everyday diets. Bread, cookies, biscuits and cakes are all suitable for calcium enrichment. A snack cake, for example, can contain as much as 200mg of calcium per serving – equivalent to 25% of the recommended daily intake. In cookies, calcium contributes to a short crumb texture. Calcium has many potential benefits in health promotion and disease prevention and treatment. Calcium is needed to help regulate blood pressure, improve bone health and is needed to prevent osteoporosis, cardiovascular diseases, hypertension, cancers of the colon, rectum, and prostate (Charlton *et al.*, 2007 [3].

The snack food industry is growing globally with rapid introduction of new products formulated with the intent of meeting specific health or organoleptic need of consumers. These products are increasingly becoming available every year especially in developed countries. However, they are also exported to developing countries, where snacks are relied upon to meet the physiological needs of the populace particularly children (Thakur and Saxena, 2000) [21]. An increasing proportion of the household food budget in Nigeria is spent on snack food items, in which convenience and quality are perceived as most important (Lasekan and Akintola, 2002) [15]. Most of the snacks are cereal-based and poor sources of protein (Brink and Belay, 2006). Snacks such as doughnuts, pies, cookies among others which are usually produced from wheat flour have low nutritional values (Lasekan and Akintola, 2002) [15]. Choosing healthy snack foods is just as important at snack time as it is at meal time; therefore it is possible to improve the nutritional quality of cereal proteins by incorporating millet flour into baking. Cookies produced from 100% pearl millet were described as tough, hard, gritty, and mealy in texture and taste. They lacked spread and top surface cracks, which is a desirable attribute of cookies. It is from this highlight that this researcher tends to research on the sensory evaluation and analysis of samples of cake and cookies made with Millet flour enriched with yeast and calcium. The baking industry is currently rapidly evolving with advancements in nutraceuticals and new product developments (Kotsianis *et al*., 2002). Also the bakery industry and its products are targeting to comply with consumers' improved/ healthy eating habits (Kohn, 2000) and to accomplish this goal the modernization of bakery plants and new product formulations are necessary (Kotsianis *et al*., 2002). Wheat is the most important cereal in the bakery industry to its unique functional characteristic and the quality of bakery products mainly depends on wheat quality and process parameters. Hence, it is necessary to find alternative ingredients to alleviate this issue in the baking industry. Another reason to find wheat alternative in the baking industry is to reduce the pressure on the demand for wheat as wheat demand has been increasingly growing year after year with the expansion of processing of wheat into a diversity of new products. Finding alternative ingredients to produce bakery products would help significantly reduce the pressure on wheat demand in the global scenario (Goesaert *et al*., 2007). Different bakery products have been developed in the past by using mixtures of non-wheat products such as soya flour, millet flour, rice flour, oats, etc. (Flander *et al*., 2007; Jideani, 2011; Singh *et al*., 2012) [7, 11, 20].

Generally, millet proteins are good source of essential amino acids except lysine and threonine, while they are rich in b-methionine and also rich in phyto-chemicals and micronutrients (Mal *et al*., 2010; Singh *et al*., 2012) [20]. There are numerous health benefits of millets other than their positive impact on glycemic response and diabetic treatment as well as glucose management. Those benefits include preventing cancer, cardiovascular disease, celiac disease and having antimicrobial properties.

Purpose of Study

The main purpose of the study was to carry out a sensory evaluation and analysis of samples of cake and cookies made with Millet flour enriched with yeast and calcium. Specifically, the study was to;

1. produce cake and cookies from millet flour
2. evaluate the proximate composition of cake and cookies made with Millet flour enriched with yeast and calcium
3. carry out a sensory analysis of cake and cookies produced from millet flour

Research questions

The study will seek to provide answers to the following questions:

1. How can millet flour be used in the production of cakes and cookies?
2. What is the proximate composition of cakes and cookies made with Millet flour enriched with yeast and calcium?
3. What is the sensory analysis of cake and cookies produced from millet flour?

Material and Method

Design of the study

Experimental design was used in this study because it was highly controlled and often conducted in a special created setting in which the researcher had complete adequate control over the independent and any possible extraneous variables that could affect the independent variable.

Area of the study

The study was carried out at Michael Okpara University of Agriculture, Umudike (MOUAU).

Population of the Study

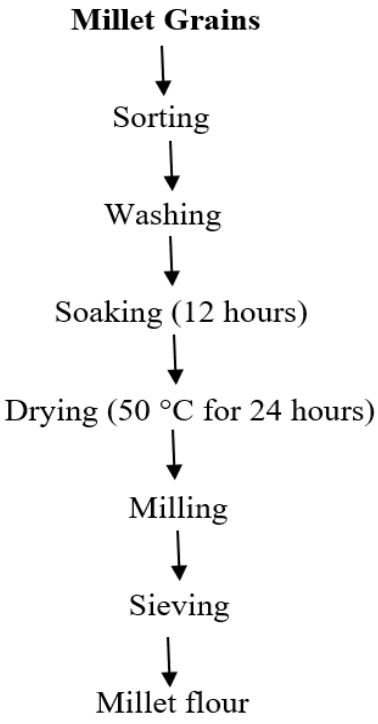
The sensory evaluation and analysis of the products was carried out in the Food Laboratory of Department of Home Science and Hospitality Management of MOUAU. Twenty semi trained panelists were used for the evaluation comprising of students and staff of the department. The panelists

evaluated the samples using a nine point hedonic scale. The attributes evaluated were taste, crumb, uniformity, texture, colour, flavor and general acceptability of the products.

Sample/ Sampling Techniques
Panel sampling techniques was used to select twenty semi trained panelists that accessed the sensory evaluation and analysis of samples of cake and cookies.

Instrument of data collection
Millet grains were procured from a local market in Umuahia, Abia state. The millet grains were sorted washed to remove all unwanted particles after which the grains were soaked for 12 hours. The soaked grains were dried for 24 hours and milled into flour. The samples were used for baking of cookies and cakes respectively. The samples were subjected to chemical analysis and sensory evaluation using standard methods.

Flour Preparation
Millet seeds will be sorted and washed to remove all unwanted particles after which seeds will be soaked for 24hours. Soaked seeds will be milled and flour sun dried for 12hours.



Source: Jideani, 2005.

Fig 1: Flow diagram for the processing of Millet into Flour

Cake preparation
Cake will be prepared according to the method described by Turabi *et al*., (2010) [22] with some modification. A cake batter recipe containing 100% millet flour, 100% sugar, 25% shortening, 100% whole fresh egg, 3% salt, 5% baking powder and 1% Improver gel cake (all percentages are given on a flour weight basis) will be used in the experiments. The amount of water added to the batter will 30% of the overall formulation.
During preparation of the cake, firstly, dry ingredients will be mixed thoroughly. In a separate cup, sugar and whole fresh egg will be mixed, and then melted shortening will be added and mixed for 1min at medium speed by using a mixer kitchen machine. Emulsifier will be added to the melted shortening. Then, dry ingredient mix and water will be added simultaneously to this mixture and mixed first for 2 min at medium speed, then for 1 min at high speed and finally for 2 min at medium speed. Cake samples will be baked in an electric oven at 175 ˚C for 30 min.

Cookies Preparation
Cookies will be prepared by the method reported by Abayomi *et al*. (2013) [1], Onabanjo and Ighere (2014) [18] with modification. Flour (200g), Sugar (80g) will be creamed with margarine or shortening (100g) until light and fluffy constituency will be obtained using Kenwood chef with initial minimum speed, and the speed increased stepwise until the mark of 6 on the chef indicator will be attained. Whole egg (60g) will be added, and then followed by flour (200g), powdered milk (20g), baking powder (0.1g) and salt (1g) will be added and mixed until a stiff paste (batter) will be obtained. The batter will be rolled on a floured board using a rolling pin to a thickness of 0.2-0.3 cm. The rolled batter will be cut into circular shapes with a cutter and arranged on a greased tray and baked at 1500°C for 20 minutes. The cookies will be brought out and packaged in cellophane bag until time for laboratory analysis.

Instrument of Data Collection
Hedonic rating scale will be developed by the panelists to determine the sensory quality of cake and cookies samples produced with millet flour and experiment test will be used to determine the proximate composition

Data Collection Techniques
The data was collected using hedonic rating scale. Each of the samples was rated for Colour, flavour, taste, texture and overall acceptability

Data Analysis Techniques
The ANOVA, least significant difference and likert analysis was used to test for the differences among the samples. Likert scale analysis was employed to analyse the level of acceptability of millet cake and cookies using the hedonic scale of 9 points.

1. Extremely dislike
2. Dislike very much
3. Moderate dislike
4. Slightly dislike
5. Neither dislike or like
6. Slightly like
7. Moderately like
8. Very much like
9. Extremely like

The hedonic scale will determine the level of likeness and dislike. Extremely like will be point 9, very much like point 8, moderately like will be point 7. The scaling will continue till extremely dislike which will be point 1.

Results and Discussions
Research question 1: How can millet flour be used in the production of cakes and cookies? The cakes and cookies were prepared using four different combinations (100% wheat, 50:50 millet + wheat, 100% millet flour enriched with yeast and calcium and 100% millet + CMC (binding agent)). The cakes and cookies were evaluated for proximate composition and sensory properties and results are presented below.

Cakes and Cookies produced from millet flour

Cakes and cookies made from processed millet flour are shown in plates 1-7. They represent different combinations of the millet flour: (wheat flour, enriched millet flour, millet flour + wheat flour and millet flour + CMC (binding agent)

Plate 1: Cookie made with wheat (control)

Plate 2: Cookie made with Wheat + Millet (50:50)

Plate 3: Cookie made with enriched millet flour

Plate 4: Cake made with wheat flour (control)

Plate 5: Cake made with millet + CMC

Plate 6: Cake made with millet+wheat (50:50)

Plate 7: Cake made with enriched millet

Research Question 2: What is the proximate composition of cakes and cookies made with millet flour enriched with yeast and calcium?

Proximate Composition of Cookies samples

The proximate composition of cookies produced with different combinations of millet and wheat are presented in Table 1.

Table 1: Proximate composition of cookies

COOKIE	Moisture (%)	Fat (%)	Proteins (%)	Fibre (%)	Ash (%)	Carbohydrate (%)	Energy (K Cal)
COW	0.65^{a}±0.05	15.65^{a}±0.30	6.87^{b}±0.035	1.35^{a}±0.05	0.48^{a}±0.03	75.00^{b}±0.12	348^{a}±3.00
COMW	0.58^{b}±0.02	16.91^{b}±0.01	8.63^{a}±0.20	1.80^{b}±0.20	0.93^{b}±0.02	71.15^{a}±0.15	492^{b}±11.00
COEM	0.74^{c}±0.04	17.82^{c}±1.00	8.40^{a}±0.10	1.44^{a}±0.04	0.77^{c}±0.075	70.53^{a}±0.03	485^{c}±13.00

Mean values with the same superscript within the same column are not significantly different (P≥0.05). Values are means ± standard deviation of duplicate determinations
COW: Cookie made with wheat flour (100%)
COMW: Cookie made with millet flour + wheat flour (50:50)
COEM: Cookie made from enriched millet flour (100%)

Cookies baked by replacing refined wheat flour with 50% millet and 100% millet flour enriched with yeast and calcium were compared with cookies prepared with 100% refined wheat flour. The fat content of the cookies increased with the addition of millet. Fat content of the samples ranged from 15.65% to 17.82% with COW having the lowest fat content while COEM had the highest fat content. Since millet is richer in protein content than refined wheat flour, incorporation of cookies with millet enhanced protein content (increased from 6.87 (control) to 8.63 and 8.40 for COMW and COEM).
The moisture content of control cookies (100% refined wheat flour) was not significantly ($P\leq$ 0.05) higher than COMW (50:50 millet +wheat) cookies. Millet cookies made from enriched millet flour had the highest moisture content. Higher moisture content of cookies results in a soggy and soft texture which is a major cause for lower consumer acceptability. Fat content remained similar for control and millet cookies. Cookies fortified with millet had significantly ($P\leq$ 0.05) higher fibre, ash and energy. However carbohydrate content of the control sample (COW) was significantly higher than that of COMW and COEM which ranged from 71.15% and 70.53%.

Proximate Composition of Cakes samples
Data in Table 2 presents proximate composition and mineral content of the cookies prepared out of refined wheat flour and millet.

Table 2: Proximate composition of cake samples

CAKE	Moisture (%)	Fat (%)	Proteins (%)	Fibre (%)	Ash (%)	Carbohydrate (%)	Energy (K Cal)
CW	12.10^{a}±0.00	25.70^{a}±0.20	5.90^{a}±0.00	0.48^{a}±0.11	0.62^{a}±0.10	55.30^{a}±0.30	348^{a}±2.00
CMC	12.27^{a}±0.26	23.89^{b}±0.04	6.09^{a}±0.01	0.52^{a}±0.02	0.67^{a}±0.20	56.56^{b}±1.00	412^{b}±10.0
CMW	12.30^{a}±0.65	25.60^{a}±0.60	6.90^{b}±0.20	0.46^{a}±0.06	0.84^{a}±0.28	53.90^{c}±0.76	473^{c}±3.00
CEM	13.31^{b}±0.01	26.70^{c}±0.30	8.50^{c}±0.30	0.43^{a}±0.03	0.99^{a}±0.01	50.07^{d}±0.02	492^{d}±2.00

Mean values with the same superscript within the same column are not significantly different (P≥0.05). Values are means ± standard deviation of duplicate determinations
CW: Cake made with wheat flour (control) (100%)
CMC: Cake made with Millet flour + CMC (binding agent) (100%)
CMW: Cake made with millet flour + wheat flour (50:50)
CEM: Cake made with enriched millet flour (100%)

Moisture, protein, ash and energy content were found to be lower in cakes prepared from 100% wheat flour (control). Cakes were characterized with a low moisture content which ranged from 12.10% to 13.31%. CEM had the highest moisture content. Ash is an inorganic compound containing the mineral content of a food product and which nutritionally aids the metabolism of other organic compounds, such as protein, fat and carbohydrate (Okaka, 2005) [19]. Significant difference exists among the cake samples, with the CEM sample having the highest value. The increased ash content recorded in the enriched cake samples may be attributed to the inclusion of calcium and yeast in the cake recipe and this implies the presence of higher mineral contents in the enriched cakes.)
The fat content of the products ranged from 23.89% – 26.70%, with the lowest found in CMC. Millet is well identified for its high fat content and also the high fat content could be due to addition of visible fat in the cake recipe. The protein content of the products ranged from 5.90% – 8.50%, with the highest seen in CEM. There was significant difference in the protein content of the control (CW) as compared with the other millet fortified cake samples. Regarding the energy value of the samples, significant ($p<$ 0.05) difference exist among the cake samples. The increase in the enriched cake could be a function of the product composition. Fat, protein and carbohydrate values contributed to the calorie content of the cakes.

Sensory Properties of Cake samples
The results of the sensory evaluation of cake samples are presented in Table 3

Table 3: Analysis of sensory properties of the cake samples

Samples	Flavor	Taste	Color	Texture	Overall acceptability
CW	7.40^{c}	6.60^{c}	6.60^{c}	7.70^{d}	6.80^{d}
CMC	7.30^{d}	6.30^{d}	6.40^{d}	7.20^{e}	6.40 ^{e}
CMW	7.10^{d}	6.10^{e}	6.20^{e}	7.10^{e}	6.20^{f}
CEM	7.20^{d}	7.40^{b}	7.10^{b}	4.90^{f}	6.30^{c}

Mean values with the same superscript within the same column are not significantly different (P≥0.05). Values are means of duplicate determinations.
CW: Cake made with wheat flour (control) (100%)
CMC: Cake made with Millet flour + CMC (binding agent) (100%)
CMW: Cake made with millet flour + wheat flour (50:50)
CEM: Cake made with enriched millet flour (100%)

As shown in Table 3, the color score was higher for CEM cake (7.1) than the other cake samples (6.60 for CW, 6.40 for CMC and 6.20 for CMW). However, these sensory scores were within the acceptable range. Flavor scores were similar for control and the other cakes samples. The values range from 7.10 for CMW samples to 7.40 for the control (CW) samples. Values for texture ranged from 4.90 for the CEM samples to 7.70 for the CW samples. The CW and CMW samples had better texture because of the presence of gluten in the wheat flour. Addition of CMC as binding agent in the CMC could also be attributed to its acceptable texture level. Taste and overall acceptability scores for control and the other samples of cake made from fortified flour were markedly higher than 6.0, which are considered as the quality limit of a product. All the sensory scores given by the panelists revealed that the cakes prepared by fortifying with millet flour were acceptable.

Question 3: What is the sensory analysis of cake and cookies produced from millet?

Sensory Properties of Cookies samples

The results of the sensory evaluation of cake samples are presented in Table 4

Table 4: Sensory properties of cookie samples

Samples	Flavor	Taste	Color	Texture	Overall acceptability
COW	6.01^{e}	6.60^{c}	6.50^{cd}	8.70^{a}	6.90^{b}
COMW	8.50^{a}	7.90^{a}	7.90^{a}	8.50^{b}	8.40^{a}
COEM	7.80^{b}	7.50^{b}	7.00^{b}	5.00^{c}	6.80^{b}

Mean values with the same superscript within the same column are not significantly different (P≥0.05). Values are means of duplicate determinations.
COW: Cookie made with wheat flour (100%)
COMW: Cookie made with millet flour + wheat flour (50:50)
COEM: Cookie made from enriched millet flour (100%)

The COMW cookie samples had higher scores for most of the attributes evaluated except for texture. The mean scores for the flavor of the cookies ranged from 6.01 to 8.50. There was significant ($p< 0.05$) difference in terms of flavor between the cake samples the least flavor was recorded for the control samples while COMW had the highest flavor value. The taste of the COW cookie samples with a mean scores of 6.60 showed that there was significant ($p< 0.05$) difference when compared to the COMW sample with a mean score of 7.90. The COEM cookie samples color had mean scores of 7.00. There was significant ($p< 0.05$) difference in Colour between the cookie samples. The enriched cookies had dark brown coloration with green patches of plant-based materials.
The mean scores for the overall acceptability of the cookies ranged from 6.80 to 8.40. There was significant ($p< 0.05$) difference in the overall acceptability of the cookies.

Conclusion

Based on the findings of this study, the researcher concluded that enriched millet flour had a potential for substituting refined wheat flour in the preparation of cakes and cookies. Nutritive value of the cookies improved in terms of protein, ash and mineral content after replacing refined wheat flour with enriched millet. Out of the products, millet flour enriched with yeast and calcium had the highest protein content. The addition of binding agent in cakes positively improved the physical properties of the cake. Cakes had a combination of desirable and lasting vanilla-like aroma coupled with typical baked millet aroma. In addition, texture perceived in these cookies further enhanced their sensory appeal making them highly palatable. This study had shown that millet has a good potential for use in cakes cookies formulation with the objective to enhance its nutritional qualities and sensory properties.

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