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Quality Attributes of Biscuits Supplemented with Pumpkin Leaf Flour

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Abstract

Quality attributes of wheat-dried pumpkin leaf flour biscuits at different proportions of 100:0, 97.5: 2.5, 95.0:5.0, 95:7.5 and 90:10 to obtain samples A (control), B, C, D and E were evaluated respectively. The effect of this substitution on the proximate composition, vitamin, mineral, physical parameters and sensory qualities were investigated. The protein content (10.50 -11.03 %), ash (2.14 -2.54 %) and crude fibre (1.82 – 2.35 %) of the supplemented biscuits increased significantly ($P<0.05$) with increase in pumpkin leave flour compared to the control. The carbohydrate content (56.20–54.58 %) were observed to decrease significantly ($P<0.05$).The moisture (16.50–16.51%) and fat content (1.00–1.01 %) showed no significant difference ($P<0.05$) of the supplemented samples. The calcium (6.83 –7.20 mg/100 g), potassium (38.02–40.80 mg/100 g), phosphorus (37.54–39.93 mg/100 g) and iron content (2.14 – 2.62 mg/100 g) increase significantly with corresponding increase in the percentage of substitution. The vitamin A (equivalent). Vitamin E and vitamin B_1 (2.22–2.72 mg/100 g, 2.03-2.54 mg/100 g and 2.02-2.53 mg/100 g) respectively increased significantly ($P<0.05$). The diameter, height, spread ratio and hardness of the biscuits differs significantly at $P<0.05$ and there was no significant difference in the weight of samples. In the same vein, no significant difference was observed in the flavour, texture and overall acceptability of cookie samples up to 7.5 % level of substitution. The study revealed that biscuits of high protein content, mineral and vitamin contents that is acceptable to the consumers, can be produced using this simple technology of S replacing up to 7.5% level of wheat flour with pumpkin leave flour.

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Wheat, Pumpkin leaves, Supplementation, Quality, Biscuits.

Introduction

Biscuits are baked food products which are used as snacks and are often taken in between meals. Biscuits are widely accepted and consumed by almost all profiles of consumers from many countries and therefore offer a valuable supplementation vehicle for nutritional improvement. They are consumed without further processing and have a high degree of convenience (Kulkarni and Joshi, 2013). They are consumed extensively in developing countries where essential micronutrients and protein calorie malnutrition is prevalent particularly among women and children (Bala *et al.,* 2015; Singh *et al.,* 2009). It provides an excellent means of improving the nutritional quality (protein, minerals, vitamins, and bioactive compounds) of foods through incorporation of less expensive non-wheat flour for food product enrichment (Wani *et al.,* 2015). In Nigeria, the increase in urbanization coupled with the growing number of working mothers in the public and private sectors due to the current economic crunch have contributed greatly to the popularity and increased consumption of snacks including biscuits. The consumption is very high among school children who

take those snacks to school almost on daily basis for consumption during the break period. Biscuits may serve as a vehicle for providing nutritious food at affordable cost (Soni *et al.,* 2018). They offer several advantages including wide consumption, relatively long shelf-life and good eating quality. This makes nutrients enriched biscuits attractive for targeted groups particularly, child feeding programs, the elderly and low income groups (Bunde *et al.,* 2010).

Currently, most baked products including biscuits are made from 100% wheat flour which is high in carbohydrate but deficient in protein and low in vitamin and mineral contents.

Nowadays, the food industry, and the bakery food sector, is looking for new formulae to produce healthier foods that meet the consumers' expectation (Dordoni *et al.,* 2019). Inadequate nutrients intake has been reported as a major cause of retarded growth in young school children (Ho and Latif, 2016).

Since the consumption of cereal foods such as biscuits has become very popular in Nigeria, they could therefore provide an excellent means of improving the nutritional quality through incorporation of plant products high in vitamin, dietary fibre and mineral salts. Such supplementation will also increase the utilization of most of the underutilized crops which are high in essential nutrients (Kulthe *et al.,* 2011).

In Nigeria, leafy vegetables are rarely processed, presumably due to the general lack of basic preservation facilities for freezing, canning or dehydration. A relatively small quantity of harvested leafy vegetables are however, sun-dried resulting in poor quality products with variable moisture contents and microbial loads thus affecting storage stability (Smith, 2011). One of such leafy vegetables is pumpkin (*cucurbita pepo*) which is abundantly cultivated in many parts of Nigeria and the herb crop needs little or no care to strive well. Pumpkin leaves are rich in iron and play a key role in the management of anaemia, (Some mothers used to mix the leaf extract with milk). They are also noted for lactating properties and are in high demand for nursing mothers. It has a hypoglycaemic (sugar reducing) effect. It is good for diabetics; increases blood volume and boost immune system (Azizah *et al.,* 2009).

Wheat (*Triticum aestivum*) is a cereal grain, originally from the Levant region of the near east but now cultivated worldwide. Globally, wheat is the leading source of vegetable protein in human food, having higher protein content than other major cereals such as maize or rice. In terms of total production tonnages used for food, it is currently second to rice as the main human food crop and ahead of maize, after allowing for maize's more extensive use in animal feeds (Cotton and Ponte, 2003).

Food supplementation is one of the nutritional interventions used to improve the dietetic intake of micronutrients by the population. Typical foods fortified around the world are cereal flours, mainly wheat and maize flours, pasta and noodles, milk, oil and margarines, among others (Kent, 2002). Wheat flour fortification is carried out in many countries around the world to provide vitamins and minerals through bread, pasta and other baking goods.

Information on the use of dried pumpkin leaves flour to supplement wheat flour for biscuits production is limited. Currently, baked products are widely consumed; supplementing them with minerals, vitamins and protein rich products is a way of meeting the need for nutritious foods particularly biscuits since they have a relatively long shelf-life and good eating qualities. The main objective of this programme was to seek indigenous raw materials such as pumpkin leaves that could combine optimal nutritive value with good processing characteristics.

Materials and Methods

Raw Materials

Pumpkin leaves used for the study were purchased from a private garden in Makurdi, Benue state Nigeria. Wheat flour, baking powder, granulated sugar and fat were purchased from the North bank market Makurdi.

Preparation of Samples

Four leaves to the terminal bulb of pumpkin runner stem were plucked from a private garden and sorted for defective leaves and tendrils by hand. The leaves were washed with tap water and sliced using a stainless steel knife. The sliced leaves were oven dried effectively in thermo-regulated oven (Gallen, BS model OV-160) at a temperature of 60 °C for 6 hours. The resulting material was milled using a laboratory mill and sieved into flour of 250 µm particle size through a 0.25mm British standard sieve (model BS410 Endecott). The flour was sealed in cellophane bags and stored at room temperature (25°C) for further analysis.

The ratios of wheat flour (plain, Golden penny confectionary flour) to pumpkin leaf flour used for this study were 100:00, 97.5:2.5, 95:5, 92.5:7.5, and 90:10. The 100:00 served as a control sample. The cookie samples were prepared using creamy method. The fat and sugar were creamed together until light and fluffy. The measured wheat flour, pumpkin leaves flour and baking powder were added and thoroughly mixed in a bowl by hand to form dough. The dough was then rolled to a uniform thickness of 10 mm and cut to a uniform diameter of 40 mm. The cut dough pieces were transferred into oil-greased pans and baked at 180°C for 10 minutes. The biscuits were allowed to cool at room temperature for about 30 minutes and then divided into three lots, one lot was used immediately for the measurement of physical characteristics, the second lot was subjected to sensory evaluation. The third lot was well labelled and packed to used for chemical analysis.

Analyses

Moisture, crude fat ash, crude fibre and crude protein were carried out by the method described by AOAC (2010). Carbohydrate was determined by difference as described by Ihekoronye and Ngoddy (2005). Energy values were calculated using the Atwater factor (4 x protein, 9 x fat, 4 x carbohydrate). Mineral analysis was carried out by dry ashing according to procedure 14.013 of the AOAC (2005). Calcium, iron, potassium, and magnesium were determined using an atomic absorption spectrophotometer, AAS (model 372, Perkin Elimer Ltd, Beaconsfield, UK). Iron was determined using the method outlined by Onwuka (2005) where 2.0 g of the sample was first digested with 20 ml of acid mixture (650 ml concentrated HNO_3 80 ml perchloric acid, 20 ml conc. H_2SO_4) and aliquots of the diluted clear digest were used for atomic absorption spectrophotometer using filters that match the determination of iron as an element. Determination of potassium and phosphorous was carried out using the methods described by Onwuka (2005). About 2.0 g of potassium digested with 20 ml of acid mixture (650 ml of conc. HNO_3, 80 ml perchloric acid, 20 ml conc. $H2SO_4$) and aliquots of the diluted clear digest were taken for photometry using flame analyzer, Absorbance for potassium was read at 589 nm. Potassium is obtained from the calibration curves obtained from the standard. Phosphorus was determined by molybdate method using hydroquinone as a reducing agent. To 0.5 ml of mineral (phosphorus) digest were added 1.0 ml of ammonium molybdate, 1.0 ml sodium sulphate and 1.0 ml of hydroquinone. The mixture was agitated and allowed to stand for 30 minutes. The blue colour that developed was quantitated using a colorimeter at 660 nm against a standard curve. Vitamins were analysed using the near infra-red radiation analyser. The physical properties of cookie samples were analysed according to the methods described by Adeola and Ohizua (2018), as follows:

Thickness of cookie samples was determined by measuring the diameter of four biscuit samples placed edge to edge with a digital vernier caliper. An average of six values was taken for each set of samples. Average value for thickness was reported in millimeter. Diameter of biscuits was determined by placing four cookie samples edge to edge and measuring with a digital vernier caliper.

An average of six values was taken for each set of samples. Average value for diameter was reported in millimeter. Weight of biscuits was measured as average values of six individual biscuits with the help of an analytical weighing balance. Average value for weight was reported in grams. Spread ratio was calculated by dividing diameter by thickness. Hardness was measured by a compression test using a pulley type shear frame. The mean shear stress value of ten biscuits was calculated and reported as Newton per cookie.

A panel of fifteen judges, comprising staff and students from the University of Agriculture Makurdi, Benue state was used. This number of panellists is considered adequate for rough product screening and for evaluating acceptance or preference. Criteria for selection were that panellists were 18 years of age or older, regular consumers of biscuits and neither sick nor allergic to any food. Panellists were trained in the use of sensory evaluation procedures and the meaning of the descriptive terms used. At each session, samples were served on white saucers identified with specific code numbers to eliminate bias. Panellists were instructed to evaluate appearance, flavour, texture, and overall acceptability.

A nine point hedonic scale with 1= dislike extremely, 5 = neither like nor dislike, 9 = like extremely was used (Ihekoronye and Ngoddy, 2005). Overall acceptability of each sample was decided on the samples that scored 6-9 points hedonic region for appearance, flavour, and texture. Water was provided to rinse the mouth between evaluations. Data obtained were statistically analysed using analysis of variance. All analytical determinations were conducted in triplicate mean ± standard deviation values were calculated and the data were subjected to analysis of variance.

Results and Discussion

Proximate composition

The proximate composition of the wheat–pumpkin composite biscuits was as shown in Table 1. The protein content of the cookie samples was slightly higher (10.54-10.62) than the protein level reported for the control (10.50 %). This could be as a result of the addition of pumpkin flour leaves since the gradual increase in the protein of the samples is synonymous with the gradual increase in the substitution of wheat flour in the samples by pumpkin leaf flour. The composite cookie samples significantly at $p \geq 0.05$ showed higher moisture contents compared to the control sample. The ash content of composite biscuits each have higher values than the control. This is an indication that pumpkin flour contains more minerals than its control counterpart. The fibre content increased with increase in the level of substitution. Dietary fibre represent a fraction of the edible portion of plants which are not digested or absorbed in the small intestine. It is partially or fully fermented in the colon and has many beneficial effects: laxative, lowering of cholesterolemia and/or modulation of glycemia.

These beneficial effects are related to polysaccharides, oligosaccharides and lignins composition. Several epidemiological studies have shown that fibre has several benefits: they are likely to contribute in the management of certain chronic diseases such as type II diabetes, hyperlipemia, cholesterolemia (LDL and total cholesterol), hyperglycemia, obesity and prevention of certain cancers (Ovando-Martinez *et al.,* 2009). They slow down the rate of emptying the stomach, reduce the rate of food digestion (especially carbohydrate and fats), and slow down the absorption of nutrients. The fact that bran enriched- baked foods are richer in fibre makes them a major asset for the prevention of chronic non-communicable diseases. Crude fat decreased with increase in the level of substitution. Carbohydrate also decreased with increase in the level of substitution. Energy level similarly decreased with increased level of wheat flour substitution. This could be due to the fact that pumpkin leaves being leafy vegetables, they contain little fat and are low in carbohydrates.

Mineral content

The result of mineral composition of wheat-pumpkin flour biscuits in Table 2 showed significant increase in the mineral content of all the composite samples as indicated in the increase in ash content in Table1. Calcium increased significantly in the range 4.94-7.20 mg/100g. The high calcium content of wheat-pumpkin composite biscuits may also be used to decrease susceptibility of man to colon cancer, through calcium ability to bind (and increase excretion of bile acids and free fatty acids, which act as promoters of cancer by inducing colon cell hyperproliferation. Colon cancer has been linked with calcium-deficient diets An adequate intake of calcium is thought to protect against colon cancer (Iombor *et al.,* 2016). Calcium is needed for bone mineralization, neurotransmitters, hydrolysis of cell membrane phospholipids and activation/deactivation of enzymes through phosphorylation. Intake of wheat-pumpkin flour composite biscuits would go a long way in prevention or management of osteomalacia or osteoporosis (particularly in the elderly), tetany and calcium induced hypertension arising from prolonged inadequate dietary calcium intake. The result of mineral composition in Table 2 indicates that potassium has the highest (28.72-40.80 mg/100g) concentration in composite cookie samples.

Potassium influences the contraction of smooth, skeletal, and cardiac muscles and profoundly affects the excitability of nerve tissue. It is also important in maintaining electrolyte and pH balance. high amount of potassium in the body was reported to increase iron utilization (Hegarty, 2008) and beneficial to people taking diuretics to control hypertension and suffer from excessive excretion of potassium through the body fluid. Iron according to is a major constituent in the manufacture and functioning of hemoglobin, a red blood cell protein that transports oxygen from the lungs to the cells. Phosphorus was particularly high in all the wheat-pumpkin composite biscuits, which makes them good sources of this important mineral. Phosphorus is of prime importance in the development of skeletal tissues, formation of nucleic acids (DNA and RNA), energy storage and transfer (Adenosine triphosphate, creatine phosphate, intracellular second messenger (cyclic adenosine monophosphate, phosphoproteins, structural roles (formation of cell membrane) and acid-base balance of cells.

Vitamin content

The result of vitamin content of wheat-pumpkin flour composite biscuits in Table2 shows that, cookie samples gradually increased in vitamin A equivalent (1.24-2.72), vitamin E (1.23-2.54) and vitamin B_1 (1.22-2.53) with gradual increase in the substutition of wheat flour with

pumpkin leaf flour. This result is in agreement with the literature report by Azevedo-Meleiro and Rodriguez-Amaya (2007) that, pumpkin is considered to be a good source of carotenoids, and a very rich source of carotene. The main nutrient is beta carotene, which generates vitamin A in the body. Vitamin A is a powerful natural anti-oxidant and is required by the body for maintaining the integrity of skin and mucus membranes.

Table.1 Proximate Composition of Cookies Supplemented with Pumpkin Leaves Flour

Parameter	Sample A	B	C	D	E	LSD
Moisture (%)	8.80^{b}±0.02	14.50^{a}±0.09	15.50^{a}±03	16.16^{a}±0.01	16.51^{a}±0.01	0.08
Protein (%)	10.50^{b} ±0.06	10.54^{a}±0.08	10.62^{a}±0.02	10.82^{a}±0.01	11.03^{a}±0.07	1.05
Fibre (%)	0.18^{c}± 0.06	0.82^{c}±0.04	1.02^{b}±0.01	1.21^{a}±0.06	1.55^{a}±0.01	0.03
Ash (%)	0.88^{d}± 0.06	0.94^{d}± 0.01	1.03^{c}±0.08	1.13^{b}±0.01	1.24^{a}±0.05	0.04
Fat (%)	1.24^{a}±0.04	1.00^{b}± 0.01	1.00^{b}±0.07	1.00^{b}±0.07	1.00^{b}±0.01	0.04
CHO (%)	75.30^{a}±0.02	56.20^{b}±0.06	56.20^{c}±0.06	56.20^{d}±0.06	56.20^{c}±0.06	0.44
Energy(kcal/100g)	356..56^{a}±0.01	283.16^{b}±0.1	281.60^{c}±0.09	280.44^{d}±0.02	279.44^{c}±0.04	0.08

Mean ±SD of triplicate determinations, Mean values with the same superscripts within the same row do not differ significantly at ($p<0.05$)

Table.2 Mineral and Vitamin Contents of Wheat-Pumpkin Leaves Flour Cookies (mg/100g)

Nutrient			Sample			LSD
	A	B	C	D	E	
Calcium	4.94^{a}±0.03	6.83^{a}± 0.03	6.80^{a}±0.08	6.93^{a}±0.01	7.20^{a}±0.04	0.02
Potassium	28.72^{b}±0.01	37.20^{a}±0.06	38.43^{a}±0.06	39.90^{a}±0.05	40.80^{a}±0.06	1.01
Iron	1.82^{d}± 0.05	2.14^{c}± 0.01	2.30^{b}±0.02	2.53^{a}±0.01	2.62^{a}±0.04	0.10
Phosphorous	28.63^{d}±0.01	37.54^{c}±0.03	37.73^{b}±0.03	39.62^{a}±0.01	39.93^{a}±0.04	0.50
Vit. A (equivalent)	1.24^{c}± 0.08	2.22^{b} ±0.03	2.40^{b}±0.05	2.53^{a}±0.01	2.72^{a}±0.01	0.20
Vitamin E	1.23^{c}± 0.01	2.03^{d}± 0.02	2.24^{c}±0.04	2.34^{b}±0.02	2.54^{a}±0.01	0.04
Vitamin B_1	1.22^{d}± 0.08	2.02^{c}± 0.01	2.20^{b}±0.01	2.40^{a}±0.07	2.53^{a}±0.07	0.14

Mean ±SD of triplicate determinations
Mean values with the same super scripts within the same row do not differ significantly at ($p<0.05$)

Table.3 Physical Characteristics of Wheat- Pumpkin Leaves Flour Cookies

Sample	Weight(g)	Diameter(cm)	Height(cm)	Spread ratio	Hardness(N)
A	6.90a±0.01	4.13c±0.05	2.10a±0.09	1.94c±0.01	29.43a±0.03
B	6.08b±0.04	4.45d±0.01	2.03b±0.02	2.22d±0.04	28.23a±0.01
C	6.10b±0.01	4.64c±0.01	1.92c±0.06	2.41c±0.01	26.91c±0.04
D	6.08b±0.08	4.70b±0.06	1.81d±0.01	2.60b±0.08	25.80d±0.01
E	6.08b±0.05	4.82a±0.04	1.70c±0.02	2.83a±0.01	23.83c±0.=5
LSD	0.90	0.04	0.06	0.04	0.08

Mean ±SD of triplicate determinations
Mean values with the same superscripts within the same row do not differ ($p<0.05$)

Table.4 Sensory Attributes of cookies Supplemented with Dried Pumpkin Leaves Flour

Sample	Appearance	Taste	Texture	Flavour	Overall acceptability
A	8.00[a]	8.80[a]	8.01[a]	8.60[a]	8.11[a]
B	7.81[b]	8.21[a]	7.22[a]	8.32[a]	7.23[a]
C	7.23[b]	7.92[b]	7.03[a]	8.01[a]	6.82[b]
D	5.22[c]	7.83[b]	6.94[b]	7.62[b]	6.41[b]
E	3.91[d]	5.84[c]	6.52[b]	5.07[c]	5.02[c]
LSD	0.06	0.6	0.80	0.32	0.91

Mean values with the same superscripts within the same row do not differ significantly at ($p<0.05$)

It is also an essential vitamin for good visual sight. Research studies suggest that natural foods rich in vitamin A help the body protects against lung and oral cavity cancers. Murkovic *et al.,* (2002) also reported that, the major caroteneoids in pumpkin include; β-carotene and α-carotene which are vitamin A precursors. Pumpkin is also a valuable source of vitamins such as Vitamin E **(**α-tocopherols) and Vitamin B_1 (thiamine) Vitamin E is one of the fat soluble vitamins that occur in pumpkin as tocopherols. There are various tocopherols but α-tocopherol has the highest activity.

Its action is antioxidant in nature retarding lipid oxidation and stabilising some biologically active compounds such as vitamin A precursors, hormones and enzymes against oxidation. Vitamin B_1 is the most important function of thiamine is its role as a co-enzyme. It combines with phosphoric acid to form thiamine pyrophosphate (TPP) which functions as coenzyme of carboxylase that is required in oxidative decarboxylation of pyruvate during biological oxidation of glucose. Thiamine deficiency causes beriberi a condition characterised by disturbance of the neurological and cardiovascular systems and of the gastrointestinal tract (Manay and Shadaksharaswamy, 2010).

Physical properties

The physical properties of wheat-pumpkin biscuits in Table 3 shows that, the weight of sample biscuits decreased from 6.90-6.08 with significant difference between the control and sample biscuits with pumpkin flour, whereas, there was no significant increase in weight among the wheat-pumpkin cookie samples.

Sample diameter ranged from 4.13-4.82 cm indicating a significant increase at $p<0.05$ exception of sample C, whose increase was not significant with that of the control. The height of cookie samples were significantly different at $p<0.05$ exception of samples C and E. The spread ratio varies significantly for sample biscuits exception of samples A and C. The sample hardness did not vary significantly between samples A, B and C, E while sample D, differs significantly at $p<0.05$ with all the other samples. There are several views on the mechanism by which the diameter of biscuits is reduced when wheat is supplemented with non-wheat flour (Fuhr, 2002) reported that rapid partitioning of free water to hydrophilic sites during mixing increase dough viscosity thereby limiting biscuits spread.

However, it has being suggested that spread ratio is affected by the competition of ingredient for the available water, flour or any other ingredient which absorbs water during dough mixing will decrease it (Bunde *et al.,* 2010). Pumpkin leaves flour has being reported to have a high water absorption capacity, a property which is useful in food systems such as bakery products that require hydration to improve handling characteristics.

Sensory

Sensory mean scores of biscuits using a Hedonic scale of 9-extremely like and 1-extremely dislike for the attributes of appearance, texture, taste, flavour and overall acceptability is shown in Table 4. All the sensory attributes of the cookie sample compare favourably with the control exception of appearance for sample E, whose mean score (3.9) is below average score (5.0) of the Hedonic scale based on panel judgement.

The result of sensory analysis showed that the texture data estimated by the panels were in good agreement with the measurement derived from the physical compression test. Flavour and taste were found to be a prominent factor in determining acceptability of pumpkin supplemented biscuits. Panellists described the biscuits containing more than 7.5% pumpkin flour as having an after taste and a smoky flavour. The low

overall acceptability of the biscuits from blends containing 10% pumpkin flour was attributed to the colour of the biscuits due to green pigment naturally present in the pumpkin leaves.

Conclusion

This study has shown that wheat flour supplemented with dried pumpkin leave flour at the 2.50%, 5.00% and 7.50% level produced acceptable biscuits with increased iron, calcium, potassium and phosphorus contents. The cookie samples have increase dietary fibre, ash and protein contents. Samples B, C and D compared favourably with the control (A). However, sample B (5.0 % pumpkin flour) was the most acceptable based on the panellist mean scores of the tested sensory attributes. That notwithstanding, supplementation of up to 7.50% of pumpkin leave flour was acceptable therefore, nutritious and acceptable biscuits can be produced from the addition of wheat-pumpkin flour. Also diet based composite biscuits containing up to 7.50% pumpkin leave flour were nutritionally comparable with diet based on vitamin A, B and E indicating that the underutilized highly nutritional pumpkin leaves available in tropical countries can be processed into value added products and used to combat malnutrition. The values obtained, in this study for micronutrient content of biscuits supplemented with pumpkin leaves flour compare favourably with the reported values indicating that the biscuits produced in this study may be useful as food vehicle for the alleviation of micronutrient malnutrition in developing countries.

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