PHYSICAL AND SENSORY PROPERTIES OF MULTIGRAIN AND MUSHROOM (*P. PULMONARIUS*) GLUTEN-FREE BISCUITS

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ABSTRACT

The study investigated the physical and sensory properties of gluten-free biscuits produced from composite flour blends of multigrain of sorghum(S), pear millet (P) , Kodo millet (K) and *P. pulmonarius* (M), in the ratio S:P:K:M; 90:00:00:10 (MMF), 50:10:30:10 (MMF1), 50:20:20:10 (MMF2), 50:30:10:10 (MMF3), 50:25:15:10 (MMF4) and 50:15:25:10 (MMF5) respectively. The physical properties ranged from 8.66 – 12.13 g, 5.47 – 6.33 cm, 0.55- 0.58 cm, 9.77– 11.54 and 2.30 - 2.90 kg for weight, diameter, thickness, spread ratio and break strength respectively, while the sensory parameters ranged from 5.96-7.66, 5.06- 7.83, 4.83-7.40, 4.76 -7.30 and 5.20 -7.80 for appearance, crispiness, flavor, mouthfeel and overall acceptability. There were significant ($p>0.05$) among the samples in the measured attributes. The raw material composition had a significant effect on the sensory and physical properties of the biscuits. Furthermore, the sensory evaluation results indicated that the various multigrain – mushroom (*P.pulmonarius*) biscuits produced were acceptable. However, biscuit sample MMF5 was the most acceptable which can be exploited in the production of gluten free functional biscuit on a commercial scale in household in view of the easy accessibility and availability of the grains.

Keywords: Biscuits, Millets, Sorghum, Mushroom (*P.pulmonarius*), Acceptability

1.0 INTRODUCTION

Biscuits are flour-based edible baked snacks that have been dried to an extremely low moisture level Pastries such as biscuits and bread have increased in developing countries like Nigeria and it has grown in popularity among the younger ones (Ayo *et al.*, 2018a). The basic ingredient in the different types of biscuit production includes flour and water mixture that may also contain oil, sugar and salt. Nigeria is the number one producer of Sorghum in Africa; sorghum and millets are tropical low-cost cereal grains but differin terms of grain structure and chemical composition(John *et al.*, 2017). There is an increased in utilization of sorghum and -millets worldwide in ready-to eat breakfast cereals, non-alcoholic and alcoholic beverages. They are relevant in the application of gluten-free products (John *et al.*, 2017).

Edible mushrooms are considered healthy food ingredients because they contain high levels of quality proteins, dietary fibres, vitamins, minerals, phenolic compounds, relatively low concentration of fat and digestible carbohydrates, which makes them suitable for improving the nutritional profile of foods. Generally, mushrooms possess all three functionalities of food; nutrition, taste, and physiological functionalities. Mushrooms(*P. pulmonarius*) have a distinct peculiarly pleasant savory taste called umami due to presence of sodium salts of free amino acids such as glutamic and aspartic amino acids. Hence, mushrooms are preferable and adaptable in most food formulations due to their unique flavour (Das *et al.*, 2021).

At present, the use of composite or wheat-less flours for staple processing are recent global development due to the rising global population, some economic, social, and health factors (Wang and Jian, 2022).Thus, the use of alternative raw material such as sorghum, millets and mushroom (*P.*

pulmonarius) composite flour with great potential as functional (health-promoting) foods in novel gluten-free biscuits production could help reduce the importation cost and dependency on wheat as the basic ingredient. Hence, this study aimed at assessing thephysical and sensory properties of biscuits produced from sorghum, millets and mushroom (*P. pulmonarius*) as an alternative gluten-free product.

2.0 MATERIALS AND METHODS

2.1Source of materials

Kodo millet, pearl millet and sorghum bicolor were purchased from Kure market in Minna Niger state, while the oyster mushroom was purchased from Sustainable Demonstration Farms, Orozo Abuja Nigeria.

2.2 Production of grain flours

The grains were cleaned manually by handpicking the chaff and dust. Stones were removed by washing in clean water (sedimentation). The washed and stone freed grains were oven dried at 45°C for 3h, milled using milling machine (Kenwood Blender) to produce sorghum bi-color (SB), kodo millet (KM), pearl millet (PM) flours. The various millet flours were sieved (170µm), packaged in a Ziplock bag and stored under room temperature.

2.3 Preparation of mushroom (P. pulmonarius) flours

Mushroom (*P. pulmonarius*) flour was prepared were washed thoroughly to remove all the extraneous material before oven dried at 50 °C. The fruiting bodies were grounded into fine powder, sieved (250 µm) and stored in tightly stopper bottles prior to further analysis

2.4 Production of biscuits

Biscuits was prepared from the composite flour blends of sorghum (S), pear millet (P), Kodo millet (K) and *P.pulmonarius* (M) in the ratio S:P:K:M 90:00:00:10 (MMF), 50: 10:30:10 (MMF1), 50:20:20:10 (MMF2) 50: 30: 10: 10 (MMF3) , 50:25:15:10 (MMF4) and 50: 15:25:10 (MMF5) respectively. Ten percent (10 %) of mushroom inclusion was reported as the best concentration in acha –mushroom biscuit production(Ayo *et al.*, 2018b). The biscuits were produced using the rub in method described by Airewa *et al.* (2022). Other ingredients used in the production of the biscuits were shortening (40g), sugar (30 g) corn starch (1g), milk (15 g), salt (1 g) and baking powder (1 g). The dry ingredients were mixed together thoroughly with fat until a coarse crumb-like mixture was attained. Water was added and this was thoroughly mixed into consistent dough. The dough was cut out into predetermined size and shape using a biscuit cutter and arranged on pre-oiled tray and baked in a pre-heated laboratory oven at 180 °C for 25 min. After baking, the hot biscuits were removed and allowed to cool at ambient temperature on a stainless clean tray, packed in airtight plastic transparent containers and stored at 23°C prior to subsequent analysis and sensory evaluation.

2.5 Analyses of samples

The physical properties of the biscuits, which include the weight, thickness, diameter, spread ratio and break strength of the biscuit samples were determined according to the method described by Ayo *et al.* (2018a). The average weight of (5 biscuits) was measured in (g) with an analytical weight balance. The diameter and thickness of biscuits were measured with a Vernier caliper while the spread ratio was determined from the ratio of diameter (D) to thickness (T) as (D/T). The sensory parameters were evaluated on a 9-point Hedonic scale using twenty (20) semi-trained panelists who were familiar with the product (Ayo *et al.*, 2018b). One-Way Analysis of Variance (ANOVA) and Duncan Multiple Range Test at 5 % significance level were performed using SPSS software version 20 to evaluate differences in data obtained.

0 RESULTS AND DISCUSSIONS

Physical properties of multigrain- mushroom (P. pulmonarius) mushroom based biscuits

The results of the physical properties of the biscuits produced are presented in Table 1. Differences in raw material composition contributed to the variations in results. The multigrain biscuits recorded higher weight and thickness values than the control (MMF) with the biscuit sample MMF4 having the highest weight value of 12.13 g. Higher weight of biscuits have previously been attributed to higher water holding capacity, fat and moisture contents of the biscuits (Onwuzurike *et al.*, 2023).Sample MMF3 had the lowest spread ratio values. The low spread ratio has been attributed to pearl millet addition in pearl-based cookies (Omooba *et al.*, 2015) and high spread ratio value has been related to the differences in particle sizes, limited swelling of starch and a better acceptability of the biscuit and this assertion is confirmed in Table 2 where the biscuits with high spread ratios were more preferred. Adeola and Ohizua (2018) reported a similar observation. The biscuit sample MMF (control) recorded the highest break strength value of 2.90 kg. The break strength value observed is within the range reported by Ayo et al.(2018a) for acha-tigernut biscuits; however it is generally higher than the range 1.52-2.39 kg recorded for acha–mushroom composite flour-based biscuits (Ayo *et al.*, 2018b). The break strength which is a veryimportant textural attributes of biscuits ranged between 2.30 (MMF3) and2.90 kg (MMF). The break strength depicts the peak force required to break the biscuits and it is also an important factor in post-handling and transportation. The multigrain samples had lower break strength and as such could be more susceptible to damages during product distribution (Adeola and Ohizua, 2018).

Table 1. Physical properties of biscuits produced from multigrain and mushroom (*P. pulmonarius*) composite flours

Biscuit Samples	Weight (g)	Diameter (cm)	Thickness (cm)	Spread ratio	Break strength(kg)
MMF	$8.66^{f}\pm0.01$	$6.33^{a}\pm0.02$	$0.57^{b}\pm0.00$	$11.11^{a}\pm0.01$	$2.90^{a}\pm0.04$
MMF1	$10.21^{d}\pm0.01$	$6.10^{c}\pm0.00$	$0.56^{c}\pm0.02$	10.89 ± 0.02	$2.60^{d}\pm0.10$
MMF2	$11.44^{c}\pm0.01$	$6.00^{b}\pm0.00$	$0.55^{d}\pm0.04$	$10.91^{a}\pm0.01$	$2.73^{c}\pm0.08$
MMF3	$11.72^{b}\pm0.01$	$5.47^{e}\pm0.06$	$0.56^{c}\pm0.02$	$9.77^{c}\pm0.02$	$2.30^{e}\pm0.14$
MMF4	$12.13^{a}\pm0.01$	$6.10^{c}\pm0.00$	$0.58^{a}\pm0.00$	$10.52^{b}\pm0.00$	$2.73^{c}\pm0.06$
MMF5	$9.30^{e}\pm0.01$	$6.35^{d}\pm0.00$	$0.55^{c}\pm0.00$	$11.54^{a}\pm0.10$	$2.80^{b}\pm0.00$

Values are means ± standard deviation of triplicate determinations; means with different superscript in the same column are significantly different at ($p\geq0.05$).

MMF= 90% sorghum flour, 10% mushroom flour

MMF1= 50% sorghum flour, 10% pearl millet flour, 30% kodo millet flour, 10% mushroom (*P. pulmonarius*)flour

MMF2= 50% sorghum flour, 20% pearl millet flour, 20% kodo millet flour10% mushroom (*P. pulmonarius*)floor

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MMF5=50% sorghum flour, 15% pearl millet flour, 25% kodo millet flour 10% mushroom (*P. pulmonarius*)flour,

3.2 Sensory properties of the multigrain- mushroom (P. pulmonarius) mushroom based biscuits

The results of the sensory properties of the biscuits are presented in Table 2. The mean scores for appearance, crispiness flavour, mouthfeel and overall acceptability ranged from 6.30 to 7.66, 5.06 to 7.83, 4.83 to 7.40, 4.76 to 7.30 and 5.20 to 7.80 respectively. Visually, the control sample had a creamy yellowish appearance in contrast to the multigrain biscuits samples with a darker appearance which could have contributed to the high score in appearance. This may partly be attributed to ingredient composition, pigmentation of the millets and maillard reaction. Aljobair(2022) reported lighter color attributes in sorghum cookies than in millet cookies which could be due to varietal differences. Sample MMF3 had the lowest score in all the parameters followed by sample MMF4. Generally, the mean sensory attributes scores of the biscuits samples were within the range of the

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MMF3	$11.72^{b}\pm0.01$	$5.47^{e}\pm0.06$	$0.56^{c}\pm0.02$	$9.77^{c}\pm0.02$	$2.30^{e}\pm0.14$
MMF4	$12.13^{a}\pm0.01$	$6.10^{c}\pm0.00$	$0.58^{a}\pm0.00$	$10.52^{b}\pm0.00$	$2.73^{c}\pm0.06$
MMF5	$9.30^{e}\pm0.01$	$6.35^{d}\pm0.00$	$0.55^{c}\pm0.00$	$11.54^{a}\pm0.10$	$2.80^{b}\pm0.00$

Values are means ± standard deviation of triplicate determinations; means with different superscript in the same column are significantly different at ($p\geq0.05$).

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cutoff score (5), which suggests the panelists' acceptance of the biscuits. The panels reported an after taste sensation in sample MMF3 and MMF4 and this probably could partly have resulted in slightly lower sensory scores. Samples MMF3 and MMF4 hada high pearl milletcontent which was probably more intense and could not be masked by the mushroom (*P.pulmonarius*) flavor. More desirable flavor in sorghum than pearl millet has been reported by Omooba *et al.* (2015) in sorghum and pearl millet biscuits.

Table 2. Mean Sensory Scores of Biscuits produced from multigrain- mushroom (*P. pulmonarius*) composite flours

Biscuit Samples	Sensory Parameters				
	Appearance	Crispiness	Flavor	Mouthfeel	Overall Acceptability
MMF	$7.63^{a}\pm1.18$	$6.00^{bc}\pm1.85$	$7.26^{ab}\pm1.52$	$6.93^{ab}\pm1.57$	$7.56^{b}\pm1.07$
MMF1	$7.36^{a}\pm1.27$	$7.63^{a}\pm1.37$	$6.96^{ab}\pm1.65$	$7.03^{ab}\pm1.32$	$7.56^{b}\pm1.10$
MMF2	$6.30^{b}\pm1.82$	$6.70^{b}\pm1.53$	$6.43^{b}\pm1.62$	$6.13^{bc}\pm2.02$	$6.50^{c}\pm1.30$
MMF3	$5.96^{b}\pm1.92$	$5.06^{c}\pm2.04$	$4.83^{d}\pm0.90$	$4.76^{d}\pm2.17$	$5.20^{d}\pm1.80$
MMF4	$7.06^{a}\pm1.50$	$5.56^{c}\pm2.38$	$5.30^{c}\pm1.84$	$5.96^{c}\pm1.62$	$6.26^{c}\pm1.70$
MMF5	$7.66^{a}\pm1.12$	$7.83^{a}\pm1.04$	$7.40^{a}\pm1.47$	$7.30^{a}\pm1.18$	$7.80^{a}\pm1.09$

Values are means ± standard deviation of triplicate determinations; means with different superscript in the same column are significantly different at (P>0.05).

MMF= 90% sorghum flour, 10% mushroom (*P. pulmonarius*) flour

MMF1= 50% sorghum flour, 10% pearl millet flour, 30% kodo millet flour, 10% mushroom (*P. pulmonarius*) flour

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MMF5=50% sorghum flour, 15% pearl millet flour, 25% kodo millet flour 10% mushroom (*P. pulmonarius*) flour,

Conclusion

This study concludes that acceptable physical and sensorial characteristics gluten -free biscuits can be developed using multigrain consisting of sorghum, millets and mushroom (*P. pulmonarius*) composite flour. Biscuits produced from 50% sorghum flour, 15% pearl millet flour, 25% kodo millet flour and 10% mushroom (*P. pulmonarius*) composite flour (MMF5) was the most accepted. This could add to the variety of biscuit for individuals that are non- tolerant to wheat gluten protein. Based on this study, it is highly recommended that further research should be conducted using bioprocesses such as germination of pearl millets to reduce the after taste and of course explore the nutritional properties of these gluten-free biscuits.

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