PROXIMATE COMPOSITION OF GERMINATED *FONIO* (*DIGITARIA IBURUA*) MUSHROOM (*PLEEUROTUS PULMONARIUS*) AND GINGER (*ZINGIBER OFFICINALE*) COMPOSITE FLOUR AND SENSORY PROPERTIES OF THE BISCUITS PRODUCED THEREOF

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Abstract
Biscuits were prepared from germinated *fonio,* mushroom and ginger flour blends. This study was carried out to evaluate the proximate composition of flour blends and sensory attributes of the biscuit. Composite flours were produced from germinated *fonio*, mushroom and ginger at varying proportions using I-optimal mixture design expert (version 10, Stat-Easc Inc., USA) to produce 17 flour blends giving the ingredients in the range of germinated *fonio* (78-94%), mushroom (4 -19 %) and ginger flour (1-5%). Proximate composition of the composite flours was evaluated using standard methods. The crude protein and fibre were 9.42-15.25% and 3.25-9.91 % respectively. The ash, fat and carbohydrate values within the composite flour were from 68.00-3.53 %, and 1.55-2.70 %, and 61.08-76.25% respectively. Biscuits prepared from sample O score (8.20, 8.25.8.70, 8.5, 8.07, 8.00) base on appearance, colour, taste, aroma, crispiness and overall acceptability respectively were most accepted by the panelist. Therefore, based on the proximate composition and sensory evaluation, it is evident that biscuits high in protein and other nutritious propertiescan be produced from the composite flour and can be utilized industrially.

Keywords: *Fonio*, Mushroom, Ginger, Proximate, Sensory properties

1.0 Introduction

Biscuits, like the majority of ready-to-eat (RTE) snacks that are made with cereal, either alone or in combination with pulses, tubers, fruits, and vegetables. Biscuits are a popular bakery product that appeals to people of all ages because of their longer shelf life, better taste, and role as snacks (Jayathilakan*et al.,* 2015).The main ingredient in biscuit making, wheat, is low in vitamin A but high in protein, fiber, carbohydrate, and energy.But when wheat is milled and turned into flour, the bran that contains these nutrients is removed. Dependence on wheat for baking has been a significant issue in Nigeria. As a result, the resulting wheat flour and its products become deficient in these nutrients and their consumers experience problems with protein-energy malnutritionAhure and Ejoha (2020). Increasing production costs, an increase in the price of baked goods, and a progressive decline in affordability have been caused by higher importation costs as a result of foreign exchange issues. While Nigeria's climate is not ideal for growing wheat, it is ideal for growing other cereal crops like acha and maize.Therefore, any attempt to replace wheat flour with any of the locally accessible grain flours will significantly cut the price of baked goods in Nigeria.*Fonio* (*DigitariaIburua*), also known as acha, is a naturally gluten-free African cereal suitable for use in the diet of celiac patientsand it is one of the oldest cereals characterized with a pleasant small seeds. Acha is noted for its high pentosan, an attribute recognized for

good baking operation(Ayo *et al.* 2016).The grain is uniquely rich in methionine and cystine, and evokes low sugar on consumption.Ayo *et al.* (2007) reported fortified*fonio* and wheat flour with soybean to increase its protein content. Edible mushrooms are a good source of high-quality protein. Lysine, which is scarce in cereal but abundant in mushrooms, has a number of antioxidants and is advised as a healthy food supplement for people with diabetes and cardiovascular disease (Fernandes*et al.*, 2015). Okafor*et al.* (2012) demonstrated that adding oyster (*Pluerotuspulmonaris*) mushroom powder to wheat flour used to make bread significantly improved the bread's protein content and nutritional quality.Ginger (*ZingiberOfficinale*) is a spice and flavoring agent that has many medicinal properties. In addition to enhancing flavor, herbs and spices are also known for their preservative, antioxidant, antimicrobial, and other medicinal properties (Sharifi-Rad *et al.*, 2017). According to Ezemba*et al.* (2021) reported the use of malted sorghum and ginger as flavor in the production of biscuits.

The production of composite flours from germinated *fonio*, mushroom, and ginger powder will mitigate biscuit diversification and its overall use in the baking industry. The aim of this study was to produce composite flour from germination *fonio,* mushroom, and ginger powder and assess the acceptability of the resulting biscuits.

2.0 Materials and Methods

Fonio (*Digitariaiburua*) grains was gotten from Kure Market, Minna Niger State, Nigeria.While mushroom (*Pleurotuspulmonarius*) used for this study was purchased from Sustainable Demonstration Farms Abuja, Nigeria. Ginger roots, corn starch, margarine, eggs, sugar, salt, milk, and baking powder were obtained from Kure Market, Minna Niger State, Nigeria.

2.1 Preparation of composite flours and biscuit from germinated *fonio* (*Digitiria. iburua*), mushroom (*Pleurotus. pulmonarius*) and ginger (*ZingiberOfficinale*) powder

Germinated *fonio* (*Digitaria. iburua*) flour was produced using the optimum germination period of 72 h reported by Bolarinwa*et al.* (2015). Two kilograms (2 kg) of the *foino* were sorted to remove stones, dirt and other extraneous materials. The cleaned grains were thoroughly washed and steeped in water at room temperature 30±2 ^{O}C for 12 h. The hydrated grains were spread on a previously sterilized moist jute bag and the grains were allowed to germinate for 72 h. Non-germinated grains were discarded and the germinated seeds were dried at 60 ^{O}C for 8 h in a cabinet dryer (model-RCD-20, Ningbo BeliunRhong, China).The withered rootless grains were gently winnowed, and the germinated grains were dry milled and sieved to produce germinated *fonio* flour (GF). Mushroom fruiting bodies, were washed thoroughly to remove mud, ferns and other extraneous material before oven (Model PSO-451 PrestoStantest Pvt. Ltd. India) dried at 50 ^{O}Cfor 8 hto obtain Mushroom flour (MF).Ginger rhizomes were cleaned and dried in aPresto laboratory hot air oven (Model PSO-451) at 50^{O}C for 8 h to obtained ginger powder (GP). Composite flours from different combination levels of germinated *fonio* (78-94%), mushroom (4 -19 %) and ginger flour (1-5%) were generated using I- optimal mixture using Design Expert (version 10, Stat-Ease Inc., USA). The proximate composition (method 925.10 for moisture, 923.03 for ash, 962.09 for fibre, 920.39 for fat, 955.04 for protein) of the samples were determined using

the AOAC (2012) procedures. Biscuits were produced using the mixing method described by Okpala and Okoli (2012) from the various composite blends of germinated *fonio*, mushroom and ginger. 100 % wheat flour biscuit was also produced and used as control. Other ingredients used in the production of biscuits were shortening (40g), sugar (30g) corn starch (1tsp), milk (15g), salt (1g) and baking powder (1tsp).The sensory analysis was carried out using 20 panellist constituting members of staff and students of Federal University of Technology, Department of Food Science and Technology, Minna, Nigeria. The sensory parameters; determined were appearance, colour, taste, aroma and general acceptability of the biscuits Nine – point hedonic scale was used with 9= Like extremely ... to 1= dislike extremely. (Iwe, 2002).

3.0 Results and Discussion

3.1 Proximate composition of the composite flours

The result obtained from proximate composition of flour from blends of germinated*fonio*, mushroom and ginger powder are presented in Table 1.There were significant ($p \leq 0.05$) difference in the proximate composition of the flour blends. The moisture content of the composite flours were (5.95-6.70 %) this falls below the safe moisture level (≤10 g/100 g) for prolonged storage of flours. The protein content were between 9.42 – 15.25 % and fibre content were from 3.25 - 9.91 %.Sample L having the highest amount of protein (15.25 %) and Q having the highest amount of fiber (9.91 %). The high protein content in the composite flour could be as a result of mushroom inclusion and germination which involves synthesis of enzymes by germinating seed, change in composition resulting in newly formed protein. Low ash content were observed for the composite blends which were from 1.68-3.53 %, sample J shows highest amount of ash (3.53 %) and fat content were from 1.55-2.70 %. Mushrooms are not a choice of fats and the germination process also have been reported to reduce fat contents in seed as this is used up for energy for seed growth (Chinma*et al* ., 2021). Carbohydrate content of the composite blends were from 61.08 – 76.25 %. On the whole wheat flour had the lowest amount of ash (0.45 %) and fibre (1.30 %), while the wheat flour recorded highest amount of fat content and carbohydrate at 2.73 % and 77.47% respectively. Studies have shown that consumption of food rich in dietary fiber has protective effect against chronic diseases such as diabetes and cancer. This implies that the composite flours may be nutritionally more beneficial.

Table 3: Proximate composition of germinated *fonio*(*Digitaria. iburua*), mushroom (*Pleurotuspulmonarius*) and ginger (*ZingiberOfficinale*) composite flour blends

Runs	GF	MM	GG	Moisture content %	Protein %	Fibre (%)	Ash %	Fat %	Carbohydrate %
A	93.00	4.00	3.00	6.11±0.12	10.67±0.35	3.25±0.15	1.97±0.04	1.75±0.34	76.25±0.43
B	82.33	13.33	4.33	6.41±0.02	12.42±0.10	7.07±0.01	2.05±0.06	2.35±0.00	69.70±0.17
C	78.00	17.00	5.00	6.57±0.03	14.00±0.00	8.05±0.42	3.00±0.00	2.42±0.59	65.96±0.35
D	78.00	19.00	3.00	6.70±0.47	13.87±0.06	8.74±0.02	3.30±0.05	2.12±0.16	64.67±0.53
E	84.50	10.50	5.00	6.14±0.10	12.85±0.09	7.54±0.37	2.01±0.00	2.22±0.05	69.24±0.06
F	93.00	4.00	3.00	5.95±0.07	10.54±0.35	4.77±0.16	1.68±0.25	1.80±0.03	71.01±0.43
G	82.92	15.17	1.92	6.33±0.12	12.53±0.10	9.15±0.04	2.84±0.19	2.12±0.16	66.63±0.16
H	86.67	8.33	5.00	6.45±0.07	13.76±0.12	4.96±0.00	2.08±0.02	2.24±0.59	70.51±0.02
I	82.33	13.33	4.33	6.20±0.07	13.39±0.37	7.87±0.00	2.01±0.04	2.35±0.78	66.67±0.06
J	82.92	15.17	1.92	6.10±0.01	13.24±0.60	9.11±0.01	3.53±0.04	2.52±0.19	65.50±0.04
K	87.00	12.00	1.00	5.95±0.07	11.89±0.00	8.73±0.23	2.69±0.27	2.52±0.19	68.22±0.13
L	80.00	19.00	1.00	6.50±0.42	15.25±0.28	9.91±0.04	3.03±0.00	2.43±058	61.08±0.12
M	89.92	7.92	2.17	5.95±0.07	9.67±0.50	8.25±0.04	2.27±0.03	2.25±0.56	71.81±0.62
N	89.92	7.92	2.17	6.20±0.07	10.37±0.10	5.34±0.15	2.09±0.00	2.58±0.03	72.62±0.13
O	94.00	5.00	1.00	6.21±0.07	9.85±0.06	7.25±0.04	2.17±0.28	2.70±0.28	71.84±0.02
P	91.00	4.00	5.00	6.13±0.02	9.42±0.62	7.47±0.15	1.95±0.11	1.55±0.04	66.06±0.07
Q	87.00	12.00	1.00	6.17±0.07	13.29±0.27	9.75±0.37	2.00±0.00	2.02±0.00	66.77±0.00
CC	-	-	-	9.03±0.01	9.00±0.00	1.32±0.12	0.45±0.05	2.73±0.25	77.47±0.09

Each value is a mean of triplicate analyses ± standard deviation. All values are on dry weight basis

GF=Germinated *fonio* (*Diitariaiburua),* MM= Mushroom (*Pleurotuspulmonarius*), GG= Ginger powder, C= Wheat flour

3.2 Sensory properties of germinate *fonio*(*Digitariaiburua*), mushroom (*Pleurotuspulmonarius*) and ginger (*ZingiberOfficinale*) based biscuits

The results for the sensory analysis of the germinated *fonio*, mushroom and ginger biscuit is as presented in Table 2. The scores of all the sensory attributes were found to be statistically significant ($p \leq 0.05$) among the formulation combinations. Sample O (94:00%, 5.00% 1.00%) scored the highest overall acceptability followed by sample N and P. The appearanc were from 6.52-8.00 with run O having the highest value which is same with the contro (CC). The sensory properties in term of taste, aroma, and crispness the composite flour

differ compared to the control wheat biscuit

Table 2: Sensory properties of germinated *fonio*(*Digitariaiburua*), mushroom (*Pleurotus. pulmonarius*) and ginger (*ZingiberOfficinale*)based biscuits

Runs	Appearance	Colour	Taste	Aroma	Crispiness	Overall acceptability
A	7.10±0.19	7.00±0.17	6.80±0.29	6.65±0.27	7.00±0.12	7.05±0.27
B	6.52±0.11	6.14±0.12	6.52±0.22	6.14±0.15	6.81±0.13	6.24±0.20
C	7.25±0.14	7.30±0.14	6.25±0.19	6.40±0.15	6.85±0.13	5.85±0.27
D	7.00±0.13	6.95±0.09	6.16±0.25	6.21±0.27	6.42±0.15	6.21±0.23
E	6.95±0.08	6.85±0.10	6.05±0.26	6.20±0.26	6.35±0.19	6.05±0.26
F	7.35±0.11	7.15±0.15	7.00±2.05	6.95±0.21	7.10±0.17	7.05±0.19
G	7.30±0.14	7.25±0.12	7.25±0.16	6.85±0.16	7.15±0.13	7.10±0.12
H	7.30±0.14	7.25±0.12	7.25±0.16	6.85±0.16	7.15±0.13	7.10±0.12
I	7.45±0.11	7.20±0.09	6.20±0.32	6.35±0.31	6.05±0.35	6.36±0.32
J	6.95±0.11	6.95±0.08	6.35±0.33	6.50±0.18	6.50±0.19	6.35±0.22
K	7.35±0.19	6.85±0.18	6.85±0.18	6.85±0.18	6.85±0.18	6.85±0.18
L	7.00±0.00	6.85±0.10	6.40±0.16	6.45±0.13	6.50±0.13	6.35±0.18
M	7.60±0.15	7.60±0.15	7.60±0.15	7.60±0.15	7.60±0.15	7.60±0.15
N	7.80±0.22	7.80±0.22	7.80±0.22	7.80±0.22	7.80±0.22	7.80±0.12
O	8.20±0.17	8.25±0.17	8.70±0.10	8.55±0.17	8.07±0.11	8.00±0.70
P	7.70±0.21	7.70±0.21	7.70±0.21	7.00±0.21	7.70±0.21	7.70±0.11
Q	7.40±0.23	7.40±0.23	7.40±0.2	7.40±0.23	7.40±0.22	7.40±0.23
CC*	8.00±0.80	6.90±1.32	7.00±1.50	6.80±1.5	7.80±1.50	7.80 ±1.32

Each value is a mean of triplicate analyses ± standard deviation. CC*= Wheat flour biscuit

4.0 Conclusion

The proximate composition of blends of germinated *fonio*, mushroom, and ginger composite flour and the sensory attribute of the biscuit were evaluated in this study. The study shows that there were significant difference ($p \leq 0.05$) in the proximate composition of the composite flour and sensory attribute of the biscuit. the proximate composition reveals that the moisture content were from 5.95-6.70%, the protein and fiber content were from 9.42- 15.25 % and 3.25- 9.91%, respectively, and the ash, fat, and carbohydrate content w were from 1.68-3.53%, 1.55-2.70%, and 61.08-76.25%. Depending on the proportion, the protein and ash contents of the flour blends increased. The high protein content of the

composite flour may be due to mushroom inclusion and germination, which involves enzyme synthesis by germinating seed. All of the composite flours were successful in producing acceptable biscuits with sample O having the highest overall acceptability.

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