USE OF MUSHROOM POWDER TO MAKE BREAD

BY

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SR/1967/RRP/22/54

UNIVERSITY OF BENIN,

BENIN CITY.

SEPTEMBER, 2023.

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY, FACULTY OF LIFE SCIENCE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR of SCIENCE (HONOURS) DEGREE (BSc.) IN PLANT BIOLOGY AND BIOTECHNOLOGY.

SEPTEMBER, 2023.

CERTIFICATION

We certify that this research work was carried out by Tessy Omorovbiye ENABULELE of the Department of Plant Biology and Biotechnology, University of Benin, Benin City, Nigeria.

Signed: _____ _____

Dr. A. T. Dania Date

(Project Supervisor)

Signed: _____ _____

Prof. D.E Vwioko Date

(Head of Department)

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External Examiner Date

DEDICATION

This project work is dedicated to the Almighty God, the author and finisher of our faith, my father, Mr. Nosakhare Innocent Osagie and my Step-dad, Hon. Friday Ero. I thank the Lord for providing strength, good health, wisdom and the resources that was used to carry out this research.

ACKNOWLEDGEMENT

My heartfelt gratitude goes to my supervisor, Dr. A. T. Dania for his immense support during the course of this study.

I also want to express my gratitude to the head of the department, Prof. D. E. Vwioko and the entire personnel of the department of Plant Biology and Biotechnology.

To my mum, Mrs. Tina Ero, my step-father, Hon. Friday Ero, my father, Mr. Nosakhare Innocent Osagie, my grandmother, Mrs. Helen Obaseki, My mentors, Apostle Clement and Reverend (Mrs) Anita Isikhuanele, my only sister, Miss Victory Ero and finally to my amazing friends Queen, Monica and coursemates, thank you for your love, prayers and support. I love you all dearly.

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ABSTRACT

Different types of mushrooms, such as *Marasmiellus inoderma*, *Pleurotus ostreatus*, and *Ganoderma lucidum*, from the families Marasmieceae, Pleurotaceae, and Ganodermataceae respectively, are exceedingly adaptable and may offer health advantages. Additionally, they create mushroom powder, a healthy, gluten-free substitute for traditional wheat flour that emphasizes its culinary uses and environmental benefits. The discussion then moves to a study that aims to increase dietary fiber, improve flavor and scent, and enrich bread with nutritional content of mushroom while investigating potential health advantages and encouraging culinary innovation. The ultimate goal of this study is to maximize the production of mushroom bread and determine whether it can be produced economically while still satisfying consumer demand. It also include determining how different mushroom types affect flavor and acceptability, lowering the amount of sugar in bread, finding the ideal ratios for mushroom powder, evaluating the effects of processing methods, analysing nutritional value and health benefits, and assessing shelf life and consumer perceptions. The mushroom powder which was processed by dehydration was added in different percentage and levels to bread flour which is then used to make bread. The bread is to be made delicious, in wheat bread style, reduced sugar content and have an original mushroom taste. It was done by measuring ingredients, mixing and kneading into a dough, proofing, baking and cooling off completely. The proximate was determined with content of moisture 25.10%, fibre 0.53%, fat 22.23%, ash 1.70%, dry matter 74.93%, protein 9.99% and carbohydrate 40.45%. Palatability test and mold analysis was carried out to determine consumer acceptance and determine the shelf life of the bread. This study infuses biotechnology into baking and vice versa.

CHAPTER 1

INTRODUCTION

BACKGROUND OF THE STUDY

Mushrooms are a type of fungus having a variety of shapes, sizes, and colors. They are found all over the world and are a common ingredient in many cuisines due to their unique flavor and texture. Mushrooms can be categorized into two broad groups: edible and poisonous. Edible mushrooms are safe for consumption and have a variety of health benefits, while poisonous mushrooms can be deadly if consumed. Mushrooms are used in a variety of dishes, including soups, stews, sauces, and stir-fries. They can also be eaten raw in salads or used as a meat substitute that are especially pertinent for diabetics, vegetarian and vegan dishes.

Mushrooms are low in calories and fat, but high in fiber, vitamins, and minerals. They are a good source of protein and antioxidants, which help protect the body from damage caused by free radicals. Some varieties of mushrooms also contain compounds that may have anti-inflammatory and immune-boosting properties. Mushrooms support a healthy immune system as they contain macronutrients that support a healthy immune system. According to the Mushroom Council, the immune system will benefit from mushrooms whose nutrients includes Selenium, which helps the body make antioxidant enzymes to prevent cell damage, Vitamin D, which assists with cell growth, boosts immune function and reduces inflammation, Vitamin B6, which helps the body form red blood cells, proteins and DNA. Additionally, the polysaccharide and vitamin B content of these foods may provide other health advantages, such as better blood sugar and cholesterol.

Nigerians consume a lot of bread, which is a popular staple cuisine there. With many regional and cultural variations, it is a product made from wheat flour, water, yeast, salt, and occasionally sugar. Bread is frequently used for breakfast or as a snack, and it goes well with tea, coffee, beans, akara,

pap and other foods. Nigeria's bread production and consumption have increased dramatically over the years as a result of urbanization, shifting lifestyles, and rising consumer demand for quick and inexpensive meal options. It is easily accessible in grocery shops, supermarkets, bakeries, and even on the streets, where it is sold by neighborhood vendors among other munchies. Depending on the area and the baker's recipe, bread in Nigeria can have a variety of flavors, textures, and sizes. Sliced bread, Agege bread, coconut, sardine and whole wheat bread are some popular bread varieties. As non-communicable diseases like diabetes in the nation are becoming more prevalent, there have been recent initiatives to increase the nutritional content of bread by adding whole grains and other healthier ingredients. For many Nigerians, bread continues to be a practical and beloved food item. It is still a crucial component of Nigerian cuisine.

A sort of flour manufactured from dried mushrooms is called mushroom powder (or mushroom flour). It is becoming more well-liked as a healthy and gluten-free substitute for conventional wheat flour. Mushroom flour is renowned for its distinctive nutritional profile, delicious flavor, and a host of health advantages. A variety of recipes can use mushroom powder. To make spice, bread, spaghetti, pancakes, and other baked items, it can be combined with other flours. Since mushroom powder is naturally gluten-free, it can be used by anyone who is sensitive to gluten or who is on a gluten-free diet. It is a good source of vitamins (especially B vitamins like riboflavin and niacin), minerals (including potassium, copper, and selenium), dietary fiber, and antioxidants, as well as other important nutrients. People are aware of the possible health advantages of mushrooms. They have few calories, no fat, and no cholesterol. They include bioactive substances including beta-glucans, which may have anti-inflammatory effects as well as immune-boosting qualities. An environmentally favorable substitute for conventional wheat production is the manufacturing of mushroom flour. Agricultural waste or byproducts, such as straw or sawdust, can be used to produce mushrooms, minimizing the environmental impact of large-scale wheat cultivation.

Gluten is a structural protein naturally found in certain cereal grains (Hervè, 2002). It is present in bread flour as it contains a very high level, but, it is not present in mushroom powder. It is an essential factor in bread making. Mushroom powder cannot make bread dough consistency as a primary ingredient, so, is mixed with bread flour due to its high gluten content.

In this study, three mushrooms were used. The first, *Marasmiellus inoderma, Pleurotus ostreatus* and *Ganoderma lucidum* were the second and third mushrooms respectfully.

The Fragrant Parachute, also known as *Marasmiellus inoderma*, is a tiny fungus in the family Marasmiaceae. It is a plant pathogen that causes root-rot of maize (Sabet *et al*., 1970). Marasmiellus rot on banana and basal rot of golden shower orchid. It can be found all over the world in different places like North America, Europe, Asia, and Africa. When young, it has a convex or bell-shaped shape, but as it ages, it flattens out or slightly sinks. The color of the cap might vary but is typically brown or tan. The stem is often yellowish or pale brown in color, brittle, and long. The as sweet or fruity sweet, fruity scent of *Marasmiellus inoderma* is one of its distinguishing characteristics. Fresh mushrooms give out a pleasant aroma that some people say smells like peaches or apricots.

Classification of *Marasmiellus inoderma*

Kingdom	Fungi
Division	Basidimycota
Class	Agaricomycetes
Order	Agaricales
Family	Marasmieceae
Genus	*Marasmiellus*

Species *M. Inoderma*

Binomial name *Marasmiellus inoderma* (Berk.)

Pleurotus ostreatus, the oyster mushroom, oyster fungus, hiratake, or pearl oyster mushroom is a common edible mushroom (Alan and Tom, 2014). Due to its culinary appeal and potential health advantages, it is widely grown and consumed worldwide. The broad, fan- or oyster-shaped cap of oyster mushrooms gives them a distinctive appearance. Its color can range from white to gray, brown, or even pinkish. The stem is frequently off-center and small, and it thickens up near the base. They are highly acclaimed for their sensitive texture and subtle flavor. They have a moderate, savory flavor that is frequently compared to nuttiness or a touch of sweetness. They can be used in a variety of culinary preparations, including stir-fries, soups, stews, pasta dishes, and as a meat substitute, thanks to their adaptability. They may support immunological and heart health, assist proper blood sugar regulation, and have antioxidant and anti-inflammatory benefits in addition to being very nutritious.

Classification of *Pleurotus ostreatus*

Kingdom Fungi

Division Basidimycota

Class Agaricomycetes

Order Agaricales

Family Pleurotaceae

Genus *Pleurotus ostreatus/*

Species	*P. ostreatus*
Binomial name	*Pleurotus ostreatus* (Jacq. ex Fr)

Ganoderma lucidum is a red-colored species of Ganoderma with a limited distribution in Europe and parts of China, where it grows on decaying hardwood trees (Loyd *et al*., 2010). They have been linked to several positive health impacts, such as supporting the immune system, reducing stress, improving liver and cardiovascular health, and perhaps having an anticancer effect. According to the State Pharmacopoeia of the People's Republic of China (2000), *Ganoderma lucidum* acts to replenish Qi (which simply means vital energy), ease the mind, and relieve cough and asthma, and it is recommended for dizziness, insomnia, palpitation, and shortness of breath.

Classification of *Pleurotus ostreatus*

Kingdom	Fungi
Division	Basidimycota
Class	Agaricomycetes
Order	Polyporales
Family	Ganodermataceae
Genus	*Ganoderma*
Species	*G. lucidium*
Binomial name	*Ganoderma lucidium* (Curtis)

AIMS

The aims of this study are to evaluate the acceptability, palatability, nutritional composition, and the shelf-life mushroom powder in bread for nutritional enrichment, potential health benefits and culinary innovation and diversity.

OBJECTIVES

The objective of this study is to:

- Examine the nutritional worth of mushroom bread comparing it to traditional bread, paying close attention to crucial elements like protein content, dietary fiber, and carbohydrate content.
- Analyse the changes in mushroom bread over the course of its shelf life.
- Look into the viability of adding functional or medicinal mushrooms to bread recipe.
- Through sensory analysis and consumer preference research, determine the impact of mushroom bread intake on consumer perception and acceptance.

CHAPTER 2

MATERIALS AND METHOD

SOURCE OF THE MATERIALS:

The fruiting bodies of *Marasmiellus inoderma, Pleurotus ostreatus and Ganoderma lucidum* mushrooms that were used to produce the powder used in this study were gotten from the African Center for Mushroom Research, Technology and Innovation (ACMRTI), in the department of Plant Biology and Biotechnology, University of Benin, Benin City, Edo State.

PRODUCTION OF THE MUSHROOM POWDER:

The fruiting bodies of the respective mushrooms were harvested, collected and dried using a dehydrator until it completely dehydrated and crunchy. It was then collected and grinded to powder using a mill (or blender). Certainly, the blender was clean and wiped down to avoid any form of contamination possible. The smooth mushroom powder was poured into a zip-lock bag to prevent every form of contamination.

THE BAKING PROCESS

An electronic scale was used to weigh the amount required of every ingredient, and the already weighed ingredient was packed and labelled in a zip-lock bag. All ingredients, including dry and wet, were weighed in grams (g).

The tables below show the different recipes, different ingredient measurements and percentage used in this study. There are four levels of mushroom content percentage with different name or label tags.

Table 1: Recipe of bread baked with *Marasmiellus inoderma* with mushroom powder

Ingredients	Percentage (%)	M1 (2%)	M2 (4%)	M3 (6%)	M4 (8%)
Mushroom powder		10g	20g	30g	40g
Bread flour	100%	490g	480g	470g	460g
Sugar	11%	53.9g	52.8g	51.7g	50.6g
Salt	1.6%	7.84g	7.68g	7.52g	7.36g
Yeast	0.7%	3.43g	3.36g	3.29g	3.22g
Improver	0.2%	0.98g	0.96g	0.94g	0.92g
Preservative	0.3%	1.47g	1.44g	1.41g	1.38g
Softner	0.1%	0.49g	0.48g	0.47g	0.46g
Flavor	1%	0.49g	0.48g	0.47g	0.46g
Milk	5%	25g	25g	25g	25g
Water	50%	250g	250g	250g	250g
Butter	2.8	14g	14g	14g	14g

***Key: M1 = 2% *Marasmiellus inoderma* mushroom bread. M2 = 4% *Marasmiellus inoderma* mushroom bread. M3 = 6% *Marasmiellus inoderma* mushroom bread. M4 = 8% *Marasmiellus inoderma* mushroom bread.**

Table 2: Recipe of bread baked with *Pleurotus ostreatus* with mushroom powder

Ingredients	Percentage (%)	P1 (4%)	P2 (8%)	P3 (12%)	P4 (16%)
Mushroom powder		20g	40g	60g	80g
Bread flour	100%	480g	460g	440g	420g
Sugar	11%	52.8g	50.6g	48.4g	46.2g
Salt	1.6%	7.68g	7.36g	7.04g	6.72g
Yeast	0.7**%**	3.36g	3.22g	3.08g	2.94g
Improver	0.2%	0.96g	0.92g	0.88g	0.84g
Preservative	0.3%	1.44g	1.38g	1.32g	1.26g
Softner	0.1%	0.48g	0.46g	0.44g	0.42g
Flavor	0.1%	0.48g	0.46g	0.44g	0.42g
Milk	5%	25g	25g	25g	25g
Water	50%	250g	250g	250g	275g
Butter	2.8%	14g	14g	14g	14g

***Key: P1 = 2% *Pleurotus ostreatus* mushroom bread. P2 = 4% *Pleurotus ostreatus* mushroom bread. P3 = 6% *Pleurotus ostreatus* mushroom bread. P4 = 8% *Pleurotus ostreatus* mushroom bread.**

In the recipe for *Pleurotus ostreatus* mushroom bread, a higher percentage of the mushroom powder was used. This is because the mushroom powder was readily available, more abundant in stock and therefore, ‘triggered enthusiasm for adventure'. In the case of P4, 25g extra of water was added because of the high percentage of mushroom powder used. While the percentage for four levels of the other mushroom breads were 2%, 4%, 6%, and 8%, the percentage for the four levels of *Pleurotus ostreatus* mushroom bread was 3%, 6%, 9% and 12%.

Table 3: Recipe of bread baked with *Ganoderma lucidum* with mushroom powder

Ingredients	Percentage (%)	G1 (2%)	G2 (4%)	G3 (6%)	G4 (8%)
Mushroom Powder		10g	20g	30g	40g
Bread Flour	100%	490g	480g	470g	460g
Sugar	11%	53.9g	52.5g	51.7g	50.6g
Salt	1.6%	7.84g	7.68g	7.52g	7.36g
Yeast	0.7%	3.43g	3.36g	3.29g	3.22g
Improver	0.2%	0.98g	0.96g	0.94g	0.92g
Preservative	0.3%	1.47g	1.44g	1.41g	1.38g
Softner	0.1%	0.49g	0.48g	0.47g	0.46g
Flavor	0.1%	0.49g	0.48g	0.47g	0.46g
Milk	5%	25g	25g	25g	25g
Water	50%	250g	250g	250g	250g
Butter	2.8%	14g	14g	14g	14g

***Key: G1 = 2% *Ganoderma lucidium* mushroom bread. G2 = 4% *Ganoderma lucidiom* mushroom bread. G3 = 6% *Ganoderma lucidiom* mushroom bread. G4 = 8% *Ganoderma lucidiom* mushroom bread**

All the percentage of the ingredients were calculated in respect to the bread flour only except the percentage of the water, butter and milk which was calculated with the total flour weight (weight of the bread flour in addition to the weight of the mushroom powder

A plain bread in which mushroom powder was not added was also baked alongside the mushroom bread. It was used as the ‘Control’ and labelled as ‘C’. The table shows the recipe of the control bread.

Table 4: The recipe of the control bread

Ingredient	Percentage	Measurement
Bread flour	100 %	500g
Sugar	11%	55g
Salt	1.6%	8g
Yeast	0.7%	3.5g
Improver	0.2%	0.2g
Preservative	0.3%	1.5g
Flavor	0.1%	0.5g
Softner	0.1%	0.5g
Milk	5%	25g
Butter	2.8%	14g
Water	50%	250g

All the dry ingredients (flour, sugar, salt, yeast, improver and preservative) are weighed and poured into the electronic mixer bowl. The mixer is turned on at low speed to enable the dry ingredients mix properly. The water, flavor and milk are then introduced into the dry ingredients already in the mixer. It is then mixed on low to medium speed for ten minutes. The butter is not added in the beginning the little gluten in the dough form. After ten minutes of mixing, the butter is added. The dough is kneaded for an extra five minutes or until it is ready. The windowpane test is done on the dough by taking out a small piece of the dough and stretching it out lightly until there is no tear. If there is a tear, the dough is allowed to knead for a few minutes more. Another way to conduct this test is to roll the entire dough into a ball and use a finger to lightly press the dough. If the dough bounces back slowly, it is ready. If the dough does not bounce back, it is allowed to knead for a few

more minutes. After the dough is bought out of the mixer, it is cut, weighed, shaped and placed in the pan. It is allowed to proof for one hour in a warm place there is an increase in size is visible. After one hour of proofing, it is then transferred into the already preheated oven for baking. It is steam-baked for thirty minutes. After finishing the baking process, the bread was allowed to cool off completely, packed and labelled accordingly.

PALATABILITY TEST

To conduct the palatability test, samples of the baked mushroom bread were collected accordingly and distributed amongst lecturers and students in the department of Plant biology and biotechnology to taste, and feedback was received from these individuals.

SHELF-LIFE TESTING

The shelf-life is tested by placing the bread samples on a flat surface for a couple of days until molds are noticeable.

DETERMINATION OF THE PROXIMATE

This experiment was done using the official methods of analysis (AOAC, 2007).

Moisture

Two grams of the sample was weighed into a previously weighed crucible. The crucible containing sample was then transferred into the oven set at $100^{O}C$ to dry to a constant weight for 24 hours overnight. At the end of the 24 hours, the crucible with sample was removed from the oven and transferred to desiccator, cooled for 10 minutes and weighed.

If the weight of empty crucible was Wo
Weight of crucible plus sample was W_1
Weight of crucible plus oven-dried sample W_3
(% DM) % Dry Matter = $\frac{W_3 - Wo}{} \times \frac{100}{}$

$$\% \text{ Moisture} = \frac{W_1 - W_3}{W_1 - Wo} \times \frac{100}{}$$

or % Moisture = 100 – % DM.

Ash Content

Two grams of the samples were weighed into a porcelain crucible. This was transferred into the muffle furnace set at 550ºC and left for about 4 hours. About this time, it had turned to white ash. The crucible and its content were cooled to about 100ºC in air, then room temperature in a desiccator and weighed. This was done in duplicate. The percentage ash was calculated from the formula below:

$$\text{Ash content} = \frac{\text{wt. of ash}}{\text{original wt. 1of sample}} \times \frac{100}{}$$

Fibre

Two grams of the sample were accurately put the fibre flask and 100ml of 0.255N H_2SO_4 added. The mixture was heated under reflux for 1 hour with the heating mantle. The hot mixture was filtered through a fibre sieve cloth. The filtrate obtained was thrown off and the residue was returned to the fibre flask to which 100ml of (0.313N NaOH) was added and heated under reflux for another 1 hour. The mixture was filtered through a fibre sieve cloth and 10ml of acetone was added to dissolve any organic constituent. The residue was washed with about 50ml hot water on the sieve cloth before it was finally transferred into the crucible. The crucible and the residue were oven-dried at 105ºC overnight to drive off moisture. The oven-dried crucible containing the residue was cooled in a desiccator and later weighed to obtain the weight W_1. The crucible with weight W_1 was transferred to the muffle furnace for Ashing at 550°C for 4 hours. The crucible containing white or

grey ash (free of carbonaceous material) was cooled in the desiccator and weight to obtain W_2. The difference $W_1 - W_2$ gives the weight of fibre. The percentage fibre was obtained by the formula:

$$\% \text{ Fibre} = \frac{W_1 - W_2}{\text{wt. of sample}} \times 100$$

Crude fat

One gram of each dried sample was weighed into fat free extraction thimble and plugged lightly with cotton wool. The thimble was placed in the extractor and fitted with reflux condenser and a 250ml soxhlet flask which had been previously dried in the oven, cooled in the desicator and weighed. The soxhlet flask was then filled to $^3/_4$ of its volume with petroleum ether (boiling point. 40º – 60ºC). The soxhlet flask, extractor plus condenser set were placed on the heater. The heater was put on for six hours with constant running water from the tap for condensation of ether vapour. The set was constantly watched for ether leaks and the heat source was adjusted appropriately for the ether to boil gently. The Ether was left to siphon over several times (at least 10 – 12 times) until it was short of siphoning. Any ether content of the extractor was carefully drained into the ether stock bottle. The thimble containing sample was then removed and dried on a clock glass on the bench top. The extractor, flask and condenser were replaced, and the distillation continued until the flask was practically dry. The flask which now contained the fat or oil was detached, its exterior cleaned and dried to a constant weight in the oven. If the initial weight of dry soxhlet flask was Wo and the final weight of oven dried flask + oil/fat was W_1, percentage fat/oil was obtained by the formula:

$$\frac{W_1 - Wo}{\text{Wt. of Sample taken}} \times 100$$

Nitrogen content

Nitrogen content of the samples was determined by the kjeldahl method. The method involves: Digestion, Distillation and Titration.

Digestion: Two grams of the sample into a round bottom flask and add 25mls of concentrated sulphuric acid, 0.5g of copper sulphate and 5g of sodium sulphate.

The samples were then heated using a heating mantle in a fume cupboard slowly at first to prevent undue frothing, continue to digest for 45mins until the sample become clear pale green. The samples were allowed cool and 100mls of distilled water. Distillation was done against 10mls of the boiled digest using 10mls of sodium hydroxide and 50mls of 2% boric acid containing screened methyl red indicator. The alkaline alkaline ammonium borate formed is titrated directly with 0.1*N* HCl. The titre value which is the volume of acid used is recorded. The volume of acid used is fitted into the formula which becomes

$$\%N = 14 \times \left\{ \frac{VA \times 0.1 \times w \times 100}{1000 \times 100} \right\}$$

VA = volume of acid used

w = weight of sample

Calculation: Percent Crude Protein (CP)

CP = % N X F

- F = 6.25 for all forages and feeds except wheat grains
- F = 5.70 for wheat grain

CHAPTER 3

RESULTS

After the breads were fully baked, they smelled nicely. The aroma was inviting and fruity. The more the mushroom powder concentration, the intense the smell of the bread. The baked loaves didn't yield much, but there was a slight difference in size in comparison to the size before they were baked. The control bread was lightly coloured while the mushroom powder breads had different shades of brown colour. The *Marasmiellus inoderma* mushroom bread had a light brown shade, the *Pleurotus ostreatus* and *Ganoderma lucidium* mushroom breads were brown and dark brown respectively. The shades seemed to differ from one concentration to another. The lesser the mushroom powder concentration, the lighter the mushroom bread appeared. The control bread which happened to be a light colored bread, had a blank taste and a crumbling texture. The control bread just had a mild smell of the flavors that was used in baking the bread which was a vanilla and special milk flavor. A bit of nutmeg was also added. The color of the mushroom bread changes in respect to the type of mushroom and the level the mushroom. The *Marasmiellus inoderma* mushroom bread were a lighter kind of brown in comparison to the *Pleurotus ostreatus* mushroom bread which was a darker kind of brown color and *Ganoderma lucidum* mushroom bread which looked black in colour. The lowest concentration appeared lighter, so, one can easily tell which Concentration was more or less amongst different mushroom breads of the same mushroom.

Attempts to baking the mushroom bread with ice cold water were made but the results didn't turn out to be very effective as the dough flattened, had a slightly slimy texture and did not retain its original shape. The breads baked with room temperature water didn't flatten, maintained its original texture concentration was dry and more difficult to work with. So, the higher the mushroom powder

concentration, the dryer the dough appears. This is what resulted to the use of higher measurements of water in the bread amended with 12% *Pleurotus ostreatus* mushroom powder.

Samples of the baked mushroom bread were distributed amongst individuals some of whom were lecturers and students in the department of Plant biology and biotechnology. Subsequently, the feedback that was received from these individuals was documented. Some people also rejected tasting the bread as they seemed to not like eating mushrooms or any mushroom-related food in general for personal reasons. Different persons had their different preferences. While some persons seemed to enjoy some of the bread and tagged the others 'bitter', some students also preferred the 'bitter' breads. The main point that was concluded was that the study was quite innovative and would yield income if monetized. 34.5% and 65.5% of the persons whom tasted the bread were male (M) and female (F) respectively.

In table 7, the third percentage concentration of mushroom bread seemed to have the higher scale of preference followed by the fourth concentration bread. This is one of the reasons it was selected for the proximate analysis as it also represented a balanced ratio of mushroom bread. The *Ganoderma lucidium* mushroom breads appeared to be the only sets of breads that retained moisture as it was less crumbling and soft. *Ganoderma lucidium* mushroom breads were quite dark in appearance hence, was not every enticing to eat.

Table 5: Effect of the Mushroom Powder on the Taste of the Bread.

PC		M (%)		P (%)		G (%)	
		M	F	M	F	M	F
1	GOOD	100	75	100	50	100	50
	FAIR	-	25	-	50	-	33.50
	BITTER	-	-	-	-	-	12.50
2	GOOD	100	87.50	100	87.5	100	25
	FAIR	-	12.50	-	12.5	-	25
	BITTER	-	-	-	-	-	-
3	GOOD	100	100	66.66	75	33.33	12.50
	FAIR	-	-	-	25	33.33	-
	BITTER	-	-	-	-	-	-
4	GOOD	100	75	66.66	37.50	33.33	12.50
	FAIR	-	75	-	37.50	33.33	-
	BITTER	-	-	-	25	-	66.66
C	GOOD	33.33	50				
	FAIR	66.66	50				

(*Key: M = *Marasmiellus inoderma* mushroom bread, P = *Pleurotus ostreatus* mushroom bread, G = *Ganoderma lucidium* mushroom bread, C = Control bread, PC = Percentage concentration, M = Male, F = Female).

Table 6: Effect of the Mushroom Powder on the Texture of the Bread.

PC		M (%)		P (%)		G (%)	
		M	F	M	F	M	F
	GOOD	100	75	100	50	100	100
1	FAIR	-	25	-	50	-	-
	GOOD	100	87.50	100	37.50	100	100
2	FAIR	-	12.50	100	62.50	-	-
	GOOD	100	100	100	-	100	100
3	FAIR	-	-	-	100	-	-
	GOOD	100	37.50	66.66	-	100	100
4	FAIR	-	62.50	33.33	100	-	-
C	GOOD	33.33	50				
	FAIR	66.66	50				

(*Key: M = *Marasmiellus inoderma* mushroom bread, P = *Pleurotus ostreatus* mushroom bread, G = *Ganoderma lucidium* mushroom bread, C = Control bread, PC = Percentage concentration, M = Male, F = Female).

Table 7: Effect of the Mushroom Powder on the Aroma and Acceptability of the Bread.

PC		M (%)		P (%)		G (%)	
		M	F	M	F	M	F
	GOOD	100	75	100	50	33.33	50
1	FAIR	-	37.50	-	50	66.66	50
	GOOD	100	87.50	100	50	33.33	25
2	FAIR	100	12.50	-	50	66.66	75
	GOOD	100	100	100	62.50	33.33	12.50
3	FAIR	-	-	-	37.50	66.66	87.50
	GOOD	100	100	100	87.50	33.33	12.50
4	FAIR	-	-	-	-	66.66	87.50
C	FAIR	100	100				

(*Key: M = *Marasmiellus inoderma* mushroom bread, P = *Pleurotus ostreatus* mushroom bread, G = *Ganoderma lucidium* mushroom bread, C = Control bread, PC = Percentage concentration, M = Male, F = Female).

The Control bread took about eight days to develop mold, which is a longer period of time compared to the mushroom breads which in about six days developed mold.

It appeared that the more abundant the mushroom powder is, the higher the tendency to grow more mold. For instance, the lowest mushroom breads, that is, the M1, P1 and G1, grew mold in certain spots in comparison to the M4, P4 and G4 which grew mold enough to cover the entire bread.

Table 8: The proximate composition of the bread amended with 6% concentration *Marasmiellus inoderma* mushroom powder.

Parameters	Amount
Moisture	25.10
Dry matter	74.93
Crude fat	22.23
Crude protein	9.99
Crude fibre	0.53
Crude ash	1.70
Carbohydrate	45.45

Plate 1: Samples of the bread unmeliorated with mushroom powder.

Plate 2: Samples of bread amended with 6% concentration of *Marasmiellius inoderma* mushroom powder.

Plate 3: Samples of bread amended with 4% concentration of *Pleurotus ostreatus* mushroom powder.

Plate 3: Samples of bread amended with 4% concentration of *Pleurotus ostreatus* mushroom powder.

Plate 5: Sample of the breads collectively.

CHAPTER 4

DISCUSSION

The process of commercial bread baking might not efficiently support mushroom bread baking. Bread bakers use ice cold water to bake bread commercially. Yeast makes bread rise and double in size soon as water mixes with the dry ingredients to form a dough at a very fast rate. Ice cold water is added to the dough to ensure that the dough rises after it has been placed in the pan and ready for proofing. The ice cold water makes all the dough no matter how much it is, rise at the same time. It makes the dough become cold thereby halting the process of rising as yeast only rise in a warm environment.

A blend component called a bread improver, sometimes referred to as a dough enhancer, serves to raise the quality of bread and enzymes, ascorbic acid, and emulsifier are the common ingredients. The bread rises more quickly thanks to the enzymes in the improver. By fortifying the gluten structure, ascorbic acid gives the bread more volume and keeps it from collapsing. Ascorbic acid aids in the gas-trapping process resulting in snatching the minute gas bubbles that produce huge holes in bread dough after baking. Emulsifiers aid in increasing dough resistance. Emulsifier maintains the product's quality throughout the manufacturing process by preventing fat breakdown and keeping moisture in the dough. The dough goes through a variety of steps throughout baking, including mixing, scaling, proofing, baking, and slicing, the bread will not maintain its quality after the dough has undergone a great deal of stress, which is the reason emulsifier was invented. Using bread improvers helps to produce a trouble-free process and makes big scale production done with ease and very quickly. When baking on a large scale, the complexity of the entire baking process may actually effect the bread quality. Bread softner is used to ensure the dough maintains its texture even after a number of days. The mushroom bread had a denser or thicker texture compared to the

bread not amended with mushroom powder, it might be helpful to bake the bread without the improver as it feels almost unnecessary. Mushroom powder improve the smell and enhance the color of bread, thereby making it look appealing and reducing the application of food dye in bread making.

In as much as the bread needed to taste good, it was important to be mindful that excess sugar consumption is injurious to health. Sugar is effective in bread making as it tends to increase the activity rate of the yeast. Two little sugar content can decrease the yield of the bread. This may have been what resulted to the low yield of the yeast as stated earlier. The bread is able to sit in the freezer and if kept frozen for up to two months.

The known moisture content in bread is 35%, protein content 11%, carbohydrate 49%, total fat 0.032%, 0.027% fibre and for ash varies between 45% - 55%. In comparison to the results from the proximate analysis, the mushroom bread have higher fat and fibre content. The moisture, carbohydrate, ash and protein contents were quite lower than that of normal bread.

The result of the proximate analysis of bread contains between 27.22% - 29.05% moisture, 1.32% - 1.77% ash, 9.13% - 9.79% crude protein, 1.64% - 4.50% crude fat content, 0.10% - 0.23% crude fiber, and 55.89% - 59.40% carbohydrate in a work by Ojo, *et al.* (2021). The above stated results were gotten from samples of bread produced in local bakeries in Ogbomosho, Oyo state, Nigeria. In comparison, the moisture of the mushroom bread is lower and dry matter seems very high which accounts for the reason the bread is crumbly and dry. Moisture tends to increase bread appearance, shelf-life and resistance to contamination. Fat appears to be very high, though it is required to enhance the gluten structure, it might not be necessary in this context as it might increase chances of obesity and heart diseases. The mushroom bread seems to have higher fibre content as fibre aids digestion and production of vital intestinal bacteria. Ash is the residual of incineration, the ash content appears to be minimal. Breads have carbohydrate content as high as 59.40%, but mushroom

bread contains a lower carbohydrate content of 40.45%. this represents a healthier version and serves as a better alternative to bread for obsessed, diabetic and people who are interested in weight loss or lesser carbs intake. Mushroom bread also have a richer protein content which aids oxygen transport, maintains immune function and muscle tissues. The growing demand for healthier and more ecologically friendly food options is in line with the research on sustainable culinary innovation as well as providing an healthier alternative to other bread variants.

CONCLUSION

In conclusion, this study evaluates the acceptability, palatability, nutritional composition and the shelf-life mushroom powder in mushroom bread for nutritional enrichment, potential health benefits and culinary innovation and diversity. It examines the nutritional worth of mushroom bread comparing it to traditional bread, paying close attention to crucial elements like protein content, dietary fiber, and carbohydrate content. It is recommended that further studies are carried out to properly unravel more information about mushroom bread.

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