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# Study of the Sensory Evaluation, Nutritional and Microbiological Status of Novel *Pleurotus ostreatus*, Meat, Fish and Beans Pies Produced in Delta State

Otali, Cyril Chinedu[1*]; Okoye, Simonpeter Uche[2]

[1]Department of Science Laboratory Technology, Federal Polytechnic, Orogun, Delta State, Nigeria.

Corresponding Author: Otali, Cyril Chinedu[1*]

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**Abstract: The White Oyster Mushroom (*Pleurotus ostreatus)* pie is a pastry filled with minced mushroom and other ingredients made as a snack, likened to meat pie; a popular snack over the world and it's sold as a street-vended ready-to-eat food. This study assessed the sensory, nutritional and microbiological evaluation of mushroom pie with respect to other pies: the meat, fish and beans pies. A total of 480 samples were analysed for sensory evaluation, microbiological quality and nutritional status. The mushroom pie scores the highest mean value of appearance, flavour, aroma and taste with 8.65, 9.00, 8.90 and 8.85 respectively. Based on the outcome of result, the novel mushroom pie is well accepted as snack by the panellists. The mean total viable count ranged between $2.3 \times 10^5$ and $4.7 \times 10^6$ CFU/g. The identified isolates were *Staphylococcus* sp, *Enterobacter* sp, *Bacillus* sp, *Micrococcus* sp and *Enterococcus* while fungal isolates are *Rhizopus stolonifera*, *Aspergillus* sp, *Mucor* sp, *Saccharomycess* sp and *Penicillium notatum*. The nutritional analysis revealed that meat pie has 16.71% crude protein, mushroom pie has 16.26% while beans pie and fish pie have 12.48% and 13.67% respectively. Makers of snacks such as meat pie are hereby encouraged to make mushroom pie for public consumption.**

***Keywords:*** *Pleurotus ostreatus, Mushroom Pie, Meat Pie, Fish Pie, Beans Pie.*

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## I. INTRODUCTION

The consumption of snacks such as meat pies, sausage rolls, egg rolls etc are popular ready-to-eat snack in Nigeria and many parts of the world, is widespread due to their convenience, palatability, and affordability. The *Pleurotus streatus* (White Oyster mushroom) is being explored in designing a new food product (snacks) like the common meat pie and other pies. Food processors engage in new product development with the hopes of gaining new customers, expanding into new geographic markets, increasing profits, elevating brand excitement, or increasing market shares (Aramouni and Deschenes, 2015). Companies use varying techniques to generate ideas for new products and mushroom pie is a new product that need be explored and introduced into the snacks industry (Aramouni and Deschenes, 2015).

Miles and Chang 1997 defined Mushroom as A macro-fungus characterised by a prominent fruiting body, which can be either epigeous (above ground) or hypogeous (below ground), large enough to be visible to the human eye and capable of being collected by hand. Mushrooms are adaptable fungi which yields lots of nutritional and health benefits (Kratika, 2018). This research work explores the development of a novel mushroom product. Sensory testing is crucial for assessing new products, ensuring they meet consumer preferences and maintain quality (Aramouni and Deschenes, 2015). The consumption of snacks such as meat pies, sausage rolls, egg rolls etc are popular ready-to-eat snack in Nigeria and many parts of the world, is widespread due to their convenience, palatability, and affordability. Mushroom is considered as value addition to make snacks refer to as mushroom pie. However, their safety remains a public health concern. Mushroom pies can harbor various microorganisms introduced through ingredients, poor handling, inadequate cooking, or storage, posing risks to consumers. Assessing their microbiological quality is critical in understanding contamination risks and guiding food safety interventions.

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Meat and mushroom pies are savoury pastries filled with meat and mushrooms, along with other tasty ingredients. Meat pie is a favoured snack due to its palatability, moisture, and lack of crumbs when consumed, provided it is properly made.

Ready-to-Eat (RTE) foods are those consumed immediately after purchase or preparation without requiring further cooking or processing to eliminate pathogens (Mengistu *et al*., 2022). They encompass a wide variety of products from meat pies and fried snacks to sandwiches and fruit sold in diverse settings such as streets, markets, cafeterias, and vending machines (Mengistu *et al*., 2022). Due to their nature, RTE foods present unique microbiological risks: any contamination during preparation, handling, or storage remains viable at the point of consumption.

The study aimed to determine the microbiological safety, nutritional status and consumer acceptance of novel mushroom pie in relation with meat, fish and beans pies.

## II. MATERIALS AND METHODS

➢ *Study Area*

The research was performed in the Science Laboratory Technology (SLT) at the Federal Polytechnic Orogun, Delta State, Nigeria. Orogun is in Ugheli North Local Government having a geographical index coordinate as 5° 41' 0" North, 6° 11' 0" East (Ralph *et al*., 2025). Orogun is bordered to the east by Abbi and Amai, to the north by Abraka, to the west by Eku, Kokori, and Agbara, and to the south by Emevor and Owhelogbo (Otali *et al*., 2025).

➢ *Experimental Materials*

The experimental materials include an oven, meat grinder, flour mixer, and essential ingredients like as salt, spices, and seasonings, as well as Irish potatoes, all sourced from Orogun Town Market. Sample preparation entailed combining 4 kg of beef (interchanged with mushroom, beans, and fish for alternative pies) with 0.5 kg of Irish potatoes, processed using a meat grinder, and kept in two distinct bowls. Each sample was allocated 45 g of pepper, 250 g of flour, 5 g of table salt, 10 g of Maggi, 110 g of freshly shredded onion, 70 ml of frying oil, and 10 g of baking powder in identical amounts. The pies were thereafter encased for shape and placed in the oven, preheated at 80°C for 25 minutes. Preparation of Samples: Four kilos of beef, mixed with mushrooms, beans, and fish for additional pies, was amalgamated with 0.5 kilograms of Irish potatoes, processed using a meat grinder, and kept in two distinct bowls. Forty-five grams of pepper, two hundred fifty grams of flowers, five grams of table salt, ten grams of Maggi, one hundred ten grams of freshly shredded onion, seventy millilitres of cooking oil, and ten grams of baking powder were combined into two distinct samples of meat in equal proportions. The pies were placed into the casing for shaping, then positioned in an oven set to 80°C for 25 minutes.

- Data Collection: The samples of mushroom, beef, beans, and fish pies were evaluated by a set of semi-trained panels, utilising a Nine-Point Hedonic Scale and a quantitative descriptive analytic scale.

➢ *Preparation of Media and Diluents*

Nutrients Agar, Eosin Methylene Blue Agar, Cetrimide Agar, Sabouraud Dextroxe Agar and Mannitol Salt Agar were prepared according to Cheesbrough (2000). Physiological saline was prepared by dissolving 9.8 g of sodium chloride in 1 litre of distilled water and dispensed in 90 ml/9 ml portion followed by sterilization at $121^0$C in an autoclave (Sharma, 2000; Cheesbrough, 2000).

➢ *Inoculation and Incubation*

Ten grams (10 g) of different baked products (beans pie, fish pie, meat pie and mushroom pie) were weighed into 90 ml of sterile diluents and subsequently diluted serially in 9 ml diluents until desired dilution was obtained. One-tenth of dilution $10^6$ was inoculated into nutrient agar plate and same quantity from $10^4$ was inoculated into other media, spread plated and incubated at $37^0$C for 24 h for bacterial growth and 72 h for moulds growth.

➢ *Enumeration and Characterization and Identification*

Plate count was done using electronic/digital colony counter and colonies expressed as total colony forming units/gram (Cfu/g). Colonial, microscopic and biochemical characterization was carried out according to methods of Beishir (1987), Sharma (2003), Chessbrough (2000), Barnett and Hunter (2000) and Harrigan and MacCance (2000). Identities of the isolates were confirmed with reference to Buchanan and Gibbons (1994), Barrow and Feltham (1993).

➢ *Data Analysis*

All data about consumer acceptance were evaluated using descriptive statistics, whereas preference and sensory qualities were assessed using the General Linear Model in SPSS version 2016.

## III. RESULTS AND DISCUSSION

➢ *Results*

Table 1 Total Counts and Colonial Characteristics of Bacteria Isolated on Mannitol Salt Agar

| Sample code | Total Colony Counts (Cfu/g) | Colony Types | Colonial Characteristics | Most Probable Identity |
|---|---|---|---|---|
| MSP1 | $1.5 \times 10^6$ | MSPx | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| MSP2 | $1.55 \times 10^6$ | | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |

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| | | | | |
|---|---|---|---|---|
| MSP3 | 1.05 x $10^6$ | | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| MSP4 | 2.15 x $10^6$ | | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| | | | | |
| FHP1 | 8.0 x $10^5$ | FHP1x | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| FHP2 | 7.0 x $10^5$ | FHP2x | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| FHP3 | 2.0 x $10^6$ | FHP3x | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| FHP4 | 2.2 x $10^6$ | FHP4x | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| | | | | |
| BNP1 | No Growth | | | |
| BNP2 | No Growth | | | |
| BNP3 | 2.5 x $10^5$ | BNP3x | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| BNP4 | 2.0 x $10^5$ | BNP4x | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| | | | | |
| MTP1 | 3.85 x $10^6$ | MTP1x<br><br><br>MTP1y | Tiny, glossy, wet, and smooth golden colonies<br>Mucoid and slimy light pink colonies | *Staphylococcus sp*<br><br>*Staphylococcus sp* |
| MTP2 | 2.65 x $10^6$ | MTP2x | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| MTP3 | 4.0 x $10^6$ | MTP3x | Tiny, glossy, wet, and smooth golden colonies | *Staphylococcus sp* |
| MTP4 | 2.95 x $10^6$ | MTP4x<br><br><br>MTP4y | Tiny, glossy, wet, and smooth golden colonies<br>Mucoid and slimy light pink colonies | *Staphylococcus sp*<br>*Staphylococcus sp* |

Analysis was Done in Duplicate and the Mean Value Obtained.

Table 2 Total Counts and Colonial Characteristics of Bacteria Isolated on Eosin Methylene Blue Agar

| **Sample code** | **Total Colony Counts (Cfu/g)** | **Colony Types** | **Colonial Characteristics** | **Most Probable Identity** |
|---|---|---|---|---|
| MSP1 | Zero Increase | | | |
| MSP2 | Zero Increase | | | |
| MSP3 | Zero Increase | | | |
| MSP4 | Zero Increase | | | |
| | | | | |
| FHP1 | 1.5 x $10^4$ | FHP1a | Coarse, textured bright pink colonies | *Enterobacter* sp |
| FHP2 | Zero Increase | | | |
| FHP3 | Zero Increase | | | |
| FHP4 | Zero Increase | | | |
| | | | | |
| BNP1 | Zero Increase | | | |
| BNP2 | Zero Increase | | | |
| BNP3 | Zero Increase | | | |
| BNP4 | Zero Increase | | | |
| | | | | |
| MTP1 | Zero Increase | | | |
| MTP2 | Zero Increase | | | |
| MTP3 | Zero Increase | | | |
| MTP4 | Zero Increase | | | |

Analysis was done in duplicate and the mean value obtained.

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Table 3 Total Counts and Colonial Characteristics of Bacteria Isolated on Nutrient Agar

| Sample code | Total Colony Counts (Cfu/g) | Colony Types | Colonial Characteristics | Most Probable Identity |
|---|---|---|---|---|
| MSP1 | 21.65 x $10^6$ | MSP1u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | MSP1v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | MSP1w | Rough mucoid and slimy cream colonies | *Bacillus* sp |
| | | MSP1x | Smooth moist and shiny cream colonies | *Enterococcus* sp |
| | | MSP1y | Small circular moist and shiny yellow colonies | *Micrococcus* sp |
| MSP2 | 1.9 x $10^6$<br>1.0 x $10^6$ | MSP2u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | MSP2v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | MSP2w | Rough mucoid and slimy cream colonies | *Bacillus* sp |
| | | MSP3x | Smooth moist and shiny cream colonies | *Enterococcus* sp |
| MSP3 | 1.7 x $10^6$ | MSP3u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | MSP3v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | MSP3w | Rough mucoid and slimy cream colonies | *Bacillus* sp |
| | | MSP3x | Smooth moist and shiny cream colonies | *Enterococcus* sp |
| | | MSP3y | Tiny, glossy, wet, and smooth golden colonies | *Micrococcus* sp |
| MSP4 | 1.7 x $10^6$ | MSP4u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | MSP4v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | MSP4w | Smooth moist and shiny cream colonies | *Enterococcus* sp |
| | | | | |
| FHP1 | 5.25 x $10^6$ | FHP1u | Small smooth moist and shiny low convex golden yellow colonies | *Staphylococcus* sp |
| | | FHP1v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | FHP1w | Rough mucoid and slimy cream colonies | *Bacillus* sp |
| | | FHP1x | Smooth moist and shiny cream colonies | *Enterococcus* sp |
| FHP2 | 1.7 x $10^6$ | FHP2u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |

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| | | | | |
|---|---|---|---|---|
| | | FHP2v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | FHP2w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | FHP2x | | *Enterococcus* sp |
| FHP3 | 3.35 x $10^6$ | FHP3u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | FHP3v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | FHP3w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | FHP3x | | *Enterococcus* sp |
| FHP4 | 13.2 x $10^6$ | FHP4u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | FHP4v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | FHP4w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | FHP4x | | *Enterococcus* sp |
| BNP1 | 7.1 x $10^6$ | BNP1u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | BNP1v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | BNP1w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | BNP1x | Small circular moist and shiny yellow colonies | *Enterococcus* sp |
| | | BNP1y | | *Micrococcus* sp |
| BNP2 | 3.2 x $10^6$ | BNP2u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | BNP2v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | BNP2w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | BNP2x | Small circular moist and shiny yellow colonies | *Enterococcus* sp |
| | | BNP2y | | *Micrococcus* sp |
| BNP3 | 4.05 x $10^6$ | BNP3u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | BNP3v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | BNP3w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |

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| | | | | |
|---|---|---|---|---|
| | | BNP3x | Small circular moist and shiny yellow colonies | *Enterococcus* sp |
| | | BNP3y | | *Micrococcus* sp |
| BNP4 | 2.85 x $10^6$ | BNP4u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | BNP4v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | BNP4w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | BNP4x | Small circular moist and shiny yellow colonies | *Enterococcus* sp |
| | | BNP4y | | *Micrococcus* sp |
| MTP1 | 5.1 x $10^6$ | MTP1u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | MTP1v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | MTP1w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | MTP1x | | *Enterococcus* sp |
| MTP2 | 2.75 x $10^6$ | MTP2u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | MTP2v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | MTP2w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | MTP2x | | *Enterococcus* sp |
| MTP3 | 2.6 x $10^6$ | MTP3u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | MTP3v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | MTP3w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | MTP3x | | *Enterococcus* sp |
| MTP4 | 65.85 x $10^6$ | MTP4u | Tiny, glossy, wet, curved, and smooth golden colonies | *Staphylococcus* sp |
| | | MTP4v | Dull and dry serrated flat cream colonies | *Bacillus* sp |
| | | MTP4w | Rough mucoid and slimy cream colonies<br>Smooth moist and shiny cream colonies | *Bacillus* sp |
| | | MTP4x | | *Enterococcus* sp |

Analysis was Done in Duplicate and the Mean Value Obtained.

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Table 4 Total Counts and Colonial Characteristics of Bacteria Isolated on Cetrimide Agar

| Sample code | Total Colony Counts (Cfu/g) | Colony Types | Colonial Characteristics | Most Probable Identity |
|---|---|---|---|---|
| MSP1 | Zero Increase | | | |
| MSP2 | Zero Increase | | | |
| MSP3 | Zero Increase | | | |
| MSP4 | Zero Increase | | | |
| | | | | |
| FHP1 | Zero Increase | | | |
| FHP2 | Zero Increase | | | |
| FHP3 | Zero Increase | | | |
| FHP4 | Zero Increase | | | |
| | | | | |
| BNP1 | Zero Increase | | | |
| BNP2 | Zero Increase | | | |
| BNP3 | Zero Increase | | | |
| BNP4 | Zero Increase | | | |
| | | | | |
| MTP1 | Zero Increase | | | |
| MTP2 | Zero Increase | | | |
| MTP3 | Zero Increase | | | |
| MTP4 | Zero Increase | | | |

Table 5 Total Counts and Colonial Characteristics of Bacteria Isolated on Sabouraud Dextrose Agar

| Sample code | Total Colony Counts (Cfu/g) | Colony Types | Colonial Characteristics | Microscopic Characteristics | Identity of Isolates |
|---|---|---|---|---|---|
| MSP1 | $5.0 \times 10^5$ | MSP1a<br><br>MSP1b | White fluffy cotton wool like colony<br><br>Light browns spores on wrinkled mycelia with yellow reverse side | Hyphae non septate. Spores enclosed in a sporangium<br><br>Hyphae septate. Conidia globosed | *Rhizopus stolonifer*<br><br>*Aspergillus* sp |
| MSP2 | Zero Increase | | | | |
| MSP3 | Zero Increase | | | | |
| 5MSP4 | Zero Increase | | | | |
| | | | | | |
| FHP1 | $4.0 \times 10^5$ | FHP1a<br><br>FHP1b | White fluffy cotton wool like colony<br><br>Short white mycelia | Non septate hyphae. Spores enclosed in a sporangium, sporangiophore septate | *Rh. Stolonifer*<br><br>*Mucor* sp |
| FHP2 | Zero Increase | | | | |
| FHP3 | Zero Increase | | | | |
| FHP4 | Zero Increase | | | | |
| | | | | | |
| BNP1 | Zero Increase | | | | |
| BNP2 | Zero Increase | | | | |
| BNP3 | Zero Increase | | | | |
| BNP4 | Zero Increase | | | | |
| | | | | | |
| MTP1 | $1.0 \times 10^6$ | MTP1a<br><br>MTP1b | Smooth moist and shiny butyrous cream colonies | Large spherical Gram positive budding cells | *Saccharomyces* sp<br><br>*Rh. Stolonifer* |

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| | | | | | |
|---|---|---|---|---|---|
| | | MTP1c | Green spores enclosed in a white wrinkled mycelia | Hyphae septate. Conidia arranged like mop head | *Penicillium notatum* |
| MTP2 | Zero Increase | | | | |
| MTP3 | Zero Increase | | | | |
| MTP4 | Zero Increase | | | | |

Analysis was Done in Duplicate and the Mean Value Obtained.

Table 6 Colonial and Microscopic Characteristics of Bacterial Isolates

| Spore Formation | Motility | Gram Reaction | Gram Morphology | Probable identity |
|---|---|---|---|---|
| - | - | +S | Cocci predominantly in clusters, few in tetrads and pairs | *Staphylococcus* sp |
| - | - | +S | Cocci predominantly in tetrads, few in clusters | *Micrococcus* sp |
| + | + | +R | Large rods with central spores in short chains | *Bacillus* sp |
| - | - | +S | Cocci predominantly in long chains, few in pairs | *Enterococcus* sp |
| + | + | +R | Short rods in chains, spores subterminal | *Bacillus* sp |
| - | - | -R | Short rods in chains and pairs | *Enterobacter* sp |

R, Rod Shaped; S, Spherical or Cocci/Round Shaped

Table 7 Biochemical and Sugar Fermentation Characteristics of Bacterial Isolates

| **$NO_3$ reduction** | **Cit** | **Ure** | **Oxi** | **Cat** | **Coag** | **In** | **MR** | **VP** | **S** | **L** | **G** | **M** | **Identity of isolates** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| + | - | - | - | + | + | - | - | + | + | + | + | + | *Staphylococcus aureus* |
| - | - | - | - | - | - | - | + | - | + | + | + | + | *Staphylococcus epidermidis* |
| + | + | - | - | + | - | - | + | - | + | + | + | - | *Enterobacter* sp |
| + | + | - | - | + | - | - | - | + | - | - | + | - | *Bacillus cereus* |
| - | + | + | - | + | - | - | + | - | - | - | - | - | *Micrococcus luteus* |
| + | + | - | - | + | - | - | - | + | + | - | + | - | *Bacillus subtilis* |
| - | + | - | - | - | - | - | + | - | + | + | + | | *Enterococcus* sp |

$NO_3$, Nitrate Reduction Test; Cit, Citrate; Ure, Urease; Oxi, Oxidase Test; Cat, Catalase Test; Coag, Coagulase Test; In, Indole Test; MR, Methyl Red Test; VP, Voges Proskaeur Test; S, Sucrose; L, Lactose; G, glucose; M, Maltose; nd, Not Done.

The microbiological analysis of the mushroom, beef, fish, and bean pies revealed a broad assortment of bacteria and fungi present in the samples. The identified bacteria consisted of *Staphylococcus* sp, *Enterobacter* sp, *Bacillus* sp, *Micrococcus* sp, and *Enterococcus*, whilst the fungal isolates included *Rhizopus stolonifer*, *Aspergillus* sp, *Mucor* sp, *Saccharomyces* sp, and *Penicillium notatum.* The presence of these organisms in mushroom, beef, fish, and bean pies exemplifies a regrettable state of insufficient hygiene and sanitation practices used in the preparation and packaging of these treats. The findings demonstrate that the mushroom pie has the greatest bacterial variety, with isolates such as *Staphylococcus* sp, *Enterobacter* sp, *Bacillus* sp, *Micrococcus* sp, and *Enterococcus.* The meat pie samples were infected with *Escherichia coli*, *Staphylococcus* sp, and *Bacillus* sp; nonetheless, the bacterial levels remained below the permitted range for items considered safe for human consumption. *Escherichia coli* and *Staphylococcus aureus* are categorised as commensal microorganisms in humans and animals. Their presence in food products indicates extensive human intervention (WHO, 2002). This study corroborates the results of Adesiyun (1995) and Okonko *et al*. (2009), demonstrating that meals exposed to human contact, regardless of being cooked or uncooked, were mostly infected with *Escherichia coli* and *Staphylococcus aureus*. Their claim suggested that the detection of *Escherichia coli* in food products indicates faecal contamination of the water sources used in snack preparation. The presence of *Bacillus cereus* in the pie samples may be attributed to insufficient handling of raw materials during the harvesting and preparation phases (WHO, 2002). All four detected bacteria from the pie samples have been associated with severe foodborne illnesses.

The vendors' environmental and handling conditions were recorded. The research demonstrated that the mushroom pie samples exceeded the allowable thresholds for microbial load in ready-to-eat meals. The average overall viable count ranged from $2.3 \times 10^5$ to $4.7 \times 10^6$ CFU/g. *Staphylococcus aureus* was the primary bacterium isolated, followed by *E. coli*. The bacterial load suggests inadequate handling and insufficient temperature regulation. Vendors frequently exhibited a deficiency in fundamental food safety knowledge, and the majority functioned in unsanitary conditions. The research indicated that the mushroom pie samples surpassed the permissible thresholds for microbial load in ready-to-eat meals. The average overall viable count varied from $2.3 \times 10^5$ to $4.7 \times 10^6$ CFU/g. *Staphylococcus aureus* was the predominant organism isolated, succeeded

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by *E. coli*. The bacterial burden signifies improper handling and insufficient temperature regulation. Vendors often exhibited a deficiency in fundamental food safety knowledge, and the majority functioned in filthy conditions. The findings underscore the urgent need for public health interventions, improved hygiene training for food handlers, and stricter regulatory enforcement to ensure food safety in the street food sector. The handling of meat pies, including preparation, storage, and distribution, significantly influences microbial quality. Poor water quality, contaminated utensils, improper refrigeration, and inadequate personal hygiene among vendors have been identified as major contributors to contamination (Clarence *et al*., 2014; Eke and Elechi, 2021). This is consistent with findings from the study by Mepba *et al*. (2017) in Port Harcourt, where *Bacillus* spp. and *Klebsiella* spp. were frequently isolated, and food handling methods were observed to play a major role in determining microbial loads.

The findings in this study corroborate with international data, such as the UK assessment by McLauchlin *et al*., (2016), which examined 862 meat pies and found 6% of them either borderline or unsatisfactory due to elevated levels of *Bacillus* spp. Similarly, Lubna and Ghada (2012) observed the presence of *Staphylococcus aureus* in 82.5% of meat pies. In the Nigerian context, multiple studies point to the endemic nature of microbial contamination in street-vended mushroom pies. Kigigha *et al*., (2017), in a study conducted in Yenagoa, reported total heterotrophic bacterial counts ranging from $2.5 \times 10^3$ to $1.07 \times 10^4$ CFU/g, with predominant isolates including *Staphylococcus aureus*, *Escherichia coli*, *Micrococcus*, *Bacillus*, *Proteus*, and *Pseudomonas*. These findings are supported by Ernest *et al*., (2017), who found E. *coli* (39%), S. *aureus* (35%), and B. *cereus* (26%) in meat pie samples from Onitsha. Clarence, *et al*., (2014) reported similar results in Benin City, with microbial loads ranging between $8 \times 10^3$ and $3.8 \times 10^4$ CFU/g depending on storage conditions, and the presence of six different bacterial genera.

Table 8 Result for Sensory Evaluation of MTP

| S/No. | Attributes | Number of Judges | Total Points | Mean Value |
|---|---|---|---|---|
| 1. | Features | 20 | 161 | 8.05 |
| 2. | Flavour | 20 | 159 | 7.95 |
| 3. | Scent | 20 | 152 | 7.60 |
| 4. | Feel | 20 | 178 | 8.90 |
| 5. | Taste | 20 | 176 | 8.80 |
| 6. | Overall Acceptability | 20 | 176 | 8.80 |

Table 9 Result for Sensory Evaluation of MSP

| S/No. | Attributes | Number of Judges | Total Points | Mean Value |
|---|---|---|---|---|
| 1. | Features | 20 | 178 | 8.65 |
| 2. | Flavour | 20 | 180 | 9.00 |
| 3. | Scent | 20 | 178 | 8.90 |
| 4. | Feel | 20 | 178 | 8.90 |
| 5. | Taste | 20 | 177 | 8.85 |
| 6. | Overall Acceptability | 20 | 176 | 8.80 |

Table 10 Result for Sensory Evaluation of FHP

| S/No. | Attributes | Number of Judges | Total Points | Mean Value |
|---|---|---|---|---|
| 1. | Features | 20 | 165 | 8.25 |
| 2. | Flavour | 20 | 151 | 7.55 |
| 3. | Scent | 20 | 143 | 7.15 |
| 4. | Feel | 20 | 144 | 7.20 |
| 5. | Taste | 20 | 148 | 7.40 |
| 6. | Overall Acceptability | 20 | 148 | 7.40 |

Table 11 Result for Sensory Evaluation of BNP

| S/No. | Attributes | Number of Judges | Total Points | Mean Value |
|---|---|---|---|---|
| 1. | Features | 20 | 155 | 7.75 |
| 2. | Flavour | 20 | 136 | 6.80 |
| 3. | Scent | 20 | 127 | 6.35 |
| 4. | Feel | 20 | 125 | 6.25 |
| 5. | Taste | 20 | 119 | 5.95 |
| 6. | Overall Acceptability | 20 | 119 | 5.95 |

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Table 12 Result of Proximate Analysis

| Parameters | Crude protein Mean±Std Value | Crude fat Mean±Std Value | Ash Mean±Std Value | Carbohydrates Mean±Std Value | Crude fibre Mean±Std Value | Moisture Mean±Std Value |
|---|---|---|---|---|---|---|
| **MTP** | 16.706±0.570[a] | 6.486±0.148[b] | 9.670±0.560[a] | 49.606±0.466[a] | 8.303±0.396[ab] | 9.236±0.176[a] |
| **MSP** | 16.256±1.003[a] | 6.826±0.293[b] | 9.303±0.334[a] | 49.563±1.886[a] | 8.5706±0.468[a] | 9.100±1.064[b] |
| **BNP** | 12.473±0.500[a] | 7.083±0.823[b] | 9.303±0.334[a] | 52.563±1.886[a] | 9.570±0.468[a] | 9.096±1.066[b] |
| **FHP** | 13.666±1.419[b] | 8.966±0.737[a] | 6.866±0.115[b] | 50.433±1.686[a] | 7.433±0.550[b] | 12.633±0.152[a] |

Values are Averages ± Standard Deviation of Triplicate Determinations; Various Superscripts within the Column Indicate Significance at (P<0.05).

The mean score of the sensory evaluation of the novel mushroom, meat, fish and beans pies was based on the sensory attribute's appearance, texture, flavour, taste and over acceptability. The sample coded MSP which is *Pleurotus ostreatus* pie (the mushroom pie) and MTP which is meat pie had the highest mean score in overall acceptability with mean value of 8.80. Although, the mushroom pie scores the highest mean value of appearance, flavour, aroma and taste with 8.65, 9.00, 8.90 and 8.85 respectively. Findings revealed that 100% of the panelist agreed that all samples have snacks-consuming satisfaction.

Based on the outcome of this result, the novel mushroom pie is well accepted as snack by the panellists. Makers of snacks such as meat pie are hereby encouraged to make mushroom pie for public consumption.

The nutritional analysis revealed that meat pie has 16.71% crude protein, mushroom pie has 16.26% while beans pie and fish pie have 12.48% and 13.67% respectively. Makers of snacks such as meat pie are hereby encouraged to make mushroom pie for public consumption as it is are good source of nutrient.

## IV. CONCLUSION

The sample MSP (mushroom pie) exhibited the highest ratings in colour, flavour, taste, texture, and overall acceptance, rendering it the most favoured product among the panellists. The results indicated that all sensory parameters of the pie samples were deemed acceptable by the panellists. The results indicated that all sensory criteria of the pie samples were deemed satisfactory by the panellists.

The result of this study has shown that mushroom can be incorporated into snacks as pie with good acceptability level. The researchers therefore recommend mushroom should be used to make snacks like meat in meat pie and fish in fish pie. This will help to diversify the use of mushroom and improvement on the value chain.

- Compliance with Ethical Standards

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➢ *Disclosure of Conflict of Interest*

The researchers at no point maintain conflicts of interest throughout the research process or paper publication.

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