Physicocemical Properties and Sensory Evaluation of Patty from *Pleurotus ostreatus* Mushroom

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A proposal of final year project presented in fulfilment of the requirements for the degree of Bachelor of Applied Science (Product Development Technology) with Honours

Faculty of Agro Based Industry
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DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for higher degree to any universities or institutions.

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Physicochemical Properties and Sensory Evaluation of Patty from *Pleurotus ostreatus* Mushroom

ABSTRACT

Mushrooms became main and mostly used to replace meat-based products. In the vegan community, they use mushrooms as their replacement for chicken, beef, and other meat-based products because mushrooms have the taste and properties just like meat. This study mainly focuses on *Pleurotus ostreatus*, which is known as white oyster mushroom. The effects of different percentages of mushrooms on the physicochemical and sensory properties of patty were investigated. Formulation three has the highest protein value (11.53 ± 0.22%) compared to other formulations because the amount of mushroom was increased to 80%. Formulation 3 follows the same moisture content and ash trend but recorded the lowest fat content (0.62 ± 0.06%). The control was significantly lowest (yellowness b*) at 7.68 ± 2.536 than the developed formulation. On the other physical traits, there is no significant different (p>0.05) between the formulations 10.00 ± 0.00. Besides that, there is a signification difference (p<0.05) between the formulation and the texture profile analysis except for the springiness. In sensory evaluation formulation 1 score highest mean value in overall acceptance (5.57%). In summary, formulated patty has better results than control patty and *P. ostreatus* consumers accept mushroom patty.

Keywords: *Pleurotus ostreatus*, physicochemical properties, sensory evaluation, patty, physical traits

Sifat Fisikokimia dan Penilaian Deria Patty daripada Cendawan *Pleurotus ostreatus*

ABSTRAK

Cendawan menjadi utama dan kebanyakannya digunakan untuk menggantikan produk berasaskan daging. Dalam komuniti vegan, mereka menggunakan cendawan sebagai pengganti ayam, daging lembu dan produk berasaskan daging lain kerana cendawan mempunyai rasa dan sifat seperti daging. Kajian ini tertumpu terutamanya kepada *Pleurotus ostreatus* yang dikenali sebagai cendawan tiram putih. Kesan peratusan berbeza cendawan terhadap sifat fizikokimia dan deria patty telah disiasat. Formulasi 3 mempunyai nilai protein yang paling tinggi (11.53 ± 0.22%) berbanding formulasi lain kerana jumlah cendawan meningkat kepada 80%. Formulasi 3 mengikut trend yang sama kepada kandungan lembapan dan abu tetapi ia mencatatkan kandungan lemak terendah (0.62 ± 0.06%). Kawalan adalah paling rendah (kekuningan b*) pada 7.68 ± 2.536 daripada formulasi yang dibangunkan. Pada ciri fizikal yang lain, tidak terdapat perbezaan yang signifikan ($p>0.05$) antara formulasi 10.00 ± 0.00. Selain itu, terdapat perbezaan signifikasi ($p<0.05$) antara formulasi dan analisis profil tekstur kecuali keanjalan. Dalam rumusan penilaian deria formulasi 1 skor nilai min tertinggi dalam penerimaan keseluruhan (5.57%). Secara ringkasnya, patty yang diformulasikan mempunyai hasil yang lebih baik daripada patty kawalan dan patty cendawan *Pleurotus ostreatus* diterima oleh pengguna.

Kata kunci: *Pleurotus ostreatus,* sifat fizikokimia, penilaian deria, patty, sifat fizikal

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LIST OF ABBREVIATION AND SYMBOLS

%	Percentage
℃	Degree Celsius
g	gram
cm	centimetre

CHAPTER 1

INTRODUCTION

1.1 Research Background

Typically, burger patties are made from meat like chicken, beef, and other types of meat that contain high-fat content. In today's modern world, people are more conscious about the amount and food for health and environmental reasons. A vegetarian lifestyle and reducing intake of animal-based products have become a way of life**.** Based on a survey by Hookway, (2014), the number of vegetarians and vegans and the demand for vegetarian food has grown, which is good news for those concerned about their health (Herawati et al., 2021).

Furthermore, consumers prefer foods high in protein while being low in fat and calories. Many customers want products with high nutrition and sensory properties comparable to meat products but no actual meat. Consumers prefer products that can reliably replicate what is being substituted and, if possible, add nutritional values to meat products for a various of reasons, including personal belief and wellbeing (Sharima et al. 2018). In reality, a consumer known more about nutritional facts and takes note of labeling information on packaging concisely before buying their products. In their hectic lifestyles, customers are gravitating toward more frozen foods.

Pleurotus ostreatus is a popular Asian delicacy, with increasing yearly demand. *Pleurotus* was first cultivated in Germany as a subsistence measure for food storage during World War I, and Kaufer did the first documentation of cultivation in 1917. *Pleurotus* is a genus of cultivated mushrooms with a wide range of species. *Pleurotus* species have been identified as mushrooms that serve two purposes for humans: medicine and food. *Pleurotus ostreatus,* commonly known as Oyster mushrooms, are recommended for obese people and diabetes patients due to their nutrient density and high quality of proteins, minerals, and vitamins and their low-calorie content and lack of starch. Compounds of fungal aroma stimulate the appetite and lend a distinct flavour to mushroom dishes (Josiane et al., 2018).

The mushroom's growth is important factor that need to given attention including temperature, gases, humidity, ventilation, and light. All of the mentioned conditions have an impact on the shape and yield of mushrooms. Due to morphological variations of different specimens and similarity of isolates belonging to different species, this taxonomic confusion has always been associated with the genus. This study aims to develop a patty from *Pleurotus ostreatus* mushroom and analyse the physicochemical properties derived from *P. ostreatus* mushroom (Josiane et al., 2018).

1.2 Problem Statement

Vegetarianism was extremely popular in the United States, with an estimated 15 million adherents. There are no published statistics on the percentage of Malaysians are vegetarians. The expansion of the vegetarian meal in food markets, indicates a growing demand for vegetarian foods (Wong et al., 2011).

Besides that, there is less choice for the vegan and vegetarian community for burger patty in food markets. The sources of vegetable protein, which is mushroom as the raw material of burger patties, can be developed innovative product and replacement for the meat-based patty. The edible fungus known as oyster mushrooms, a species of *Pleurotus*, are widely farmed all over the world and particularly in India, Africa, Europe, and Southeast Asia. Oyster mushrooms are the world's third most commercially produced mushroom and 85 % of all oyster mushrooms are genus of *Pleurotus* in the world. In terms of global market share, *Pleurotus ostreatus* is second next to *Agaricus bisporus.* The species that have been cultivated in temperate and subtropical regions around the world. *Pleurotus* are the most important wood decomposers which they grow on a broader range of forest and agricultural wastes than other species. The white oyster mushroom is perishable and the shelf life 1 to 3 days at room temperature during marketing (Xiao et al., 2011).

1.3 Hypothesis

Ho: There is no significant difference between physicochemical properties and sensory evaluation in developing of *Pleurotus ostreatus* mushroom patty.

H1: There is a significant difference between physicochemical properties and sensory evaluation in developing of *Pleurotus ostreatus* mushroom patty

1.4 Significance of Study

This study was focused on the development of patty from *Pleurotus ostreatus* with some basic ingredients. This patty will be healthier and more nutritious than other patty and can be consumed by all age groups. It's also creating a new market among the vegan and vegetarian communities. It will also be one of the best meat replacements in the future.

1.5 Objective of the study

The objectives of this study are as follows:

1. To develop patty from *Pleurotus ostreatus* mushroom.
2. To analyse the physicochemical properties of patty derived from *Pleurotus ostreatus* mushroom.
3. To perform the sensory evaluation of patty derived from *Pleurotus ostreatus.*

1.6 Limitations of Study

Overall, this study was taking a month because a few weeks to find out the best formulation and another few weeks to analyse all the physicochemical properties. Due to pandemic Covid-19, the sensory evaluation might be difficult to perform to find panellist.

CHAPTER 2

LITERATURE REVIEW

2.0 *Pleurotus ostreatus* mushroom

Mushrooms are classified as functional food because it provides health benefits. *Pleurotus ostreatus* is the scientific name of white oyster mushroom. The scientific classification of *P. ostreatus* mushrooms were belongs to fungi kingdom and the phylum is Basidiomycota in the family of the *Pleurotaceae* and class of Agaricomycetes. The genus *Pleurotus.* The genus *Pleurotus* contains approximately 40 species and grows widely in subtropical areas, is tropical and easily artificially cultivated. *Pleurotus* genus includes *P. ostreatus, P. florida, P. sajor-caju, P. flabellatus, P. cystidiosus, P. highbing 51, P. sapidus, P. tuberegium, P. eryngii, P. ulmarium, P. citrinopileatus, P. pulmonarius, P. geesteranus,* and other special considerations due to their high nutritional value and medicinal significance (Pöggeler et al., 2006).

Pleurotus species is a popular edible mushroom grown in the tropics region. It only became popular in the last decade and grown in many subtropical and temperate countries. *Pleurotus* is commonly known as oyster mushroom throughout the world, but it is also known as "Dhingri" in India and "Abalone mushroom" in China. White oyster mushroom fruiting bodies were generally white colour and grew on the flat hood's edge when young, the margin is inrolled and smooth, but it is often lobed and wavy. Figure 1 shows the morphological structure of the white oyster mushroom. White oyster mushroom fruiting bodies are shallow funnel like shells.

This fungus' fruiting body consists of a stem which is stipe or stalk and cap know as pileus. The stem size varies normally between 2 and 6 cm depending on the environment and climate conditions that influence growth. The flesh is white, firm, and varies in thickness due to the arrangement of the stipes. Descend on the stalk if present and the mushroom's gills are white to cream in colour. The stipe is asymmetrical, with a lateral attachment to wood and the mushroom's spore print is white to lilac-grey (Sher et al., 2011).

Figure 1: Morphological structure of white oyster mushroom (Mudakir et al 2015)

Physical factors influencing oyster mushroom growth and production are related to nutritional requirements for oyster mushroom fruit growth. The optimal temperature for fruit formation is 12-28°C, while the optimal temperature for mycelium growth is 22-30°C. The optimum humidity during mycelium growth is between 60-80%, and the optimum humidity during fruit formation is between 80-95%, with a pH of about 6-7 for medium pH. Sawdust, rice husk, straw, cotton waste, tea leaf waste, paper waste, corn husk, and other lignocellulosic materials can all support the growth of this fungus. Due to its adaptability and storage durability white oyster mushroom (*P. ostreatus*) is the most popular among farmers in various types of cultivated oyster mushrooms. (Mudakir, 2010).

2.2 Life cycle of *Pleurotus ostreatus* mushroom

A major fungal group of *Pleurotus* mushrooms is typical of the Basidiomycetes life cycle shown in Figure 2. It starts with the germination of a basidiospore in a suitable substrate, which results in the formation of a monokaryotic mycelium with genetically identical nuclei (n) and the ability to grow indefinitely by itself. They can form a fertile dikaryon through hyphal fusion or plasmogamy when two compatible monokaryotic mycelia come into close contact. This dikaryon (n+n) contains two genetically distinct nuclei from each monokaryon throughout the mycelium, with clamp connexions and binucleate in each hyphal compartment. The dikaryotic mycelium will differentiate into fruit bodies with specialized structures known as basidia when the environmental conditions such as light, temperature and relative humidity are favorable. Karyogamy fusion of the paired nuclei which is 2n and recombination and segregation of meiosis occur in these club-shaped, binucleate cells that form in the lamellae hymenium of each fruiting body. The four haploid nuclei that result move to the basidium's sterigmata to form four new basidiospores. The sexual life cycle starts again when basidiospores are discharged while fruit bodies are mature (Adebayo & Martinez-Carrera 2015).

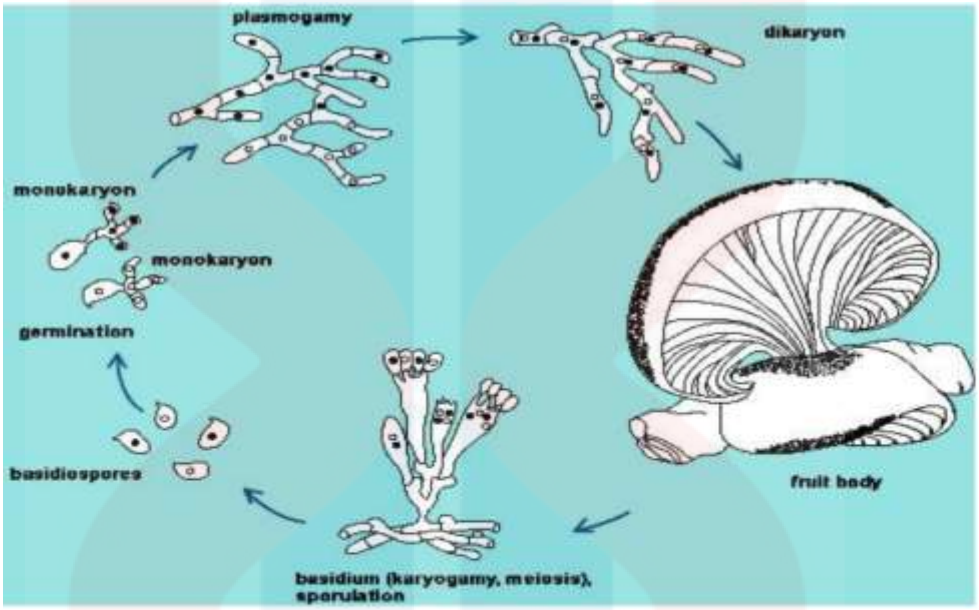

Figure 2.2: Life cycle of *Pleurotus Ostreatus* Oyster mushroom *(Adebayo & Martinez-Carrera 2015).*

2.3 Nutritional value of *Pleurotus ostreatus* mushroom

Pleurotus ostreatus has a distinct flavor and aroma. They are nutritious foods high in protein, carbohydrates, fiber, vitamins, minerals and low in fat and calories (Khan et al., 2010). A fresh *P.ostreatus* mushroom contains 85-95% of moisture. According to Saritha et al., 2009, approximately 100 different bioactive compounds are contained in the *P. ostreatus* fruiting body, which is a possible new source of dietary fiber. Non-starch polysaccharides, of which β-glucan is the most intriguing functional component and phenolic compounds are abundant in fungal cell walls such as gallic acid, protocatechuic acid, homogentisic acid, myricetin, rutin, chrysin, tocopherol like α-tocopherol, naringin, and γ- tocopherol, β-carotene o and ascorbic acid each with their own exceptional medical effects.

Protein content in *P. ostreatus* has been stated to be vary depending on the strain, physical and chemical differences in the substrate's growing medium composition, harvest time, and pileus size (Akyüz et al., 2010). *P. ostreatus* mushroom proteins are of high quality because some members of this genus contain complete proteins with a well-balanced distribution of non-essential amino acids and essential amino acid (Wang et al., 2001 & Adebayo et al., 2021). According to Oloke, (2017), mushrooms rank second to animal meats in terms of crude protein content, but far ahead of most other food such as milk which is categorist as an animal product.

Pleurotus mushrooms contain some essential fatty acids even though their low in fat. Based on different studies with different *Pleurotus* species, the fat content of dried fruit bodies ranged from 0.2 to 8 g per 100g. In *P. ostreatus*, the major monounsaturated fatty acid is Oleic acid, and the major polyunsaturated fatty acid is linoleic acid. Because of their low total lipid content and low proportion of desirable n-3 fatty acids, mushroom lipids have a limited nutritional contribution (Hossain et al., 2007).

P. ostreatus mushrooms know as a good source of fiber and carbohydrates. Carbohydrates are primarily found in *P. ostreatus* as polysaccharides that represented by glycogen and indigestible forms such as dietary fibres, chitin, cellulose, α- and β- glucans, and other hemicelluloses such as Xylans, mannans, and galactans. Pleuran is a specific β-glucan found in *P. ostreatus* which is a source of antitumor polysaccharides. Besides that, more vitamin B1, vitamin B3 and folacin contains in *P.ostreatus* but fewer vitamin B12 than other mushroom species. The vitamin content in *P.ostreatus* is Thiamin, Niacin, Riboflavin, Ascorbic acid and Folate (Mattila et al., 2000).

Copper, potassium, iron, magnesium, zinc and phosphorous contain more in pilei of *P.ostreatus* while the stipes of *P. ostreatus* contain more sodium. Various mushroom species manifest *P. ostreatus* has a higher activity of polyphenol_oxidase compound, indicating a different enzymatic activity. Rapid darkening of harvested mushrooms causes by enzyme's effect due to the catalysis of phenol compound oxidation, reducing their sensory and nutritive properties. In contrast, the darkness of a product reduces its keeping quality and thus its market value.

According to Deepalakshmi et al., 2014, *P.ostreatus* mushroom has a medicinal effects and active compounds that haves few direct human intervention trial. There is an increasing volume of *in vitro* and *in vivo* animal trials describing various potential health benefits. Figure 3 shows the pharmacological properties of *P. ostreatus.*

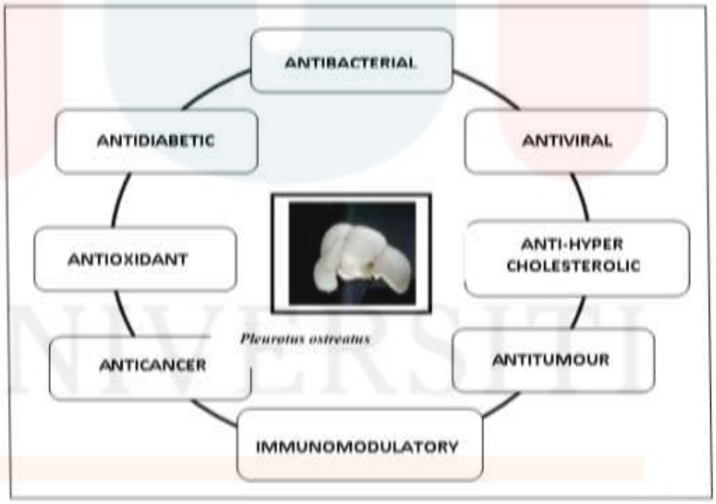

Figure 2.3 : Pharmacological properties of *P. ostreatus*

2.4 Burger Patty made off with *Pleurotus ostreatus*

2.4.1 Soy Protein Isolate (SPI)

According to the Codex Standard, soy protein products are classified based on their dry base protein content. Soy protein isolate contains 90% of protein. Soy protein isolate (SPI) is made by extracting the soluble protein and removing non-protein components such as fat and carbohydrates. It has a natural flavour and causes less flatulence than soy flours because of this process. Soy isolates are primarily used to improve texture and increase protein content, act as an emulsifier, and improve moisture retention of patty (Astawan, 2020).

Based on Danowska-Oziewicz (2014), implying that SPI can be added to patties at amounts up to 5% without compromising their quality. Higher amount of SPI in patties will be less juicy, more cohesive, and harder.

2.4.2 Cassava Flour

Cassava flour is primarily used in baking and confectionery products to substitute wheat flour at various levels. Cassava flour is made from the cassava root vegetable. This is a carbohydrate-rich vegetable containing essential vitamins and minerals (Dini et al., 2014). Cassava flour, known as -free, also withstands with frying and turns a lovely golden-brown patty. Cassava flour absorbs more liquid than wheat flour (Adam, 2021).

2.4.3 Salt

According to the Department of Food Science, Nutrition, and Health Promotion, salt has many purposes, just as natural flavours, reducing the spoilage of microorganisms and enhancing the patty aroma, colour and appearance. Salt has water-binding properties, which make the texture look smooth and firm. Salt is a food ingredient known as sodium chloride (NaCl), that is widely used in the home. However, excessive salt consumption can lead to a variety of health problems. An increase in blood pressure (hypertension) is the major health risk caused by the sodium content of common salts.

2.4.4 Bread crumb

The important role of breadcrumbs its act as coating agents who will bind the entire component. 'It's also making the patty crisp and crunchy. Bread crumb also protects the patty texture and color from the effect of reheating and freezing (Kristanti et al., 2021).

2.4.5 Canola oil

Canola is edible and industrial forms made from the seed of several cultivars of the plant family Brassicaceae, a bright, yellow-flowering plant. Canola oil, is a vegetable oil derived from a type of rapeseed that is low in erucic acid. Because of its fatty acid compositions, canola oil is regarded as a very healthy oil. Canola oil is high in polyunsaturated fatty acids and contains omega-6 fatty acid, 11% alpha-linolenic acid (ALA), an omega-3 fatty acid, and the least amount of saturated fatty acid 7%. Canola oil is one of the healthiest vegetable oils because it lowers disease risk factors and improves overall health (Barthet, 2017).

FYP FIAT

2.4.6 Paprika

Paprika is a ground spice made from a mixture of dried *Capsicum anuum* peppers, such as hot chili peppers, sweet peppers, poblano peppers, cayenne peppers, and aleppo peppers. Many different cuisines use seasoning to add colour and flavour to their dishes. Paprika is high in vitamin B6, vitamin A, and beta-carotene, all beneficial to skin health. Paprika is also high in potassium, which can aid in blood pressure reduction and blood flow (MasterClass staff, 2021).

2.4.7 Oregano

Oregano is a Mediterranean herb that has been grown for hundreds of years. Origanum vulgare meaning "joy of the mountain" in Greek, is another name for wild marjoram (MasterClass staff, 2021). Its light green leaves are used as a culinary seasoning in dry or fresh, and sensory responses include pungent, pleasantly bitter, herbaceous, and aromatic. Antioxidants are found in oregano and other herbs. Antioxidants in the diet aid the body's elimination of free radicals, which are harmful substances produced by natural processes and environmental stresses (Singletary, 2010).

2.4.8 Onion Powder

Onion powder is ground onion that has been dehydrated and is commonly used as a seasoning. Onion powder is a versatile natural flavoring that can be used in various dishes. It also goes well with garlic powder and other spices to make a wide range of savory seasonings (McCormick, 2017).

2.4.9 Garlic powder

Garlic powder is a spice made from dehydrated garlic used to enhance the flavour of food. Garlic powder is a popular addition to traditional Central Asian and European dishes because it provides the flavor of garlic without the time and effort of preparing and has a longer shelf life. Garlic is also known for its antimicrobial properties, and it is used in the treatment of a variety of viral and bacterial (Siddhi, 2020).

2.4.10 Fennel Powder

It is a Mediterranean native, and Fennel is a fragrant perennial herb with yellow flowers. Dried fennel seeds or fennel power are often used in cooking as anise flavoured spice. Fennel has a lot of health benefits, such as curing digestive problems (Lexi, 2020).

2.4.11 Tomato paste

Tomatoes are the edible berries of the *Solanum lycopersicum* plant. Tomatoes are one of the best sources of umami flavor. The tomatoes were blended and mixed well in patty. Tomato paste is a must-have pantry for whipping up delectable, deeply flavored meals, which can completely transform a bland dish (Victoria., 2019).

2.4.12 Chili

Chili is the berry-fruit of plants belonging to the nightshade family, *Solanaceae*, from the genus Capsicum. Chili is frequently used to flavor foods, particularly popular with spicy chilis (Bonaccio et al., 2019).

2.5 Proximate analysis of *Pleurotus ostreatus* mushroom patty

2.5.1 Protein Content

According to Mæhre et al., (2018) when protein content is measured based on amino acid residue analysis, it is known as direct protein determination. Usually, *P. ostreatus* contain a certain amount of protein compared to the other mushrooms.

2.5.2. Determinations of Ash

The inorganic residue left after the ignition or complete oxidation of organic matter in a food sample is called to as ash. This helps in determine the amount and type of minerals present in food, which is important because the amount of minerals present can influence the physiochemical properties of foods (Liu, 2019).

2.5.3 Determination of moisture analysis

The total solids are the dry matter that remains after moisture analysis, defined as moisture content determination. Moisture content must also be determined to calculate the content of other food constituents on a consistent and dry weight basis. The amount of moisture in a food product affects its processability, quality, and deterioration resistance. As a result, determining the moisture content of a patty accurately is critical (Nielsen, 2010).

2.5.3 Determination of Fat

Fat source analysis aims to determine the composition and quality of fat in food. It nourishes the body by providing all of the essential fatty acids that the body is unable to produce and aiding in body building. As a result, the amount of fat in our food has to be measured so that can estimate its quantity and manage our diet accordingly (Nielsen, 2017).

2.6 Physicochemical analysis of *Pleurotus ostreatus* mushroom patty

2.6.1 Determination of Color

The color measurement of patty used as an indirect measure of the consistency attributes such as flavor, taste, and texture content. Color is an important factor in determining as consumer acceptance (Berry, 1997). According to Pankaj et al. (2012), the first sensation that the user perceives and uses to accept or reject food is the appearance of the food, which is primarily determined by surface colour. Besides, the visual appearance of the product and its colour have a significant impact on a consumer's perception of the food's quality. In addition, colour is an important sensorial attribute that provides basic quality information for human perception, and it has a close relationship with quality factors like freshness, maturity, variety and desirability, and food safety, making it an important grading factor for most food products (Wu and Wen Sun, 2013).

2.6.2 Cooking yield measurement

The measurement of cooking yield to identify the changes that happens in the patty before and after cooking. The loss is in the form of a vapor that depends on the heat source's temperature (heridan et al., 2002).

2.6.3 Diameter reduction

The purpose of measure diameter reduction is to determine the amount of moisture lost and physical stability during the grilling process of the patty. (Trinh et al., 2012).

2.6.4 Changes in Thickness

Measurement of changes in thickness of patty before and after cooking because thickness of patty influences the texture quality. (Trinh et al., 2012).

2.6.5 Texture profile analysis (TPA)

The determining the textural properties of patty based on attribute of chewiness, juiciness, and hardness. A textural analysis is an important aspect for quality control and determining the taste of specific food products. It also determines the chewability index of the products. The textural properties of the product entice the consumer to taste it repeatedly. Therefore, Texture Profile Analysis (TPA) is a test to objectively measure texture parameters originally developed at the General Foods Corporation (1963). The textural properties are important for consumer acceptances and it's also influenced the quality of the food (Trinh et al., 2012).

2.7 Sensory evaluation

Statistical analysis of evaluation of consumers preference toward products uses the human senses to identify the product characteristics. The principles of experimental design apply in sensory analysis. The discipline necessitates the use of human assessor panels (Sharif et al., 2017).

CHAPTER 3

METHODOLOGY

3.1 Materials

3.1.1 Chemical and Reagents

The chemicals used for product analysis are sulphuric acid, bromocresol green, catalyst tablets for protein analysis, sodium hydroxide (NaOH), methyl red, boric acid (4%), ethanol, distilled water, petroleum ether and 0.1N hydrochloric acid (HCl) solution.

3.1.2 Raw materials

The fresh of *Pleurotus ostreatus* mushrooms were collected from Jeli, Kelantan. Salt, bread crumbs, cassava flour, paprika, oregano, onion powder, garlic powder,fennel powder, chili, and canola oil were purchased from the groceries.

3.1.3 Equipment and apparatus

The apparatus and equipment involved in this experiment were a bowls, plate, spatula, blender, knife, colander, chopping board, biodegradable packaging, beaker, weighing balance, aluminium foil, pH meter, measuring cylinder, volumetric flask, homogenizer, petri dish, glass rod, conical flask, retort stand, burette, spectrophotometer, titration, filter funnel, freezer, crucibles and incubator.

3.2 Method

3.2.1 Experimental Design

This experiment started with the cleaning process of the *Pleurotus ostreatus* mushroom. The formulations of mushroom patty were developed, and a few experiments were ran after the development of the formulation, including proximate analyses (protein, fat, ash, and moisture contents). After that, physicochemical analyses were performed to analyse the colour, moisture analysis, cooking yield measurement, and texture profile analysis of the formulated samples. Sensory evaluation was done with 30 untrained panelists and choose the best formulation for further analysis.

3.2.2 Development of patty from *Pleurotus ostreatus* mushroom

Mushrooms were cleaned and cut into small pieces before blended. Next, other ingredients were added according to the formulations. All the ingredients were mixed and made in a round shape. The shaped patty is steamed for 15 minutes. After that, the patty was left for 10 seconds at room temperature Later, the patty was stored in a deep freezer (20 ºC) until further use.

3.3 Proximate analysis of *Pleurotus ostreatus* mushroom patty

The approval method use was (AOAC, 2005) to determine protein content, ash, moisture content and fat.

3.3.1 Determination of Protein content

This protein determination test was carried out using the standard method AOAC Kjeldahl. This method involves three stages. The first stage is digestion of 1g of patty with 12 mL of sulphuric acid (H_2SO_4) and two Kjehdahl tablets were added into a tube. Catalyst tablet added to absolute efficiency to set the ratio of catalyst and sulfuric acid. Due to the digestion process going faster, catalyst tablet was added. After the sample was prepared into the digestion tube, it was placed into the digester machine.

The second stage is distillation. After digestion, 80 mL of distilled water and 50 mL of 40% NaOH were added to the tube. Then, the 25 mL of boric acid solution (4%) and 2-3 drops of methyl red and bromocresol green were added into a conical flask.

The third stage is titration. The receiver conical flask was brought to do the titration process. It was titrated against 0.1N HCl solutions. The endpoint is indicated by pink colour and calculated using the following formula:

$$\% \text{ Protein} = \% \text{ nitrogen} \times \text{factor } (6.25)$$

$$\% \text{ Nitrogen} = \frac{(\text{mL standard acid} - \text{mL blank}) \times \text{N of acid} \times 14}{\text{Weight of sample}}$$

3.3.2 Determination of Ash

The inorganic residue left after the ignition or complete oxidation of organic matter in a food sample is ash content. The ash content is determined using proximate analysis for nutritional evaluation, and it is a crucial quality attribute for some food ingredients (Baraem, 2017). *P. ostreatus* ash content was performed in triplicate using according to AOAC Methods (AOAC, 2005). Briefly, around 1g of ground *P. ostreatus* patty was weighed into a tared crucible. The crucible was placed in a cool muffle furnace. The sample was ignited for 12–18 hours (overnight) at about 550 ºC. The muffle furnace is switched off and waited to open until the temperature has dropped to at least 250 °C. Crucibles was moved to a desiccator equipped with a porcelain plate and desiccant. After that, the remaining ash was weighed and the average with standard deviation was calculated based on the following formula:

$$\% \, Ash \, content = (w_1 - w_2 \div w) \times 100$$

w1 = weight of dried sample with crucible

w2 = weight of sample with crucible

w = weight of sample

3.3.3 Determination of Moisture content

AOAC Official Method 990.19 was used to determine moisture content using the air oven drying method. 1g of samples were weighed and the samples were dried overnight in a Model 600 air oven at 105°C for the measurement. The dish was then weighed after cooling in a desiccator.

3.3.4 Determination of Fat

Fat content was determined using FOSS Soxtec ™ 2055 fat extraction system under AOAC official method 2003.05. This system is a new generation of Soxhlet extraction system which was conducted manually. Four steps were involved during the extraction process of fat, which were was boiling (15 minutes), rinsing (20 minutes), recovery (10 minutes), and pre-drying (2 minutes).

Prior to the extraction process, aluminum cups were cleaned using distilled water and heated at 103°C for 30 minutes inside hot air oven. In the meanwhile, of heating, some defatted cotton was placed inside the cellulose thimble, and folded V-shape filter paper was placed above the defatted cotton. 1 g of sample powder was placed inside the filter paper and was covered with some defatted cotton. The number of the sample inside the thimbles was recorded in a sheet of paper. The cellulose thimbles were moved to the thimble support using magnet holder. The thimble stand was inserted into the extraction unit. The remaining petroleum ether inside the extraction system was piped out and kept in the bottle of petroleum ether. The water tap for reflux condenser was turned on before running the machine to prevent solvent evaporation from condenser.

After heating, the cups were cooled down in desiccator for 20 minutes. the initial weight of aluminium cups was recorded as Wi. Each aluminium cup was pumped with 80 ml of petroleum ether and inserted under the thimbles inside the extraction unit using cup holder. The cellulose thimbles were placed inside the aluminium cup by adjusting down the handles at both sides of the system. The machine was switched on by pressing the “Main” button on the system and the light indicator was turned on. The button “Run” was pressed to start the extraction process. Press timer to carry out boiling process after “beep” sound.

The boiling process was conducted in 15 minutes. The left handle was moved to a level higher after 15 minutes and timer was pressed again to undergo rinsing process. Rinsing process took 20 minutes. After 20 minutes, the left handle was moved to a level higher than previous, and timer was pressed to carry out recovery process. Recovery process used up 10 minutes. After 10 minutes, the timer was pressed without further moving the left handle. Pre-drying process was conducted and took 2 minutes.

After 2 minutes, the right handle was adjusted to the top. The aluminium cups were unloaded and removed from the extraction unit and heated inside the oven at 105 ℃ for 30 minutes. Then, they were cooled down in desiccator for 20 minutes. the final

The sample needs to be as finely processed as possible for the solvent to penetrate the sample thoroughly (Min & Ellefson, 2010). The recorded data used to calculate crude fat as the formula below:

$$\text{fat} = (W2 - W1) \times 100 \div \text{Sample(g)}$$

W1 = weight of the empty flask

W2 = weight of extracted fat and flask

S = Sample

3.4 Physicochemical Analysis of *Pleurotus ostreatus* mushroom patty

3.4.1 Determination of colour

According to *PR Newswire* (2014), High-performance colour measuring tools, such as the CR-400 Chroma Meter, and colour analysis software are designed to evaluate the colour and appearance of the food, beverage, and packaging products will be displayed by Konica Minolta Sensing experts. These technologies produce the data required to fix anomalies or inefficiencies in the manufacturing process early in the process, resulting in less waste and rejections. The colour of the samples is determined using a Minolta Chroma Meter CR-400 colourimeter and the CIE-Lab colour scale, with the L*a*b* (Sidor *et al*, 2017).

According to Chroma Meter CR-400 (Konica Minolta) manual, The Chroma meter is the feature of a User Index that can configure the evaluation formula and colour calculation formula as desired. Chroma Meter CR-400 is a lightweight and high precision tool that serves as an absolute measuring tool, especially the determination of colour measurement. The Chroma meter is compatible with SpectraMagic NX software and is easy to use.

The measuring head of the chroma meter CR-400 is used to measure multiple target colours in order to get colour measurement data. To use the tool, first turn it on and check that the screen display lights are working properly. By positioning the measuring head vertically on the sample, the colour measurement must be determined in different targets. The measuring head cannot be adjusted during the colour measure phase. The colour data was shown on the screen display (Minolta, 2013).

3.4.2 Cooking yield measurement

The cooking yield of mushrooms patties was determined by measuring the weight of six patties for each batch and calculating weight differences for patties before and after cooking, as follows (El-Magoli et al., 1996). The percentage of cooking yield was calculated using the following formula:

$$\text{Cooking yield (\%)} = \frac{(\text{Cooked weight x } 100)}{\text{Raw weight}}$$

3.4.3 Diameter reduction

EL-Magoli et al., 1996 recommended to measure the diameter of six burgers for each formulation and calculating measurement differences before and after cooking using following formula:

$$Diameter\ reduction(\%) = \frac{raw\ burger\ diameter\ - cooked\ burger}{raw\ burger\ diameter}\ x\ 100$$

3.4.4 Changes in Thickness

According EL-Magoli et al., 1996 recommended to measure the thickness of six burgers for each formulation and calculating measurement differences before and after cooking using following formula:

$$Thickness\ reduction\ (\%) = \frac{raw\ patties\ thickness\ - cooked\ patties\ thickness}{raw\ patties\ thickness}\ x\ 100$$

3.4.5 Texture profile analysis (TPA)

The Texture Analyzer (Brookfield CT3) is an instrument that works by applying a controlled deformation to a sample under given test conditions, either in compression or tension. The CT3 can measure a number of physical properties from compression and tensile data that have been shown to be strongly correlated to human sensory assessment of food such as textural (or rheological) food properties like hardness, chewiness, gumminess, tenderness, ripeness, elasticity, and adhesiveness (Brookfield, 2011). An analytical probe is depressed into the sample at a set rate to a desired depth in this method, with a predetermined required duration between the end of the compression cycle and the beginning of the second compression cycle (Pandit et al.,2016)

Texture profiles such as chewiness, gumminess, hardness, springiness, and cohesiveness were evaluated by TexturePro CT V.lT Build 28. Before TPA measurement, the cooked patty was tempered to 20 ºC and cut into 2 cm x 2 cm thick slices. Platen compressions were used, cuts, and compressed twice. The samples were compressed to 60% of their original height using a cylindrical probe for TA11/1000 at a trigger load of 5g, and a cross-head speed of 20 cm/min was used and fixture of 1000g. The patty thickness will be varied and measured concerning its original thickness to provide an analogous condition induced by the cooking process and comparable calculation in the sensory examination (Wan et al., 2011).

3.5 Sensory evaluation

Sensory evaluation method was used to determine the degree of freshness of the patty based on organoleptic characteristics such as taste, color, aroma, flavour, and texture, including tenderness, hardness, and springiness juiciness, and overall acceptance. According to Trindade et al., (2009), a scale range of 1 to 7 indicates dislike extremely to like extremely based on the hedonic test. All patties were be cut into a small and served to the panelists who used a 7-point descriptive scale to rate the sensory attributes.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Development of patty from *Pleurotus ostreatus* Mushroom

The development of patty from *Pleurotus ostreatus* mushroom, was performed to determine the nutritional content based on proximate analysis such as protein, ash, moisture, fat and carbohydrates contents. Next, physicochemical properties were analysed based on physical characteristics of patty evaluated on cooking yield, cooking loss, diameter reduction, changes in thickness, changes in colour, and texture profile analysis. Apart from that, sensory evaluation was performed to choose the best formulation for further analysis. The mushroom patty was developed using three different formulations. The formulation was developed by adding *Pleurotus ostreatus*, cassava flour, isolated soy protein, canola oil, salts, paprika, oregano, onion powder, garlic powder, fennel powder, tomato paste, chili, and pepper.

Table 4.1: Amount of ingredients (g) in *Pleurotus ostreatus* mushroom patty.

Ingredient	Formulation 1	Formulation 2	Formulation 3
Pleurotus ostreatus	48g	56g	64g
Cassava flour	22.1 g	14.1 g	6.1 g
ISP	4.8g	4.8g	4.8g
Canola oil	1.4g	1.4g	1.4g
Salts	0.6g	0.6g	0.6g
Paprika	0.2g	0.2g	0.2g
Oregano	0.2g	0.2g	0.2g
Onion Powder	0.2g	0.2g	0.2g
Garlic Powder	0.2g	0.2g	0.2g
Fennel powder	0.2g	0.2g	0.2g
Tomato paste	1.4g	1.4g	1.4g
Chili	0.6g	0.6g	0.6g
Pepper	0.1g	0.1g	0.1g
Total	80g	80g	80g

Table 4.1 shows the three different formulations used to form a patty. The various combinations were developed by varying the proportion of white oyster mushrooms. The difference in each formulation is that the amount of mushroom increased while the amount of cassava flour decreased. The goal was to determine the effects of white oyster mushrooms on patty's development. This formulation was developed to determine the best nutritional *Pleurotus ostreatus* mushroom patty to consume.

4.2 Proximate Analysis of *Pleurotus ostreatus* mushroom patty

4.2.1 Protein content

In natural raw foods, protein is recognized as the key structural component that defines their overall food texture. Isolated proteins were used as ingredients in foods because of their particular functional properties, such as having a desirable shape, texture, or stability. Despite their source, all proteins are made up of an amino acid chain. The precise order and ratio of amino acids in the series determine the physical properties, such as molecular size, shape, charge, and solubility. Protein determination was carried out using the Kjeldahl method. Kjeldahl method was an indirect protein determination as it inferred the determination of nitrogen content or chemical reaction with the functional group within the protein.

Table 4.2: Protein content of uncooked *Pleurotus ostreatus* mushroom patty

	PROTEIN CONTENT % (mean ± standard deviation)
Control (commercialize patty)	6.48 ± 0.43^{c}
Formulation 1	6.48 ± 0.43^{c}
Formulation 2	9.57 ± 0.13^{b}
Formulation 3	11.53 ± 0.22^{a}

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with different superscripts are significantly different ($p<0.05$).

Table 4.2 shows the results is increase in protein content along with the increase of mushroom. Formulation 1 contains 60% of white oyster mushroom while formulation 2 is 70%, and formulation 3 is 80% mushrooms. Formulation 3 has the highest protein value (11.53 ± 0.22%) compared to others formulations because the amount of mushroom was increased to 80%. The lowest protein contents is in formulation 1 and in control (6.48 ± 0.43%) and formulation 1 has 60% of mushroom. This result proved that commercial patty and developed patty (formulation 1) have similar protein. The statistical test showed a significant mean between the formulation with $p = 0.000$ (Appendix).

In addition, when the amount of mushroom increases, the protein contains also increases. According to Wang et al., (2001) & Adebayo et al., (2021) *Pleurotus sp.* mushroom proteins are of high quality because some members of this genus contain complete proteins with a well-balanced distribution of non-essential amino acids and essential. The protein in mushrooms is known as digestible protein, and many studies claim those animal proteins are comparable with the amino acid compositions of mushrooms. This is significant because human nutrition has become more complicated since the outbreak of diseases linked to animal meat. The nutritional consequences of gradually replacing meat with mushrooms (Oloke, 2017).

According to the Table 4.1, the isolated soy protein for all the formulations was constant because Danowska-Oziewicz,(2014) recommended using less than 5% for isolated soy protein in patty to produce a good quality of mushroom patty. Isolated soy protein has never had a significant impact on protein results.

4.2.2 Ash content

The minerals present in the food sample make up most of the inorganic residue. Ash is simply the residue of food that has been burned up during digestion. The body can burn the primary nutrients such as fat, protein, carbohydrates but not minerals. The ash content is determined as part of the proximate analysis for nutritional evaluation. The organic matter burned, volatiles and water were evaporated and convert to CO_2 and N_2 oxides in the presence of oxygen (Baraem, 2017).

Table 4.3: Ash content of uncooked *Pleurotus ostreatus* mushroom patty

ASH CONTENT % (mean ± standard deviation)	
Control (commercialize patty)	4.86 ± 0.28^a
Formulation 1	2.80 ± 0.22^b
Formulation 2	3.30 ± 0.30^b
Formulation 3	4.41 ± 0.36^a

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with different superscripts are significantly different (p<0.05).

The ash content was calculated using the wet weight and expressed as a percentage of the dry weight. There were statistically significant differences among the formulations and it is determined by one-way ANOVA ($p<0.05$) with $p = 0.000$ (Appendix). The post-doc results indicate that the ash content of Formulation 3 is higher than Formulations 1 and 2. It is increased from 2.80 ± 0.22% (F1) to 4.41 ± 0.36% (F3).

There are no significant differences between control and formulation 1, ranging from 4.41 – 4.86%. The percentage of ash content in Formulations 1 and 2 ranged from 2.80 - 3.20 % and was not significant. According to a previous study by Oloke, (2017), the ash content of. *P. ostreatus* is 0.974%. The ash content of the samples in this study was higher than the values reported in previous studies. Ramadhan et al., (2011) state that the high ash value could be attributed to the use of spices as a seasoning and cassava flour in the developing patty from *P. ostreatus* mushroom.

4.2.3 Moisture content

The moisture content refers to the number of water molecules that are combined into a food product. Moisture content can reach into a food product in various ways, may relate to the product's manufacturing method, the ambient moisture in the food processing field, the packaging method of the product, or may relate to the food storage method (Nielsen, 2010).

Table 4.4: Moisture content of *Pleurotus ostreatus* mushroom patty

	MOISTURE CONTENT % (mean ± standard deviation)
Control (commercialize patty)	76.02 ± 0.87[a]
Formulation 1	70.53 ± 0.36[c]
Formulation 2	73.25 ± 0.34[b]
Formulation 3	76.16 ± 0.24[a]

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with different superscripts are significantly different (p<0.05).

Refer to Table 4.4, the moisture content in the formulation 3 is the highest compared to the other two formulations meanwhile, control is also in the same range as formulation 3, 76.16 – 76.02 %. This indicates formulation 3 and control is not significant. An increase in the percentage of mushrooms in formulation the percentage of moisture content was also increased from 70.53 ± 0.36% (F1) to 76.16 ± 0.24% (F3). The lowest moisture content indicated in formulation 1 (70.53 ± 0.36). There is a significant difference (p<0.05) of mean in between the formulation where p = 0.000 (Appendix).

Referred to the previous study, it was reported on the moisture content of *P. ostreatus* (Khan et al., 2010) that fresh mushroom contains 85-95% of moisture. *P. ostreatus* has the highest moisture content compared to another genus of mushrooms. In this study, the range of moisture of *P. ostreatus* mushroom patty is 70-75% because of the combination of other ingredients. Following processing, the moisture content of burger samples was generally reduced.

4.2.4 Fat

The fat content of all three formulations of *Pleurotus ostreatus* mushroom patty and commercialized patty was tested to assess fat content. Fat content analysis was performed by the Soxhlet method. Soxhlet method has been a common analytical practice and is undoubtedly the most commonly used and accepted method for lipids extraction.

Table 4.5: Fat content of *Pleurotus ostreatus* mushroom patty

	FAT CONTENT % (mean ± standard deviation)
Control (commercialize patty)	88.26 ± 1.24[a]
Formulation 1	2.70 ± 0.14[b]
Formulation 2	1.47 ± 0.06[bc]
Formulation 3	0.62 ± 0.06[c]

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with different superscripts are significantly different (p<0.05).

According to the Table 4.5, the highest fat content is the control (88.26 ± 1.24%) and formulation 3 showed the lowest fat content (0.62 ± 0.06%) because when the amount of *P. ostreatus* increases in the ingredient, the fat content is decreased**.** In formulation 3, 80% of mushroom was used, and the remaining 20% is made up of other ingredients. There is a significant difference (p<0.05) of mean in between the formulation where p = 0.000 (Appendix).

Based on Hossain et al., (2007) reported that *P. ostreatus* mushroom is low in fat content, but it contains some essential fatty acids, and according to different studies with different *Pleurotus* species, the fat content of dried fruit bodies ranged from 0.2 to 8g per 100g. This result proved that patty made from *P. ostreatus* is low in fat and healthy. Usually, diabetes patients and obese people are recommended to consume low-fat content food due to low-calorie value.

4.3 Physicochemical Analysis of *Pleurotus ostreatus* mushroom patty

4.3.1 Colour analysis

The color of the food is the first quality parameter that consumers evaluate. It is possible to obtain a quantitative color value using various color spaces. Even though it comes to food, there are many different color spaces. Due to its popularity, the CIE L*a*b* color space is the most commonly used because of its uniform color distribution. Its color perception is closest to that of a single human eye. Cooked *Pleurotus ostreatus* mushroom patty was analyzed for the color intensity using Konica Miltona Chroma Meter with standard CIE. L*a*b*color spaces, the chroma meter analyses colors. Therefore, L* implies lightness in the L*a*b* color space, a* implies red and green coordinates, b* implies the yellow and blue coordinates.

The 0 as black and 100 as white known the L* lightness value. The green-red opponent colors aligned in the a* axis with positive values pointing toward red (+60) and negative values were pointing toward green (-60). The blue-yellow opponents, with positive numbers pointing toward yellow (+60) and negative numbers pointing toward blue (-60) are represented by the b* axis (Markovic et al., 2013). For each formulation, three samples were used to measure the colour.

Table 4.6: Color analysis of cooked *Pleurotus ostreatus* mushroom patty

Color analysis (Mean± Standard deviation)			
	L*	**a***	**b***
Control	45.48 ± 1.109[b]	5.01 ± 1.072[b]	7.68 ± 2.536[b]
Formulation 1	45.48 ± 1.109[b]	12.24 ± 0.732[a]	16.30 ± 3.726[a]
Formulation 2	46.19 ± 0.354[ab]	11.40 ± 2.050[a]	14.42 ± 4.300[a]
Formulation 3	47.96 ± 0.972[a]	10.06 ± 1.356[a]	14.10 ± 1.714[a]

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with different superscripts are significantly different (p<0.05).

Based on Table 4.6, the L* value indicates the lightness of the sample, whereas the lighter the color has the higher the value of lightness. The result indicates that the lightness (L*) of the cooked *P. ostreatus* mushroom patty F1 to F3 increases along with the increase in the amount of mushroom. It increases from 45.48 ± 1.10% (F1) to 47.96 ± 0.97% (F3). Control and Formulation 1 is not significant and had a lower L* value (45.48 ± 1.11).

The significant increase in the lightness values with *p*= 0.035 resulted from an increase in the percentage of white oyster mushroom in between the patty formulation. This finding was consistent with previous research on physicochemical and sensory characteristics of the burger made from duck surimi-like material. The raw material used may affect the Lightness (Ramadhan et al., 2011).

Besides that, a* indicates the redness since the results are positive. The control were significantly lowest (redness a*) at 5.01 ± 1.072 than the developed formulation. The redness a* of F1 to F3 continues to decrease from 12.24 ± 0.732 (F1) to 10.06 ± 1.356 (F3). The results showed significant differences with *p* = 0.001. According to Ramandhan et al, (2011), the condiments used in patty formulation has an influence on patty color. In the current study, red chili, paprika, and tomato paste might influence the redness.

On the other hand, b* indicates the yellowness since the results are positive. The control was significantly lowest (yellowness b*) at 7.68 ± 2.536 than the developed formulation. The yellowness b* of F1 to F3 continues to decrease from 16.30 ± 3.726 (F1) to 14.10 ± 1.714 (F3). The results showed significant differences with $p = 0.050$. A previous study from Noor Hidayati et al., (2021) reported that Maillard reaction occurs in protein contain food and depends on cooking time and temperature. The water in *P. ostreatus* mushroom patty was evaporated while cooking and browning reaction occurs.

The color of the mushroom patty is a significant factor in determining consumer acceptability. The color changes depending on various factors such as the physical properties of the mushroom and the presence of other ingredients. In summary, cooked *P. ostreatus* mushroom patty has a significantly different ($p<0.050$) mean in lightness, redness, and yellowness between the formulation (Appendix).

4.3.2 Physical traits

A patty's physical characteristics are distinguishing characteristics. Others notice visual aspects of the food even if they don't know anything else about it. The geometrical, the food's dimensions of shape, size, and intrinsic characteristic variability in uniformity of the food's structure are the physical factors (Lawless et al., 2010).

Table 4.7: Physical traits of cooked *Pleurotus ostreatus* mushroom patty

Physical traits (%) (Mean± Standard deviation)			
	Cooking yield	**Diameter reduction**	**Changes in thickness**
Control	97.53 ± 0.351[a]	1.11 ± 0.000[a]	12.47 ± 0.82[a]
Formulation 1	97.27 ± 0.120[a]	1.11 ± 0.000[a]	10.00 ± 0.000[b]
Formulation 2	87.61 ± 0.225[b]	1.11 ± 0.008[a]	10.00 ± 0.000[b]
Formulation 3	77.46 ± 0.231[c]	1.11 ± 0.000[a]	10.00 ± 0.000[b]

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with different superscripts are significantly different (p<0.05).

Table 4.7 shows the results percentage of cooking yield. The cooking yield properties significantly decreased, and it is in line with the increased amount of mushroom in patty formulation. Its decrease from 97.27 ± 0.12% (F1) to 77.46 ± 0.23% (F3). Control recorded the highest cooking yield 97.53 ± 0.35%1, and there is no significant difference with Formulation 1. Formulation 3 recorded the lowest cooking yield. The statistical test showed a significant mean between the formulation with p = 0.000 (Appendix).

The amount of *P. ostreatus* used in patty formulation had an inverse relationship with cooking yield and moisture contents. This is mostly due to the high moisture content within the patties and oyster mushroom fiber's inability to form a tridimensional matrix. This is a statement with previous study Wan Rosli (2012), who investigate the effect of the addition of *P. sajor-caju* (PSC) on physical and sensorial properties of beef patty. Table 4.4 shows formulation 3 has the highest moisture content while the lowest cooking yield.

Table 4.7 shows that there is no significant different (p>0.05) between the formulation and control patty in diameter reduction. The mean value showed 1.11 ± 0.00.

This discovery is supported by the previous work of Pinero et al. (2008) who was done a similar study reported that there was no significant difference in diameter reduction between a control and a low-fat patty containing soluble oat fibre. The holding of mushroom shape and size during cooking could be attributed to the binding and stabilizing properties of mushroom fibre, which resisted changes in patty shape and held the patty particle together.

Furthermore, the control recorded the greatest changes in thickness, which is significant with (p<0.05) formulation, and there is no significant different (p>0.05) between the formulations 10.00 ± 0.00. In summary, this study reflected significant changes in cooking yield while no substantial changes of thickness and diameter reduction.

4.3.3 Texture Profile analysis

Texture Profile Analysis is a double compression test that is used to determine the textural properties of the patty. During the test, compression of samples is carried out twice to determine the physical characteristic of the sample when they are chewed. Therefore, TPA is also known as a “two-bite test since the working principle of the analyser during the test mimics the 'mouth's biting action. The TPA parameters can be divided into primary parameters: hardness, springiness, and cohesiveness. The secondary parameters are gumminess and chewiness (Novakovi & Tomaˇsevi, 2017). Primary parameters can be directly determined from the obtained force/time graph, while secondary parameters are derived from the primary parameters. The test is based on simulating the biting action of the mouth by a two-cycle compression series (Barbut, 2015).

During the TPA test, the texture attributes of cooked *P. ostreatus* mushroom patty including hardness, cohesiveness, springiness, gumminess, and chewiness were measured using a CT-3 texture analyzer.

Table 4.8: Texture Profile analysis of cooked *Pleurotus ostreatus* mushroom patty

	Texture Profile analysis (Mean± Standard deviation)				
	Hardness (g)	Cohesiveness (cm)	Springiness (cm)	Gumminess (g)	Chewiness (mJ)
Control	10171.33 ± 884.241[a]	0.27 ± 0.015[b]	0.58 ± 0.000[a]	2646.33 ± 79.475[b]	151.4667 ± 4.895[b]
F1	9848.33 ± 532.246[a]	0.50 ± 0.053[a]	0.62 ± 0.025[a]	4760.00 ± 725.274[a]	289.2333 ± 33.357[a]
F2	3874.67 ± 301.182[b]	0.56 ± 0.096[a]	0.57 ± 0.031[a]	2380.33 ± 154.079[b]	133.6667 ± 4.3189[b]
F3	3563.33 ± 425.237[b]	0.55 ± 0.045[a]	0.62 ± 0.050[a]	1957.00 ± 64.784[b]	119.533 ± 8.1426[b]

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with different superscripts are significantly different (p<0.05).

According to Table 4.8, the hardness of the mushroom patty decreased proportionally with the increased amount of white oyster mushroom in the formulation. The formulated patties were constantly decreased from 9848.33 ± 532.25g (F1) - 3563.33 ± 425.24g (F3) and significantly lower (p<0.05) than control (commercialize patty). There is a significant difference (p<0.05) of mean in between the formulation where p = 0.000 (Appendix).

The hardness represents the degree of firmness of the mushroom patty (Yusof et al., 2019). The hardness is represented as the force required to attain a given deformation. The hardness of the mushroom patty is directly related to the moisture content. The texture changes from soft to hard as the moisture content drops during the grilling process. The previous study by Kotwaliwale et al., (2007) has been reported that this decrease in hardness could be attributed to the higher moisture content of fresh 'oyster's mushrooms. Another factor that influences the hardness of the mushroom patty is oil. Referring to a previous study of Fasina et al., (2008) stated, Oil with a high viscosity tends to absorb more oil because viscous oil is difficult to drip off of food products. As a result, it will remain inside the food.

Next is cohesiveness. Control patty is recorded (0.27 ± 0.015cm) which is significantly lower (p<0.05) than a formulated patty. The formulated patty cohesiveness ranged from 0.50 – to 0.56cm. The highest cohesiveness reading was recorded at formulation 2 with 0.56 ± 0.096cm. There is no significance (p= 0.01) in between the formulation. The strength of the internal bonds makes up the cooked patties' body known as cohesiveness. Youssef et al. (2011) stated that when the fat content increase, the cohesiveness will decrease. Based on that statement, the control patty has the highest fat content (refer toTable 4.5) and lowest cohesiveness. On the contrary, Youssef et al. (2011) also indicated high cohesiveness reading because of the high value of protein concentration and the occurrence of a more cohesive protein matrix. The patties are easy to chew and swallow when it has a low cohesiveness value.

Other than that, springiness has no significant difference (p>0.05) among the formulation and control patty. These range between 0.57 – 0.62. Springiness is inversely proportional to hardness. Springiness is the recovery rate of material after deformation as a function of the distance between the first and second bites.

From Table 4.8, it can be observed that gumminess is significantly decreased ($p<0.05$) proportionally with the increased amount of white oyster mushroom in the formulation. The formulated patties constantly decreased from 4760.00 ± 725.27g (F1) to 1957.00 ± 64.78g (F3). Control patty is significantly different from Formulation 1 and not significantly different among Formulations 2 and 3. Formulation 3 recorded the lowest gumminess. There is a significant difference ($p<0.05$) of mean in between the formulation where $p = 0.000$ (Appendix). Besides that, a similar trend was recorded in chewiness. Lower chewiness indicates patty softness (Patinho et al., 2019).

Gumminess can be calculated as the product of hardness times cohesiveness (Mousavi et al., 2019). Gumminess is of *Pleurotus ostreatus* mushroom patty decreases when its hardness decreases. The product's chewiness represents the energy needed to masticate a solid food to a state ready for swallowing (Mousavi et al., 2019). Therefore, the energy needed to disintegrate this semi-solid product to a state ready for swallowing is decreased (Pandey et al., 2014). Gumminess and chewiness behavior of *P. ostreatus* mushroom patty revealed that need less energy requirement incomplete breakdown and retained.

In summary, there is a signification difference ($p<0.05$) between the formulation and the texture profile analysis except for the springiness.

4.3.4 Sensory evaluation

A total of 30 untrained sensory panels were recruited to determine the overall acceptability of patties. The panels were instructed to evaluate the mushroom patty based on the aroma, color, texture (hardness, springiness, juiciness), taste, and overall acceptability with A 7-point hedonic scale were 1= 'Dislike 'extremely'; 2= 'Dislike 'moderately'; 3=' Dislike 'slightly'; 4= 'Neither like or 'dislike'; 5= 'Like 'slightly'; 6= 'Like 'moderately'; 7= 'Like' extremely.

Table 4.9: Sensory evaluation cooked *Pleurotus ostreatus* mushroom patty

	Texture Profile analysis (%) (Mean± Standard deviation)						
	Aroma	Color	Hardness	Springiness	Juiciness	Taste	Overall acceptance
Control	4.23 ± 1.633^{b}	3.90 ± 1.605^{b}	4.63 ± 1.650^{a}	4.57 ± 1.775^{a}	4.37 ± 1.752^{a}	4.37 ± 1.956^{b}	4.40 ± 1.793^{b}
F1	5.80 ± 1.400^{a}	5.67 ± 1.470^{a}	5.57 ± 1.524^{a}	5.47 ± 1.408^{a}	5.20 ± 1.349^{a}	5.57 ± 1.278^{a}	5.57 ± 1.357^{a}
F2	5.33 ± 1.446^{a}	5.27 ± 1.639^{a}	5.00 ± 1.390^{a}	4.70 ± 1.442^{a}	5.10 ± 1.398^{a}	5.33 ± 1.539^{ab}	5.33 ± 1.539^{ab}
F3	5.57 ± 1.223^{a}	5.60 ± 1.248^{a}	5.37 ± 1.326^{a}	5.23 ± 1.406^{a}	5.20 ± 1.349^{a}	5.07 ± 1.363^{ab}	5.17 ± 1.367^{ab}

Note: Values are expressed as mean ± standard deviation (n=3). Mean values with different superscripts are significantly different ($p<0.05$).

According to Table 4.9, Formulation 1 was the highest reading of aroma (5.80 ± 1.40%) and controlled patty as the lowest reading of aroma (4.23 ± 1.63%). There is a significantly different ($p<0.05$) where $p= 0.00$. The range of aroma for the formulated patties is 5.33 – 5.80%. The results indicate that the panellist is able to different shade the aroma of each patty. The aroma was defined as the sense of smell before eating the patty and evaluating the quality. Aroma is one of the important factors for consumers deciding to accept or reject the patty before tasting it. Because only volatile molecules in the form of gas carry aroma and make it easier to detect food through smell, the volatility of aromas is related to temperature (Amerine et al., 2013).

There is a significantly difference (p<0.05) between control and formulations. The control patty recorded the lowest reading of color, which is 3.90% compared to the formulations. The color reading of formulation 1 is the highest then Formulation 2 and 3. Gengler, (2009) reported that the color can be different through the sense of sight. The eyes can discover the initial quality of food. Color is used to assess the acceptability and desirability of food. Color sends a visual signal that influences a consumer's choice and creates mental expectations about the food.

The texture of patty can be identified through hardness, springiness, and juiciness. Control patty recorded the lowest texture, hardness 4.63±1.65 % springiness 4.57±1.77% and juiciness 4.37 ± 1.75 %. The mean scores for formulated patty were ranged from 5.00 to 5.57% for hardness, 4.70 to 5.47 % for springiness and 5.10 to 5.20 % for juiciness. Overall, there is no significant (p>0.05) changes in hardness, springiness, and juiciness. The sense of touch conveys impressions of a food's texture to us through our skin. The perception of texture is extremely complex. Previous researchers have reported that untrained panellists could not differentiate the texture of the patty (Wan Rosli, 2012).

Based on the sensory evaluation table, Formulation 1 recorded the highest taste mean 5.57 ± 1.278% while control was the lowest mean in taste 4.37 ± 1.95%Formulation 1 and 2 in the mean range of 5.07 to 5.33% here is a significantly difference (p<0.05) among the taste where p= 0.022. Taste is an important factor in a person's choice of a particular food. Taste is perceived by taste buds, which are located primarily on the tongue's surface by the palate mucosa and in areas of the throat Gengler, (2009).

In overall acceptance, Formulation 1 was the highest reading 5.57 ± 1.36% and significantly different ($p<0.05$) among all the overall acceptance with $p=0.023$. These results indicate that Formulation 1 is the best formulation among the other formulation and its score highest mean value compared to the control patty that is already commercialized.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study suggests that *Pleurotus ostreatus* mushroom can develop as patty without any animal products, which is 100% vegan. Formulation 1 was the best formulation among the other formulation because its score highest mean value of 5.57 ± 1.357% in overall acceptance of sensory evaluation. The proximate analysis showed that *P. ostreatus* mushroom patty contain protein compared to commercialized patty and formulation 1 was not significantly different from other formulations. In contrast, the fat contained in formulation 1 (2.70 ± 0.14%) was significantly different from the control patty. Therefore, it is proved that *P. ostreatus* can include as a balanced diet in consumption food and consumption by obese people. The texture of patty in formulation 1 is less hard than commercialized patty and lower chewiness indicates the patty's softness. According to the ANOVA test, there are significant differences between physicochemical properties and sensory evolution in developing of *P. ostreatus* as the mushroom patty. So, we reject the null hypothesis.

5.2 Recommendations

Referring to this study, it can conclude that *Pleurotus ostreatus* is the best mushroom to develop into a patty. Hence, for the next project, it is recommended to study on the stability of patty derived from white oyster mushroom.

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APPENDIX A

Proximate analysis

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Moisture_content	Control	F1	5.48667*	.42078	.000	4.1392	6.8342
		F2	2.77000*	.42078	.001	1.4225	4.1175
		F3	-.13333	.42078	.988	-1.4808	1.2142
	F1	Control	-5.48667*	.42078	.000	-6.8342	-4.1392
		F2	-2.71667*	.42078	.001	-4.0642	-1.3692
		F3	-5.62000*	.42078	.000	-6.9675	-4.2725
	F2	Control	-2.77000*	.42078	.001	-4.1175	-1.4225
		F1	2.71667*	.42078	.001	1.3692	4.0642
		F3	-2.90333*	.42078	.001	-4.2508	-1.5558
	F3	Control	.13333	.42078	.988	-1.2142	1.4808
		F1	5.62000*	.42078	.000	4.2725	6.9675
		F2	2.90333*	.42078	.001	1.5558	4.2508
Protein_content	Control	F1	.00021	.27381	1.000	-.8766	.8771
		F2	-3.09404*	.27381	.000	-3.9709	-2.2172
		F3	-5.04904*	.27381	.000	-5.9259	-4.1722
	F1	Control	-.00021	.27381	1.000	-.8771	.8766
		F2	-3.09425*	.27381	.000	-3.9711	-2.2174
		F3	-5.04925*	.27381	.000	-5.9261	-4.1724
	F2	Control	3.09404*	.27381	.000	2.2172	3.9709
		F1	3.09425*	.27381	.000	2.2174	3.9711
		F3	-1.95500*	.27381	.000	-2.8318	-1.0782
	F3	Control	5.04904*	.27381	.000	4.1722	5.9259
		F1	5.04925*	.27381	.000	4.1724	5.9261
		F2	1.95500*	.27381	.000	1.0782	2.8318
Ash_content	Control	F1	2.06000*	.24005	.000	1.2913	2.8287
		F2	1.55333*	.24005	.001	.7846	2.3220
		F3	.44333	.24005	.321	-.3254	1.2120
	F1	Control	-2.06000*	.24005	.000	-2.8287	-1.2913
		F2	-.50667	.24005	.228	-1.2754	.2620
		F3	-1.61667*	.24005	.001	-2.3854	-.8480
	F2	Control	-1.55333*	.24005	.001	-2.3220	-.7846
		F1	.50667	.24005	.228	-.2620	1.2754
		F3	-1.11000*	.24005	.007	-1.8787	-.3413
	F3	Control	-.44333	.24005	.321	-1.2120	.3254
		F1	1.61667*	.24005	.001	.8480	2.3854
		F2	1.11000*	.24005	.007	.3413	1.8787
Fat_content	Control	F1	85.55333*	.51090	.000	83.9172	87.1894
		F2	86.78333*	.51090	.000	85.1472	88.4194
		F3	87.63000*	.51090	.000	85.9939	89.2661
	F1	Control	-85.55333*	.51090	.000	-87.1894	-83.9172
		F2	1.23000	.51090	.153	-.4061	2.8661
		F3	2.07667*	.51090	.015	.4406	3.7128
	F2	Control	-86.78333*	.51090	.000	-88.4194	-85.1472
		F1	-1.23000	.51090	.153	-2.8661	.4061
		F3	.84667	.51090	.403	-.7894	2.4828
	F3	Control	-87.63000*	.51090	.000	-89.2661	-85.9939
		F1	-2.07667*	.51090	.015	-3.7128	-.4406
		F2	-.84667	.51090	.403	-2.4828	.7894

*. The mean difference is significant at the 0.05 level.

Colour analysis

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Lightness_L	F1	F2	-.710	.767	.793	-3.17	1.75
		F3	-2.483*	.767	.048	-4.94	-.03
		control	.000	.767	1.000	-2.46	2.46
	F2	F1	.710	.767	.793	-1.75	3.17
		F3	-1.773	.767	.174	-4.23	.68
		control	.710	.767	.793	-1.75	3.17
	F3	F1	2.483*	.767	.048	.03	4.94
		F2	1.773	.767	.174	-.68	4.23
		control	2.483*	.767	.048	.03	4.94
	control	F1	.000	.767	1.000	-2.46	2.46
		F2	-.710	.767	.793	-3.17	1.75
		F3	-2.483*	.767	.048	-4.94	-.03
Redness_a	F1	F2	.837	1.135	.880	-2.80	4.47
		F3	2.173	1.135	.294	-1.46	5.81
		control	7.230*	1.135	.001	3.60	10.86
	F2	F1	-.837	1.135	.880	-4.47	2.80
		F3	1.337	1.135	.656	-2.30	4.97
		control	6.393*	1.135	.002	2.76	10.03
	F3	F1	-2.173	1.135	.294	-5.81	1.46
		F2	-1.337	1.135	.656	-4.97	2.30
		control	5.057*	1.135	.009	1.42	8.69
	control	F1	-7.230*	1.135	.001	-10.86	-3.60
		F2	-6.393*	1.135	.002	-10.03	-2.76
		F3	-5.057*	1.135	.009	-8.69	-1.42
Yellowness_b	F1	F2	1.873	2.638	.890	-6.57	10.32
		F3	2.193	2.638	.838	-6.25	10.64
		control	8.620*	2.638	.046	.17	17.07
	F2	F1	-1.873	2.638	.890	-10.32	6.57
		F3	.320	2.638	.999	-8.13	8.77
		control	6.747	2.638	.124	-1.70	15.19
	F3	F1	-2.193	2.638	.838	-10.64	6.25
		F2	-.320	2.638	.999	-8.77	8.13
		control	6.427	2.638	.147	-2.02	14.87
	control	F1	-8.620*	2.638	.046	-17.07	-.17
		F2	-6.747	2.638	.124	-15.19	1.70
		F3	-6.427	2.638	.147	-14.87	2.02

*. The mean difference is significant at the 0.05 level.

Physical traits

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Cooking_yield	Control	F1	.252	.142	.316	-.15	.65
		F2	9.918*	.142	.000	9.52	10.32
		F3	20.068*	.142	.000	19.67	20.47
	F1	Control	-.252	.142	.316	-.65	.15
		F2	9.667*	.142	.000	9.27	10.06
		F3	19.817*	.142	.000	19.42	20.21
	F2	Control	-9.918*	.142	.000	-10.32	-9.52
		F1	-9.667*	.142	.000	-10.06	-9.27
		F3	10.150*	.142	.000	9.75	10.55
	F3	Control	-20.068*	.142	.000	-20.47	-19.67
		F1	-19.817*	.142	.000	-20.21	-19.42
		F2	-10.150*	.142	.000	-10.55	-9.75
Diameter_reduction	Control	F1	.000	.002	1.000	-.01	.01
		F2	.003	.002	.505	.00	.01
		F3	.000	.002	1.000	-.01	.01
	F1	Control	.000	.002	1.000	-.01	.01
		F2	.003	.002	.505	.00	.01
		F3	.000	.002	1.000	-.01	.01
	F2	Control	-.003	.002	.505	-.01	.00
		F1	-.003	.002	.505	-.01	.00
		F3	-.003	.002	.505	-.01	.00
	F3	Control	.000	.002	1.000	-.01	.01
		F1	.000	.002	1.000	-.01	.01
		F2	.003	.002	.505	.00	.01
Thickness_reduction	Control	F1	2.467*	.024	.000	2.40	2.53
		F2	2.467*	.024	.000	2.40	2.53
		F3	2.467*	.024	.000	2.40	2.53
	F1	Control	-2.467*	.024	.000	-2.53	-2.40
		F2	.000	.024	1.000	-.07	.07
		F3	.000	.024	1.000	-.07	.07
	F2	Control	-2.467*	.024	.000	-2.53	-2.40
		F1	.000	.024	1.000	-.07	.07
		F3	.000	.024	1.000	-.07	.07
	F3	Control	-2.467*	.024	.000	-2.53	-2.40
		F1	.000	.024	1.000	-.07	.07
		F2	.000	.024	1.000	-.07	.07

*. The mean difference is significant at the 0.05 level.

Texture profile analysis

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Cohesiveness	control	F1	-.233*	.049	.006	-.39	-.08
		F2	-.293*	.049	.001	-.45	-.14
		F3	-.287*	.049	.002	-.44	-.13
	F1	control	.233*	.049	.006	.08	.39
		F2	-.060	.049	.629	-.22	.10
		F3	-.053	.049	.705	-.21	.10
	F2	control	.293*	.049	.001	.14	.45
		F1	.060	.049	.629	-.10	.22
		F3	.007	.049	.999	-.15	.16
	F3	control	.287*	.049	.002	.13	.44
		F1	.053	.049	.705	-.10	.21
		F2	-.007	.049	.999	-.16	.15
Hardness	control	F1	323.000	472.000	.900	-1188.51	1834.51
		F2	6296.667*	472.000	.000	4785.16	7808.18
		F3	6608.000*	472.000	.000	5096.49	8119.51
	F1	control	-323.000	472.000	.900	-1834.51	1188.51
		F2	5973.667*	472.000	.000	4462.16	7485.18
		F3	6285.000*	472.000	.000	4773.49	7796.51
	F2	control	-6296.667*	472.000	.000	-7808.18	-4785.16
		F1	-5973.667*	472.000	.000	-7485.18	-4462.16
		F3	311.333	472.000	.909	-1200.18	1822.84
	F3	control	-6608.000*	472.000	.000	-8119.51	-5096.49
		F1	-6285.000*	472.000	.000	-7796.51	-4773.49
		F2	-311.333	472.000	.909	-1822.84	1200.18
Springness	control	F1	-.043	.026	.402	-.13	.04
		F2	.007	.026	.994	-.08	.09
		F3	-.043	.026	.402	-.13	.04
	F1	control	.043	.026	.402	-.04	.13
		F2	.050	.026	.295	-.03	.13
		F3	.000	.026	1.000	-.08	.08
	F2	control	-.007	.026	.994	-.09	.08
		F1	-.050	.026	.295	-.13	.03
		F3	-.050	.026	.295	-.13	.03
	F3	control	.043	.026	.402	-.04	.13
		F1	.000	.026	1.000	-.08	.08
		F2	.050	.026	.295	-.03	.13
Gumminess	control	F1	-2113.667*	305.581	.001	-3092.24	-1135.09
		F2	266.000	305.581	.820	-712.58	1244.58
		F3	689.333	305.581	.188	-289.24	1667.91
	F1	control	2113.667*	305.581	.001	1135.09	3092.24
		F2	2379.667*	305.581	.000	1401.09	3358.24
		F3	2803.000*	305.581	.000	1824.42	3781.58
	F2	control	-266.000	305.581	.820	-1244.58	712.58
		F1	-2379.667*	305.581	.000	-3358.24	-1401.09
		F3	423.333	305.581	.541	-555.24	1401.91
	F3	control	-689.333	305.581	.188	-1667.91	289.24
		F1	-2803.000*	305.581	.000	-3781.58	-1824.42
		F2	-423.333	305.581	.541	-1401.91	555.24
Chewiness	control	F1	-137.76667*	14.26893	.000	-183.4608	-92.0725
		F2	17.80000	14.26893	.617	-27.8941	63.4941
		F3	31.93333	14.26893	.193	-13.7608	77.6275
	F1	control	137.76667*	14.26893	.000	92.0725	183.4608
		F2	155.56667*	14.26893	.000	109.8725	201.2608
		F3	169.70000*	14.26893	.000	124.0059	215.3941
	F2	control	-17.80000	14.26893	.617	-63.4941	27.8941
		F1	-155.56667*	14.26893	.000	-201.2608	-109.8725
		F3	14.13333	14.26893	.759	-31.5608	59.8275
	F3	control	-31.93333	14.26893	.193	-77.6275	13.7608
		F1	-169.70000*	14.26893	.000	-215.3941	-124.0059
		F2	-14.13333	14.26893	.759	-59.8275	31.5608

*. The mean difference is significant at the 0.05 level.

Sensory evaluation

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Aroma	F1	F2	.467	.370	.589	-.50	1.43
		F3	.233	.370	.922	-.73	1.20
		control	1.567*	.370	.000	.60	2.53
	F2	F1	-.467	.370	.589	-1.43	.50
		F3	-.233	.370	.922	-1.20	.73
		control	1.100*	.370	.019	.14	2.06
	F3	F1	-.233	.370	.922	-1.20	.73
		F2	.233	.370	.922	-.73	1.20
		control	1.333*	.370	.003	.37	2.30
	control	F1	-1.567*	.370	.000	-2.53	-.60
		F2	-1.100*	.370	.019	-2.06	-.14
		F3	-1.333*	.370	.003	-2.30	-.37
Colour	F1	F2	.400	.387	.730	-.61	1.41
		F3	.067	.387	.998	-.94	1.08
		control	1.767*	.387	.000	.76	2.78
	F2	F1	-.400	.387	.730	-1.41	.61
		F3	-.333	.387	.825	-1.34	.68
		control	1.367*	.387	.003	.36	2.38
	F3	F1	-.067	.387	.998	-1.08	.94
		F2	.333	.387	.825	-.68	1.34
		control	1.700*	.387	.000	.69	2.71
	control	F1	-1.767*	.387	.000	-2.78	-.76
		F2	-1.367*	.387	.003	-2.38	-.36
		F3	-1.700*	.387	.000	-2.71	-.69
Hardness	F1	F2	.567	.382	.450	-.43	1.56
		F3	.200	.382	.953	-.79	1.19
		control	.933	.382	.074	-.06	1.93
	F2	F1	-.567	.382	.450	-1.56	.43
		F3	-.367	.382	.772	-1.36	.63
		control	.367	.382	.772	-.63	1.36
	F3	F1	-.200	.382	.953	-1.19	.79
		F2	.367	.382	.772	-.63	1.36
		control	.733	.382	.225	-.26	1.73
	control	F1	-.933	.382	.074	-1.93	.06
		F2	-.367	.382	.772	-1.36	.63
		F3	-.733	.382	.225	-1.73	.26
Springness	F1	F2	.767	.391	.210	-.25	1.79
		F3	.233	.391	.933	-.79	1.25
		control	.900	.391	.104	-.12	1.92
	F2	F1	-.767	.391	.210	-1.79	.25
		F3	-.533	.391	.525	-1.55	.49
		control	.133	.391	.986	-.89	1.15
	F3	F1	-.233	.391	.933	-1.25	.79
		F2	.533	.391	.525	-.49	1.55
		control	.667	.391	.327	-.35	1.69
	control	F1	-.900	.391	.104	-1.92	.12
		F2	-.133	.391	.986	-1.15	.89
		F3	-.667	.391	.327	-1.69	.35

Sensory evaluation

Juiciness	F1	F2	.100	.380	.994	-.89	1.09
		F3	.000	.380	1.000	-.99	.99
		control	.833	.380	.131	-.16	1.82
	F2	F1	-.100	.380	.994	-1.09	.89
		F3	-.100	.380	.994	-1.09	.89
		control	.733	.380	.221	-.26	1.72
	F3	F1	.000	.380	1.000	-.99	.99
		F2	.100	.380	.994	-.89	1.09
		control	.833	.380	.131	-.16	1.82
	control	F1	-.833	.380	.131	-1.82	.16
		F2	-.733	.380	.221	-1.72	.26
		F3	-.833	.380	.131	-1.82	.16
Taste	F1	F2	.233	.402	.938	-.81	1.28
		F3	.500	.402	.600	-.55	1.55
		control	1.200*	.402	.018	.15	2.25
	F2	F1	-.233	.402	.938	-1.28	.81
		F3	.267	.402	.910	-.78	1.31
		control	.967	.402	.082	-.08	2.01
	F3	F1	-.500	.402	.600	-1.55	.55
		F2	-.267	.402	.910	-1.31	.78
		control	.700	.402	.307	-.35	1.75
	control	F1	-1.200*	.402	.018	-2.25	-.15
		F2	-.967	.402	.082	-2.01	.08
		F3	-.700	.402	.307	-1.75	.35
Overall_Acceptance	F1	F2	.233	.393	.934	-.79	1.26
		F3	.400	.393	.740	-.63	1.43
		control	1.167*	.393	.019	.14	2.19
	F2	F1	-.233	.393	.934	-1.26	.79
		F3	.167	.393	.974	-.86	1.19
		control	.933	.393	.088	-.09	1.96
	F3	F1	-.400	.393	.740	-1.43	.63
		F2	-.167	.393	.974	-1.19	.86
		control	.767	.393	.214	-.26	1.79
	control	F1	-1.167*	.393	.019	-2.19	-.14
		F2	-.933	.393	.088	-1.96	.09
		F3	-.767	.393	.214	-1.79	.26

*. The mean difference is significant at the 0.05 level.

APPENDIX B

Table F1: Developed *Pleurotus ostreatus* mushroom patty

Formulation 1	
Formulation 2	
Formulation 3	

APPENDIX C

<u>Sensory Evaluation on The Consumer's Acceptability toward burger patty made from *Pleurotus ostreatus*</u>

A) Demographic of panelists

1. **Gender:** ☐ **Male** ☐ **Female**
2. **Race:** ☐ **Malay** ☐ **Chinese** ☐ **Indian** **Others: -----------------
-**
3. **Age:** ☐ **19-21**
   ☐ **22-24**
   ☐ **25-27**
   ☐ **28-30**
   ☐ **>30**

<u>Announcement on Sensory Evaluation</u>

Please be advised that you are going to try accordance with the code provided. Please drink plain water before every tasting to avoid remnant taste of previous patty sample.

B) Sensory Evaluation

The 7-point hedonic scale is being used and displayed using number, from 1 (EXTREMLY DISLIKE) 7 (EXTREMLY LIKE)

The scale is listed as below:

1- Extremely DISLIKE

2 - Moderately DISLIKE

3- Slightly DISLIKE

4- Neither LIKE nor DISLIKE

5 - Slightly LIKE

6 - Moderately LIKE

7- Extremely LIKE

1. **Please rate the patty with the code 729.**

	Extremely dislike	Moderately dislike	Slightly dislike	Neither like nor dislike	Slightly like	Moderately like	Extremely like
Aroma							
Colour (appearance)							
Hardness (texture)							
Springiness (texture)							
Juiciness (texture)							
Taste							
Overall Acceptability							

2. **Please rate the patty with the code 782.**

	Extremely dislike	Moderately dislike	Slightly dislike	Neither like nor dislike	Slightly like	Moderately like	Extremely like
Aroma							
Colour (appearance)							
Hardness (texture)							
Springiness (texture)							
Juiciness (texture)							
Taste							
Overall Acceptability							

3. Please rate the patty with the code 798.

	Extremely dislike	Moderately dislike	Slightly dislike	Neither like nor dislike	Slightly like	Moderately like	Extremely like
Aroma							
Colour (appearance)							
Hardness (texture)							
Springiness (texture)							
Juiciness (texture)							
Taste							
Overall Acceptability							

4. Please rate the patty with the code 771.

	Extremely dislike	Moderately dislike	Slightly dislike	Neither like nor dislike	Slightly like	Moderately like	Extremely like
Aroma							
Colour (appearance)							
Hardness (texture)							
Springiness (texture)							
Juiciness (texture)							
Taste							
Overall Acceptability							

2

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