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CONSUMER ACCEPTABILITY AND NUTRITIONAL COMPOSITION OF OYSTER MUSHROOM *SHITO*

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DECLARATION

STUDENT'S DECLARATION

I, Hannah Opoku declare that this Thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work and it has not been submitted, either in part or whole. For another degree elsewhere.

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SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Thesis as laid down by the University of Education, Winneba,

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DEDICATION

This work is dedicated to my husband Mr. Twumasi Asare and children Chris Opoku Twumasi Asare, Caleb Ohene Asare and Anne Mirabel Ohenewaa Asare.

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ABSTRACT

Mushroom has been accepted as one of food commodity with unique flavour and valued by humans as culinary wonder. The study aimed to examine consumer preference and quality expectation of oyster mushroom shito, evaluate the effect of different drying methods on the nutritional composition of oyster mushroom powder, evaluate consumer acceptability of oyster mushroom *shito* and to determine the physicochemical composition of oyster mushroom *shito*. The experimental design used for the study was completely randomized design (CRD) for both treatments of the method of drying for the oyster mushroom and the preparation of the *shito* samples. Oyster mushrooms was dried using three different drying methods (oven drying, sun drying and shade drying) to obtain oyster mushroom powder which was tested at the laboratory for its nutritional composition and then used to prepare oyster mushroom *shito* which was also tested for its physicochemical composition. It was seen in the results that; the oyster mushroom powder(s) had varying nutritional composition. Results from consumer panelist on the preference and quality expectation of *shito* revealed that consumers of *shito* prefer to have sweet aftertaste with mean (4.18), neither tasty nor very tasty (3.17) for tastiness, either spicy or not spicy (3.11) for spiciness and the least expectation was mouthfeel where respondents preferred neither smooth nor rough (2.93) *shito*. For the sensory evaluation and consumer acceptability of the samples of *shito,* the results revealed varying mean for all quality sensory attributes. Results from the physiochemical composition of the oyster mushroom *shito* showed varying composition in terms of protein, fat, fiber, moisture, free fatty acids, but colour had the same range for all the samples. The study concludes that oyster mushroom can be used to prepare shito however, different drying methods affects it nutritional composition. The study therefore recommends that more studies should be done on different drying methods and its effect on the nutritional composition

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Globally, mushroom has been part of the human culinary experience for centuries especially because of its flavour. Out of the more than 2000 species of mushroom that exist in nature, 25 has been used for both food and medicine (Das, 2019). It is considered as a nutraceutical food and have high nutritional content. It also has desirable organoleptic properties and economic significance (Valverde, Hernández-pérez, & Paredes-lópez, 2015).

Edible, medicinal, and wild mushrooms comprise the global mushroom industry, which was worth $63 billion in 2013. Edible mushrooms had the largest market size (54%), followed by medicinal mushrooms (38%) and wild mushroom (8%) (Royse, Baars, & Tan, 2017). China is world's leading producer of mushroom with about 87% of total production. Almost all the consumption of mushrooms in China, European Union, and India were obtained domestically (Chitra, Venkatesh, Dhanalakshmi, Sharavanan, & Sasikumar, 2018). In Ghana, production of mushroom has risen from about 3,700 to 4,500 (Bempah, 2011 as cited in Mensah, 2015).

Mushrooms are from the fungi kingdom; unlike plants, fungi lack chlorophyll; thus, fungi depend on other organisms for food. The macro fungi have visible fruiting bodies. The visible parts of the mushroom comprise the fan shaped or ear shaped cap span (5-25cm) and the stem. Its colours range from white to grey or tan to dark-brown (Das, 2019). .

Health benefits of mushroom include immunomodulatory, hypocholesterolaemia effects, and anti-tumor effects (Adebayo & Oloke, 2017).

Oyster mushroom are highly perishable, have shorter shelf –life of cultivation and post – harvest preservation is often associated with a compromise in quality (Bano & Rajarathnam, 1988). Appropriate preservation method would allow for consumption for throughout the year, ease of transportation and use of as ingredient for other processed foods. Oven, sun and shade drying are part of the oldest and inexpensive drying method of mushroom processing (Rama & John, 2000), that can extend the shelf life.

Current research has focused on the preservation method that focus on either sensory or nutritional qualities without trying to optimize both simultaneously. Research on oyster mushroom preservation has been geared towards improving commercial processing. To fully exploit the potential of oyster mushroom in communities, there is need for simple and affordable post- harvest preservation methods that optimize the quality of oyster mushroom. This study aims to evaluates consumer acceptability and nutritional composition of oyster mushroom *shito.*

Shito, or black hot pepper sauce, is a Ghanaian convenience dish made from vegetable oil, onion, ginger, tomato puree, dried pepper, smoked fish powder, smoked shrimp powder, stock cube, and spices. To make the sauce, the ingredients are combined and fried in oil. It has a wide range of applications in the food business, with a focus on condiments. Shito is preferred over other spicy sauces as a condiment (Asafo-Adjaye, 2018).

1.2 Statement of the Problem

Over the years, several researchers have been drawn to the necessity to use mushroom, but much emphasis has been placed on the nutritional composition of mushroom, while the use of mushroom in product creation has been underutilized. The oyster mushroom is delicate and susceptible to spoilage within a day of harvest. This is a constraint that fresh oyster mushroom distributors and marketers encounter. The mushrooms do not have a cuticle to protect them from physical, microbiological, or water loss. It also has a high moisture content and a fast rate of respiration (Han Lyn, Maryam Adilah, Nor-Khaizura, Jamilah, & Nur Hanani, 2020).

It is therefore imperative to use mushrooms in products that could preserve it, replace animal protein with plant protein and enhance its economic value which is a prepared shito. Shito is a Ghanaian black hot sauce commonly consumed with other foods. It has been shown that different drying processes affect the nutritional composition, phytochemical and sensory properties of oyster mushrooms (Oloruntola & Omolola, 2019)

Physiological and morphological changes like as browning, veil opening, weight loss, and microbial deterioration all affect the economic value of mushrooms. Enzymatic activity may also contribute to flavor differences (Tolera & Abera, 2017). As a result, the current study used three drying methods to assess consumer acceptability and nutritional composition of oyster mushroom shito.

1.3 Objectives of the study

1.3.1 Main Objective

The main objective of the study is to evaluate consumer acceptability and nutritional composition of oyster mushroom *shito*.

1.3.2 Specific Objectives

The specific objectives of the study were;

i. to examine consumer preference and expectation of oyster mushroom *shito.*
ii. to evaluate the effect of different drying methods on the nutritional composition of oyster mushroom powder.
iii. to evaluate consumer acceptability of oyster mushroom *shito*.
iv. to determine the physicochemical composition of oyster mushroom *shito*.

1.4 Significance of the Study

Fresh mushrooms have high water content, high enzymatic activity and are highly perishable, for this reason; drying method will be needed be to remove some water content hence extending the shelf life.

The expectation of the study is that, the findings of the study will help to expand mushroom usage, create jobs, and help to replace animal protein with plant protein. The production of oyster mushroom *shito* will aid in the reduction of post-harvest losses and will be utilized for fortification. The research will aid in the year-round preservation of mushrooms. Customers will be able to choose from a variety of options with this product. Vegetarians will also have a variety of options. This study will address a knowledge gap in the literature

for scholars and other researchers since it will create data on consumer acceptability and nutritional composition of oyster mushroom *shito.*

1.5 Scope of the Study

The study was carried out in the Sekondi- Takoradi Metropolis in the Western Region of Ghana and specifically focused on consumer acceptability and the nutritional composition of oyster mushroom *shito.* Contextually, the study aimed to evaluate the effect of three drying methods on the nutritional composition of oyster mushroom powder and to determine the physicochemical parameters of oyster mushroom *shito*.

1.6 Organization of the study

The study is organized into five chapters each of which presented specific details on the topic under review.

Chapter One centered on the introduction of the study and detailed the following headings: background of the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study, scope of the study, definition of terms and organization of the study.

Chapter Two was centered on review of related literature necessary for the study. Review of the topic was based on both theoretical and empirical evidence, which are relevant to the study.

Chapter Three captured the materials and method for the study which included research design, sources of raw materials, product development, population and sample

characteristics, sampling technique, data collection procedure, data collection instrument, data analysis and presentation.

Chapter Four detailed the data analysis of the findings for the study and chapter Five focused on the summary, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and evolution of mushrooms

Mushrooms are exceptional in the logical grouping since they are neither plants nor creatures, however are still living beings since they play out all the existence cycles of different life forms (Wong, Lai and Cheung, 2015). Mushrooms as indicated by Xu, Yan, Chen and Zhang (2018) have a place with an uncommon gathering called the organisms which are infinitesimal. Ganopedia (2011 as referred to in Xu et al., 2018), a mushroom is a parasite that has a stem, a cap and gills or pores on the underside of the cap. Cho and Kang (2014) likewise expressed that a mushroom is a macrofungus with an unmistakable fruiting body which can be either epigeous (developing on or near the ground) or hypogeous (developing underground). Mushrooms are not just basidiomycetes, they can likewise be ascomycetes, develop underground, have a non-beefy surface and could be unappetizing (Chang, 2017). All the noxious and the non-toxic parasites that can be seen with the unaided eye and can be picked with the hand are portrayed as mushrooms.

Mushroom was first developed in 600 A.D with wood ear mushroom and later, the white catch mushroom (Agaricus bisporus) development began in around 1650 A.D in France (Xu et al., 2018). The development quickly spread after the Second World War when dependable generate turned out to be usually accessible in numerous nations. A few examinations have likewise shown that eatable mushroom species have been found in relationship with 13000-year-old vestiges in Chile, yet the main solid proof of mushroom

utilization dates to a few hundred years BC in China (Afetsu, 2014; Kortei, 2016). The Chinese worth mushrooms for therapeutic properties just as for food. Antiquated Romans and Greeks ate mushrooms, especially the high society. The Roman Caesars would have a food tester taste the mushrooms before the Caesar to ensure they were protected. Numerous societies around the globe have either utilized or keep on utilizing psilocybin mushrooms for profound purposes just as restorative mushrooms in people medication (Afetsu, 2014).

In mushroom development, rural or modern waste is changed into soil conditioner. Mushrooms have a high added an incentive in contrast with different harvests. Mushroom creation is a troublesome assignment including numerous means, from choosing a reasonable strategy and strain to bring forth fabricating, developing the harvest and advertising the end result (Mensah, 2015). Hence, the exercises of mushroom creation are embraced generally by dynamic and devoted individuals. The premise of mushroom development is the breakdown of cellulose. The phone divider structure of basically all plants is a sinewy structure made out of cellulose and hemicellulose, encompassed by a primary compound called lignin.

The lignin folds over the cellulose strands like saran wrap. This makes for an extremely solid structure, permitting a tree to stand upstanding for a very long time. The cellulose and hemicellulose are made of sugars which are extraordinary wellsprings of food, yet these are ensured by the lignin wrapping, which is a truly steady compound and hard to breakdown. A couple of living beings can breakdown the lignin and use it as a food source, subsequently uncovering the basic cellulose and hemicellulose for food use by different

creatures. The most popular and best of these lignin-breakdown creatures are known as the white decay organisms, of which Oyster mushrooms are the perfect representations.

As per Enshasy, Elsayed, Aziz and Wadaan (2017) utilization of mushrooms might be related with the beginning phases of human advancement. The examination likewise added that during the Greek and Roman times, macrofungi were considered as food and medication for eminence, and were imported from Libya and sold in southern piece of the European mainland. Here no typical residents were permitted to devour this valuable food. In Africa and the southern piece of the Sahara notwithstanding, the migrant individuals of Kalahari Desert utilized mushrooms as diet and medication. By and large, the conveyance of mushrooms contrasts from area to locale contingent upon the conditions. Bamwesigye, Akwari, and Hlavackova (2019) guaranteed in their examination that the development of mushrooms requires a yearly precipitation range somewhere in the range of 50mm and 380 mm. All in all, the time, amount, and dispersion of the precipitation assume a significant part in the nature of desert macrofungus development.

For quite a long time, it was recommended that a large portion of the wild macrofungi or mushrooms are not cultivable. In any case, with the expanded information on mushroom physiology, it is conceivable to develop numerous sorts of macrofungi (Bamwesigye et al., 2019). Mushrooms were effectively developed in green houses and in lowered culture aging. While, in light of the cooperative conduct of mushrooms as regular ectomycorrhiza, they were developed in soil with their host plant in mushrooms green houses in semiarid territory. With the quick development of bioprocess innovation enterprises, it was conceivable to develop numerous macrofungi in lowered culture under completely

controlled conditions to create the ideal biotherapeutic mixes in high fixations, in more limited creation time, and under completely sterile conditions (Kortei, Odamtten, Obodai, Wiafe Kwagyan and Prempeh, 2018).

Plate 1: The growth of mushroom, Bempah (2011)

2.2 Types of mushrooms

There are more than hundred sorts of mushrooms on the planet over, anyway not many of them are consumable and are developed for creation. Furthermore, just few are essential considering their remedial properties model catch, shiitake, straw, shellfish, woodear, and so forth Joseph (2020) rehashed that from fundamental consumable mushrooms to uncommon combinations from the far-east, the earth offers an enormous number of them. In spite of the fact that they are actually a kind of organism, mushrooms are regularly perceived as a vegetable.

2.2.2 Morel Mushrooms

Morel mushrooms are irrefutably perhaps the most exceptional sorts of consumable mushrooms. They bear resemblance to honeycomb on a stick, and they have a bizarre, secretive appearance which proposes we presumably shouldn't eat them. Be that as it may, as one eats them they taste as extraordinary as they look extremely "substantial". These are that way, just substantially more extreme with a sort of nutty savor as well. So, in the event that one prefers shiitake you'll presumably cherish Morels. They are difficult to develop morel mushrooms for a huge scope, hence uncommon to find in the market. In any case, you can grow them or plucked them yourself. Morel mushroom are the most easily to identify wild mushroom due to their unique features. Nonetheless, for a person who doesn't have the slightest idea plucking mushrooms can be very difficult. Creating packs to make your own are available too, and they can safely fill in the nursery Developing packs to create some are accessible as well, and they can securely fill in the nursery. With respect to sustenance, this type of mushroom offers critical measures of Iron: 68% DV, Vitamin D: 52% DV, Copper: 31% DV, Manganese: 29% DV, Phosphorus: 19% DV, Zinc: 14% DV, and Riboflavin (Vitamin B2): 12% DV. In total, morel mushrooms are special in both taste and appearance. Sadly, it is practically difficult to purchase, however one can without much of a stretch pick or develop them ourselves.

2.2.5 Lion's Mane Mushrooms

Like morel mushrooms, the lion's mane mushroom (Hericium erinaceus) has an uncommon appearance. It is a huge type of mushroom that looks very surprising, as appeared in the above picture. Like some different mushrooms, cell considers demonstrate that lion's mane mushrooms have mitigating, gastroprotective, cardioprotective, and an inhibitory impact on disease metastasis. Once more, these instruments need reproducing in human preliminaries before we can get excessively energized however. These mushrooms fill in the wild all through Europe, North America and Asia.

Albeit generally uncommon in Western dishes, it has an enormous influence in Chinese food. Regardless of this, the mushroom is notable in the supplement field, and a combination of things are open. These consolidate concentrates, tablets, and even coffee mix drinks. Notwithstanding, instead of purchasing removes, you can purchase the genuine article in the event that you chase around in some Asian markets. They are additionally accessible in dried structures they taste very great and have an exceptionally serious substantial flavor. Fundamentally, Lion's mane mushrooms are chewy, solid, and strange appearance yet delicious.

basidomycetous parasites which helps in medications, seasoning and fragrances. The dietary segments of mushroom shift from proteins, sugars, unsaturated fats and nutrients.

2.3.1 Proteins and amino acids

Palatable mushroom offers inflated levels of protein, however differs enormously due to its various forms as well as phases of mushroom improvement (Afetsu, 2014). The inflated levels of protein ranges between 10.0 – 40.0% w/w. The basic amino corrosive levels (g/100 g protein) of mushrooms ranges between 34 to 47%. Findings from Cheung (2017) investigation indicated that the fundamental amino corrosive outlines of mushrooms indicate proteins are inadequate in sulfur-containing amino acids as well as methionine and cysteine. Threonine and valine are also very affluent in consumable mushroom. Consumable mushroom also contains proteins which have restricting amino acids such as lysine, leucine, isoleucine, and tryptophan (Diez and Alvarez, 2013). 7.14 to 12.3 mg/g is the range of free amino corrosive amounts in dry consumable mushrooms. This adds to the basic savour characteristics of mushrooms.

Proteins are atoms made out of numerous amino acids fused together via a connection of peptides. Proteins are very essential in the food items. There must be a cautious consideration of the affluent nourishment of protein because of it impacts in the usage of protein. The protein of a food can be transformed by the duration of warming whether low or extreme (McWilliams, 2018). Protein structure in food can shifts generally. Nourishments of creature cause and vegetables are amazing wellsprings of proteins. They are basically produced from components such as hydrogen, carbon, nitrogen, oxygen and

sulphur. Its structure squares comprise of Twenty α–amino. Its distinctive components is Nitrogen which ranges between 13.4% to 19.1% as a result of the varying forms of amino corrosive synthesis.

Moreover, proteins affluent in fundamental amino acids also possess elevated levels of nitrogen (Chang, 2017). Nitrogen is also the most utilized protein component. There is a basic understanding that unadulterated protein has 16% nitrogen. In this way, the protein component can be ascertained by increasing nitrogen by the factor 6.25 = (100/16). Almost all nourishments have an overall transformation factor of 6.25 that is utilized. Basically, the carbon and hydrogen are combined with oxygen till the protein and nitrogen is transformed to ammonium sulfate. At that point concentrated sodium hydroxide is added and the summary warmed to drive off the freed smelling salts into a known volume of a standard corrosive arrangement. The unreacted corrosive is resolved and the outcomes are changed by estimation, into a level of protein in the natural example.

2.3.2 Vitamins

Mushrooms are a decent wellspring of a few vitamins, for example, Vitamin B2, Vitamin B3, and Vitamin B9, and dry weight (DW) that ranges between 1.8-5.1, 31-65, and 0.30-0.64 mg/100 g due to its varying forms (Wong et al., 2015). Furthermore, the nutrients B2 present in mushrooms might be higher compared to vegetables including other forms of eggs and cheddar (Wong et al., 2015). They also have increasing amounts of the nutrient B3 compared to vegetables. Besides, the substance of bioavailability of Vitamin B9 is 300-1412µg/100g. Mushrooms also constitutes modest amounts of other nutrients such as

Ascorbic acid, Thiamine, Cobalamin and Vitamin D2 (Kortei et al., 2018). Jayakumar (2019) added that that mushrooms contain moderately a lot of nutrient such as retinol, ascorbic acid including β-carotene as a result possess cell reinforcement features.

2.3.3 Food Fibre

Mushrooms have expected wellspring of dietary fiber because of the presents of non-starch polysaccharides. Dietary fiber comprises of non-edible sugars including lignin which are inborn as well as unblemishade among plants (Xu et al., 2018). As per Rathee et al (2017) the suggested dietary fiber admission for human is 20-30 grams for each day and mushrooms have more than the required sum. Fiber which has various medical advantages, is a polysaccharide that might be soluble or insoluble. Soluble fiber breaks down in water and structures a gel. It's principally found in natural products, vegetables, oats, vegetables and the grains psyllium. Soluble fiber ties bile acids so they can't be reabsorbed in the colon, which helps in their discharge. This decreases serum cholesterol, gambled factor for cardiovascular sickness. Soluble fiber additionally assists delay with blooding glucose, focus in diabetic patients by easing back glucose ingestion in the small digestive tract.

Insoluble fibres anyway increment fecal mass and diminishes free revolutionary in the Glycaemic Index track. Polysaccharides also known as β-glucans just as β-1,3-D-glucans or β-1,4-D-glucans are available in higher plants including certain grains seeds, for example, oats and grain (Zhanga, Cuia, Cheungb, and Wanga, 2017). Affiliated polymers also called known as β-glucans then again potentially β-1,3-D-glucans and β—1,6-D-glucans, are blended by yeasts, molds and organisms (Jayakumar, 2019). Chen and Seviour

(2017) expressed that strands have parasitic beta-glucan wealthy in mushrooms act by invigorating the entire resistant framework so they may have a bit of leeway in curing sicknesses. Beta-glucans are not combined by people, so these mixes are perceived by our insusceptible frameworks as non-self-atoms, initiating both intrinsic and versatile resistant reactions. Chen and Seviour (2017) in addition referenced that grains contain basically beta-glucans accompanied by β(1→3)(1→4) blended connections, on the other hand mushrooms accommodates bigger measures of β(1→4)(1→6) than β(1→3)(1→4) blended connections along with distinctive individual connections, for example, β(1→3)(1→4) and (1→6).

2.3.4 Carbohydrates

The substance of carbohydrates available in edible mushrooms fluctuates between 35 to 70% DW depending on its form. Oligosaccharides have elevated amounts accompanied by inadequate level of absolute solvent sugars (Wong et al., 2015). Mushrooms have iron, calcium, phosphorous, sodium, copper, potassium accompanied by inadequate fat, which makes it appropriate for low calorie counts. Mushrooms additionally contain some measure of carbohydrates in their correct extents to keep the improvement of the body developing. It is likewise said that mushrooms are healthfully helpful nourishments and a wellspring of medications advancement. Factors such as water level, fats, debris and protein create varieties among the carbohydrates structure in food sythesis when deducted by 100 (Zhanga et al., 2017). Carbohydrates can be also called hydrates of carbon. The proportion of hydrogen to oxygen in the particle is essentially two to one irrespective of the smallest or biggest carbohydrates component, just like water.

Complex carbohydrates show various qualities, that fluctuate alongside a particular sort of compound. Starch is well known due to the binding capabilities it serves. Cellulose and hemicelluloses alter surfaces if added to edible items, leading to a fairly brutal mouthfeel. Gums and gelatins fill in as coagulating specialists which provides restricted calorie commitment (McWilliams, 2018). During nourishment preparation and assessment, dampness assurance is very significant. It is significant in numerous modern issues, for instance, in the assessment of material's equilibrium or of preparing misfortunes. Water is quite a typical constituent of nourishments and is utilized so as often as possible in food planning that it is anything but difficult to underestimate it. It very well may be found in strong, vaporous or fluid structure in nourishments. The energy states change due to how it is discovered. The translucent together with strong structure (ice) speaks to its minimal energy state and steam (vaporous form) speaks to elevated energy.

Debris which may to the inorganic buildup staying after one or the other start or complete combination with oxygen in a staple. Dry and wet ashing (oxidation) are the most notable kinds of ashing. The previous is fundamentally for immediate organization as wells as groundwork for assessment with respect to specific minerals. Debris structure speaks to the absolute mineral substance contained by nourishments. Initial phase with respect to edible assessment for essential investigation is ashing. Normally, a steady natural substance from the debris of creature items can be normal, yet obtained via plant origin is different (Harbers and Nielsen, 2013). Debris is the inorganic build-up from the burning of natural issue. The debris together with prepared items relies predominantly upon their salt substance. Debris

in nourishments is controlled by gauging the moisture less mineral build-up accompanied by natural materials warmed approaching elevated degrees (around 550°C). Complete debris structure serves as a helpful boundary together with healthy benefit of certain nourishments. In dry ashing, the natural issue is scorched off without flaring for a fixed timeframe and the build-up should be liberated from carbon. Porcelain receptacles can be used for the dishes. It is broadly utilized in light of their great weight steadiness and generally low cost. Platinum is prominently generally used as cauldron substance however it is very costly as a standard method of ashing due its enormous quantities as well as tests. Porcelain receptacles have barefaced exterior but difficult to wash with weakened hydrochloric corrosive. Truth be told, unfinishade receptacles can endure up to 1200°C for standard work.

2.3.5 Fatty acids

The fatty acids also called lipids have unelevated amount in mushroom which ranges between 2-8% in water. Lipids are also known as fat and oil. Fats have a strong feature when situated in room temperature. Lipids easily dissolve among natural solvents but among water it is not dissolvable due to its synthetic mixes (Rathee et al., 2017). The degree of polyunsaturated unsaturated fats when contrasted with immersed unsaturated fats is very high, comprising over 75% of absolute unsaturated fats, of which oleic and lenoleic acids are the most critical, while palmitic corrosive is the principle soaked unsaturated fat. Lipids, proteins and starches establish the chief underlying segments of nourishments. Lipids are a gathering of substances that, when all is said in done, are dissolvable in ether, chloroform or other natural solvents yet are sparingly solvent in water (Min and Boff,

2013). Lipids, similar to sugars, are natural mixes made out of carbon, hydrogen and oxygen. Nonetheless, oxygen is available in a lot of more modest extent and hydrogen in a bigger extent in lipids than in starches. This distinction in organization represents the huge contrasts in the energy estimation of lipids and sugars which are 9 and 4 kilocalories for every gram separately (McWilliams, 2018).

For lipids to be divided, liberated and solubilised among different mixes the must be a fruitful separation between the connection of lipids. For the most part, such dissolvability is achieved when lipids disparities and the dissolvable attain an equivalent level. Normal separation solvents include oil ether as well as Ethyl. The tendency to use oil ether is high since it is more specific to gain genuine lipids. To avoid a break up in oxidized lipids, it is preferable to use Ethyl ether instead of fats. Nonetheless, it is more costly, peril of blast, gets water during extraction of an example and breaks down non lipid materials. It is separated in nourishments via hydrolysis combined with oxidation. Hydrolysis includes the partition of an unsaturated fat from the glycerol spine of a triacylglycerol or phospholipid. Lipid oxidation is a response of lipids with sub-atomic oxygen that returns through a free-revolutionary component. It can bring about extreme smell alternatively creates a condition in which the oil and fats is combined with oxygen when exposed to air (Shewfelt, 2019).

2.3.6 Mineral Salt

Mushrooms have a more extravagant inventory of minerals than numerous meats and twofold the sum found in many vegetables. They likely contain each mineral present in the material on which they develop including considerable amounts of phosphorus, potassium

and lesser measure of calcium. Other mineral salts present in mushrooms incorporate sodium, magnesium, manganese, aluminum, zinc, iron and copper (Afetsu, 2014).

2.4 Heath benefits of mushrooms

As per Rathee et al (2017) because of the increased medical advantages of mushrooms to people, numerous logical distributions have turn in making an information on the particular wellbeing impacts of mushrooms and their bioactive atoms. A portion of these may incorporate; mushrooms go about as antioxidants, hypocholesterolemic specialists in diminishing cardiovascular diseases, antitumor specialists, antiviral specialists, and antimicrobial specialists.

2.4.1 Mushrooms as antioxidants

Numerous examinations possess presumed that eatable mushrooms have strong antioxidants. An examination in Japan discovered rough alcohol concentrate of mushrooms suggests cancer prevention agent action utilizing the peroxide an incentive among its methyl linoleate framework (Chang and Miles, 2014). Further investigation suggests methanolic taken out of red, dark and snow ear mushrooms, demonstrated it inhibitorily affect lipid peroxidation. In a connected investigation of methanolic removes from dark, red and snow ear mushrooms, demonstrated that they inhibitorily affect lipid peroxidation. The 1,1-diphenyl-2-picrylhydrazyl (DPPH) extremist rummaging as well as hydroxyl revolutionary searching shows solid decreasing force and capacity to chelate ferrous particles (Wainger, Helcoski, Farge, Espinola and Green, 2018). The investigation further expressed that mushrooms, have concentrates of T. giganteum, L. edodes, D. indusiate, P.

ostreatus, F. velutipes G. frondosa, H. erinaceus and P. cystidiosus, which contains cancer prevention agent properties.

Comparable cell reinforcement features are additionally identified in different palatable mushrooms like H. marmoreus, and Agrocybe cylindracea are in the Tricholomataceae family (Tsai, 2016). Other palatable mushrooms having a place with the Bolbitiaceae family like L. edodes (shiitake mushroom), V. volvacea (straw mushroom) and Pleurotus tuber-regium likewise have intense cell reinforcement action which are significant wellbeing conveyance. The cancer prevention agent movement and cell reinforcement mixes in wild eatable mushrooms additionally have β-tocopherol, phenolics and β-carotene obtained with the use of methanol extricates, solvent among vitro cell reinforcement frameworks. At a centralization of 0.05%, a phenolic compound called Flavogalucin is taken out of the mass of threadlike processes (hyphae) constituting the thallus of a fungus tangle among Eurotium chevalieri, makes it viable as a cancer prevention agent (Wainger et al., 2018). Almost all assessments indicate a good connection discovered in the complete phenolic structure of mushroom and their antioxidative properties. The capacity of phenolics to restrain lipid combination with oxygen makes edible mushrooms a regular antioxidant.

2.4.2 Mushrooms as antimicrobial agents

A few investigations have indicated that mushrooms require antibacterial as well as antifungal combination to survive in their domain, therefore possess affluent features as antiinfection agents (Ng, 2015). A large number of the externalized optional metabolites

(extracellular discharges) of mushrooms are known to battle microorganisms and infections (Tsai, 2016). As indicated by Xu et al (2018) mushroom mixes extracted exhibited action between antifungal as well as antibacterial, notably at odds with Bacillus subtilis, Escherichia coli and Staphylococcus aureus. Additionally, this it was discovered that entire concentrates of this mushroom restrain the development of microorganisms (Pityrosporum ovale, Staphylococcus epidermidis, Propionibacterium acnes) answerable for skin issues.

2.4.3 Mushrooms as antiviral agents

Basic anti-microbials are able to cure bacterial irresistible illness but not viral ailments which critically requires explicit medications. Mushroom concentrates as well as disengaged mixes depicted antiviral impacts. These antiviral agents can be allowed to perform straightforwardly due to viral chemical restraints, viral nucleic acid blends or adsorption and take-up of infections into mammalian cells. The impacts of the agent that kills viruses or that suppresses its ability to replicate is displayed by more modest particles. Immunostimulating actions by polysaccharides alternatively supplementary complex atoms create circuitous antiviral impact (Enshasy et al., 2017). Little atomic mixes with antiviral exercises, a few triterpenes from Ganoderma lucidum (for example ganodermanontriol, ganoderic corrosive B, ganoderiol F are dynamic as antiviral agents against human immunodeficiency infection type 1 (HIV-1) (Afetsu, 2014).

Further, ganodermadiol is dynamic against herpes simplex infection type 1, causing lip exanthema and different side effects (IC50 in Vero cells 0.068 mmol) (Ng, 2015). In vitro

antiviral action against flu infections type A and B was exhibited for mycelial concentrates of Kuehneromyces mutabilis, and two separated phenolic mixes from Inonotus hispidus and ergosterol peroxide, present in a few mushrooms (Kortei, Odamtten, Obodai, Wiafe Kwagyan and Dzomeku, 2018). The antiviral movement of Collybia maculate (vesicular stomatitis infections in BHK cells) is because of purine subordinates.

2.4.4 Mushrooms as immunomodulators

A few polysaccharides or polysaccharide–protein edifices from mushrooms can animate the vague insusceptible framework as well as to apply antitumor movement via incitement by an anchor safeguard system (Wu, Zhang and Leung, 2017). Rathee et al (2017) also added that Cytokines such as IL-1b, IFN-g, TNF-a are released by NK cells, T lymphocytes and macrophages cells in mushrooms thereby creating antiproliferative which incites apoptosis as well as separation in tumor cells. Evidence suggests β-d-glucans commences strong natural reactions which authoritatively film supplement receptor type 3 (CR3, alphaMb2 integrin or CD11b/CD18) against invulnerable effector cells. One receptor that can be disguised is the ligand-receptor.

An exploratory methodology displayed schizophyllan created via S. collective was ready to tie the mRNA poly (A) tail and that can support the invulnerable frameworks of people and different dependants (Shewfelt, 2019).

In comparative investigations, Zjawiony (2014) asserted that schizophyllan, lentinan from L. edodes, out of S. cooperative, MD-part from G. frondosa combines with T. versicolor (PSK and PSP) in mushrooms are for medical purposes (for example intravenous given 0.5-1.0 mg lentinan daily). Countries such as Japan including China, the intravenous from

mushrooms are utilized for adjuvant tumour treatment (immunotherapy) notwithstanding the significant malignant growth treatments like careful activity, radiotherapy and chemotherapy. Lentinan (parental) in addition to chemotherapy immediately increases the duration of endurance, immunological boundary recoveries as well as advancement in the quality of life for individuals with illness associated with colin disease, stomach malignancy including carcinomas as opposed to patient exclusively treated with chemotherapy (Hazama 1995 as refered to in Rathee et al., 2017).

Rathee et al (2017) again detailed different examinations, first was the investigation that pre-owned patients with cutting edge colorectal malignant growth, the middle endurance time was 200 days in the lentinan treated gathering (2 mg for each week, 23 patients) and 94 days in the benchmark group. Careful evacuation an entire tumor tissue during another investigation showed utilization as regards futraful plus mitomycin among 130 patients treated with schizophyllan (weekly dose of 40mg intramuscular, that is 1134mg). This schizophyllan medication commenced on day 14 following activity. After five years, the middle endurance time was 72.2% within schizophyllan gathering furthermore 61.9% in the benchmark batch (134 patients, chemotherapy as it were).

2.4.5 Mushrooms as anti-inflammatory agents

Ethanolic separates and a proteoglycan from P. linteus show anti-inflammatory impact in the collageninduced joint pain and in the croton oil-instigated ear edema test in mice and antinociceptive impact in the squirming test (Ribeiroa, Pinhoa, Andradea, Baptistab and Valentao, 2019). Different mixes powerful in the squirming test are the ganoderic acids A,

B, G and H, secluded from G. lucidum. Paw edema in mice was caused by Pleurotus pulmonarius fruiting bodies (500 in addition to 100mg/kg) within methanolic concentrate diminishade carrageenan and formalin. This action was tantamount to the remark about diclofenac (10mg/kg). Hydroxyl-extremist rummaging was 476 mg/mL as well as 960 mg/ml attributed to lipid peroxidation hindrance all based on IC50. 22-tetraen-3-one, ergosterol, 1-oleoyl-2-linoleoyl-3 palmitoylglycerol including ergosta-4-6-8(14) which is found in edible mushroom G frondos

restrains the movement of cyclooxygenases I and II (Zhanga et al., 2017).

2.4.6 Mushrooms as centrally acting agents

Other mushroom builds and concentrate that is excluding very much researched psychoactive types such as Psilocybe alternatively Amanita muscaria category turns out possess extraordinary focal impacts hence pharmacological premium. This has a better impact on Alzheimer's dementia as a result of nerve development factor caused by phenol-similar to mixes (hericenons C, E, D, G, F, H) out of H. erinaceus. Hericium coralloides which contains Erinacin E has an aging stock which initiates a physiological response when combined with kappa opiod receptor (IC50 of 0.8 mM, official at them opiod receptor with an I 50 of >200 mM). This combination can display a process of blocking the detection of a painful or injurious stimulus by sensory neurons movement without results saw with m receptor agonists such as morphine (Saito et al., 1998).

Also, screening examinations with focus on basidiomycetes show inhibitory impacts as regards Daedaleopsis confragosa, Fomitopsis pinicola G. applanatum, H. annosum including P. betulinus on nonpartisan endopeptidase (range of 40 and 55 mg/mL based on

IC50 values) (Ng, 2015). Particular inhibitors of this metalloendopeptidase could be helpful in the treatment of agony with a range of action like that of narcotics. Scutigeral, secluded from fruiting assortments of Scutiger ovinus possess partiality as regards cerebrum dopamine D1 receptors as such can go about with similarly orally dynamic agony executioner focusing on vanilloid receptors (VR1).

2.4.7 Mushrooms as anti-allergic agents

In spite of the fact that concentrates of numerous mushrooms can invigorate the insusceptible framework, while others stifle invulnerable reactions. This could be of interest, model the Oyster mushrooms can be used in remedying allergic diseases which is escalating around the world. Ethanolic concentrates contained in eatable Japanese basidiomycetes H. marmoreus, Pholiota nameko, F. velutipes, including Pleurotus eryngii indicate critical antiallergic impacts among mice (oxazolone-instigated type IV hypersensitivity) likewise following p.o. application (Reshetnikov, Wasser and Tan, 2016). A few mixes from G. lucidum (ganoderic acids C and D); restrain the histamine release from rodent mast cells. Eating of Tricholoma populinum in mushrooms prompted the relapse of extreme allergic indications in a patient with thromboangitis obliterans and in different patients with urticaria (Reshetnikov at al., 2016). Hispolon and hispidin, segregated from organic product groups of I. hispidus, hinder the chemiluminescence reaction of human mononuclear platelets and the mitogeninduced multiplication of spleen lymphocytes of people. In total, mushrooms are utilized straightforwardly in eating routine to advance wellbeing, exploiting the added substance and synergistic impacts of the bioactive mixes present in them. The expected restorative ramifications of mushrooms are

huge at the same time, definite components of the different medical advantages of mushrooms to people actually require escalated examination, particularly with the development of new proof of their medical advantage impacts.

2.5 Uses of mushrooms

The uses of mushrooms paying little mind to the sort are characterized into five; that is for diet or food, therapeutic, backing to the environment, tasteful purposes, and modifying the environmental change. As indicated by Kamalebo, Malale, Ndabaga, Degreef and Kesel (2018) in numerous pieces of the world, mushrooms comprise significant non-wood that give assorted substances and administrations to neighborhood networks. Particularly as a wellspring of food and pay, since they healthfully mushrooms are a significant wellspring of proteins, nutrients, fats, sugars, amino acids, and minerals which fill in as option for meat and fish. Moreover, mushrooms are generally utilized as medication and for recreational or faunal purposes. The individuals of West African sub-district actually depend on wild palatable mushrooms for their work particularly as an ease elective for creature proteins and seasoning in eating regimens.

Mushrooms are generally developed for food utilization particularly the vegans. In the investigation of Kamalebo et al (2018), some ethnic gatherings devour explicit mushrooms obviously isolating their eating routine or utilization profile from the others. For example, Cantharellus, rufopunctatus, and Termitomyces mammiformis establish the most eaten and particular mushrooms utilized by individuals. Additionally, Gymnopus sp., Collybia aurea, Marasmius arborescens, and Pleurotus tuber-regium are especially eaten local Africans a

ton. There is the Auricularia cornea sp. also, the A. delicata likewise generally favored by a great many people in the Central and Southern Africans.

Also, a few investigations recommend that, in the United State throughout the decade the utilization of mushroom have expanded (Tsung, 2017). Mushrooms are ordinarily utilized as a vegetable and accordingly the per capita utilization of it development has quadrupled since 1990. Per capita utilization of all mushrooms totalled about 4.94 pounds (0.99kg) in 2015 contrasted and about 0.69 pounds (0.31kg) in 1965. New market utilization additionally expanded to 742 million pounds (3.36868x108kg) in 2001 - 2012 (Afetsu, 2014). In Ghana, mushroom is devoured as a delectable meat-substitute and as fixing in soup and stew. The utilization is about a kilogram in Wa in the Upper West Region and over 8kg in the Eastern and Ashanti Regions (Bempah, 2011; Kortei et al., 2018).

As per Enshasy et al (2017) something else that could account the expanded creation of mushrooms on the planet has been the therapeutic impact it has. Studies, for example, Reshetnikov et al (2016); Roupasa et al (2017) have referenced that substances in mushrooms help support the restorative ability of people and creatures. Specialists around the globe have taken particular interests in mushrooms due to its therapeutic features. The earth shattering medicinal as well as physiological characteristics of mushrooms includes resistant upgrade, upkeep pertaining to homeostasis in addition to guideline from biorhythm, fix and counteraction of different sicknesses including enhancement as regards perilous infections, for example, malignancy, stroke and heart illnesses (Rathee et al., 2017). The different exercises of mushrooms have been considered which incorporates hypotensive plus renal impacts, immuno-modulatory together with antitumor exercises

pertaining to polysaccharide–protein complex (PSPC) via mycelial societies immuno-modulatory. There is another antitumor exercise of lectins from consumable mushrooms and different other therapeutic impacts of most usually considered G. lucidum (Ribeiroa et al., 2019).

Notwithstanding the abovementioned, mushroom creation are utilized for its monetary reason. The all-out mushroom creation worldwide had expanded more than 18-crease over the most recent 32 years, from around 350,000 metric tons in 1990 to around 6,160,800 metric tons in 2012 (Ramanathan, Sreenarayanan and Swaminathan, 2016). The main part of that expansion happened during the last 15years. An extensive move has happened in the composite of genera that establish the mushroom supply. During the 1979 creation year, the catch mushroom, Agaricus bisporus, represented over 70% of the world's stockpile (Tsung, 2017). The People's Republic of China is the significant maker of palatable mushrooms, creating around 3,918,300 tons every year (about 64% of the world's aggregate) (Wu et al., 2017). China likewise delivers over 85% of clam mushrooms (Pleurotus spp.) become around the world.

The all-out creation incorporates all new market and handling deals along with sum collected however not sold (shrinkage and unloaded, and so forth) Normal clam mushroom yield per ranch expanded 113kg (18.3%) every week, from 617kg in 2001 to 730kg in 2002. The creation of shellfish mushrooms (Pleurotus spp.) in the United States had expanded at a yearly pace of 14% from 881214kg in 1996 to 1936310kg in 2002. This expansion mirrors a global pattern toward expanded creation of this harvest. Shellfish

mushrooms represented 14.2% (875,600 tons) of the all-out world creation (6,161,000 tons) of palatable mushrooms in 1997. The expansion in United States creation is because of expanded customer interest and the moderately high pay cultivators get for the item. As per Royse (2003 as refered to in Villaescusa, and Gil, 2018) detailed that as indicated by the United States Department of Agriculture, ranchers got a normal of $2.00 per kg for new clam mushrooms while cultivators of A. bisporus got a normal of $1.07 per kg for new item in the 2001–2002 developing season. The more exorbitant cost got for new shellfish mushroom is because of the less-created and less-solid innovation accessible to producers for developing these species.

Bempah (2011 as refered to in Mensah, 2015) revealed that in the Brong Ahafo Region raises around 3,700 to 4,500 shellfish mushrooms treated the soil sacks in a week and sells 50kg per day. This was because of accessibility of enough water pressure being utilized to shower the manure packs. In southern Ghana, mushrooms are bundled and sold on weight or pack premise. Cultivators of V. volvacea delivered 5 to 10kg every week, and sell them at GH¢ 5 for each kg to clients and Pleurotus sajor-caju is sold at GH¢3 per kg and cultivators created around 5-50kg every week (Kortei et al., 2018).

In comparable examinations, mushrooms are developed for their tasteful, faunal and backing to the atmosphere conditions. As per Osarenkhoe, Okhuoya and Theophilus (2014) rationally, it very well may be accepted that current uses of wild mushrooms were results of antiquated experimentations and potentially sharp disclosure by people regardless of puzzled geneology of their social uses. Mushrooms are likewise plants and that any

capacity the plants play via lessening the carbo cycle, mushrooms can compliment. Finally, the multidimensional use has raised mushrooms to money crops status that are all around evaluated as food, medication, and a wide scope of other expected uses as mycofungicides, biofertilizers, novel medications, creature feed supplement and bioremediants and instrument in the sound administration of agroforests

2.6 Drying methods used for mushrooms

There might be not many however significant methods of drying mushrooms. The quintessence of drying a mushroom originate from the way that mushrooms are effectively transitory yields and subsequently drying them save them throughout an extensive stretch of time. The methods of drying may incorporate the use of food dehydrator, oven, box fan, the use of the sun, and the use of horse shelters for drying. Before mushrooms are dried utilizing any method, they are cleaned in water and depleted. This assists speed with increasing the drying of the mushrooms. It is accepted that new mushrooms may be stored at cooler temperature for a couple of days, yet dried and powdered mushrooms can be saved for months if not years at room temperature in the storeroom.

2.6.1 Use of food dehydrator

The use of the food dehydrator is one of the most straightforward method of drying mushrooms, notwithstanding, it doesn't come modest, thus relatively few individuals can't use this method. In the investigation of Oyetayo (2019) mushrooms are sliced up to make them dry snappier and simpler. Mushrooms can either cut into 1/2-inch pieces or,

contingent upon the shape, they can be chopped directly down the center. Mushrooms are organized on the drying racks and gathered in a dehydrator. As indicated by Oyetayo (2019) the course of action should be done with the end goal that the pieces are not stuffed so firmly on one another. This rate up the hour of drying the mushrooms.

The drying is done ceaselessly on a lower setting, no higher than 75o C. The low settings additionally help the mushrooms not to get consumes however to have a uniform drying. Studies have demonstrated that drying of mushrooms may take somewhat more, nonetheless, one needs to take care with the temperature all together there is less danger in harming the mushrooms (Frempong, 2015). Once more, over the span of drying, one would need to keep an eye on the mushrooms pretty much every 30 minutes and eliminate them when they are saltine dry. The drying of mushrooms additionally relies upon the quantity of mushrooms on the rack so it might take some time and some may dry quicker than others.

2.6.2 Oven drying method

This method might be somewhat less expensive than the dehydrator so it is prompted that on the off chance that you can't afford a dehydrator, you can undoubtedly figure out how to dry mushrooms with an oven (Oyetayo, 2019). The fundamental thought is the equivalent, applying outside warmth to dispose of dampness. The thought is that you don't prepare them excessively hot or, in all likelihood you hazard consuming off some solid mixes, or simply making them singed and net. The main distinction with the oven and the

food dehydrator is that, the oven is preheated first. Here the oven is preheated at a temperature of about 150°C.

Mushrooms are cut into 1/2-inch pieces or, contingent upon the shape, you can chop them directly down the center. Mushrooms are masterminded on a preparing skillet or sheet that isn't oiled. Care is likewise taken not to pack them so firmly that they don't lie on top of one another. The sheets are set in the oven and heated for at any rate 60 minutes, making a point to leave the oven entryway somewhat slightly open so dampness can get away (Wu, Orikasa, Ogawa and Tagawa, 2017). Following an hour in the oven, the mushrooms are hauled them out, flipped over, and cooked or heated for another hour. The cycle is proceeded with they are altogether dry. This method of drying mushrooms requires more minding having a dehydrator, however there are no additional costs and permits each to attempt greater clumps in turn.

2.6.3 Sun/Sun drying method

Utilizing the sun or the sun is another method of drying mushrooms. It is sans simple, and may not need any power. This method takes much more; however, it likewise is the best method for protecting flavor and intensity (Frempong, 2015). One significant thing to note is the correct climate. That is a spot not muggy, but rather a sunny climate, in any case, a decent spot for drying mushrooms is a lot of significant. This method should be possible at a room that gets a ton of sun, a level roof, or a windowsill. The main to do is to ensure the room is shielded from dampness, bugs, and creatures.

Here likewise the mushrooms are cut into 1/2-inch pieces or other pieces relying upon the shape and size of the mushrooms. The mushrooms are exposed in an on either a drying

sheet or a plate and care is taken all together that the mushrooms don't get stack to one another yet, the sun beams or radiation is permitted to hit the mushrooms. After some time, the mushrooms would need to be checked all through and flipped over. This drying method can take between a day to 3 days to dry completely relying upon the force of the sun, and the sponginess of the mushrooms. Some of the time contingent upon the climate, there is a decent possibility that the mushrooms will never get completely dry and when this happen an oven or a dehydrator is used to finish the cycle.

2.6.4 Air drying method

Plump mushrooms with immense dampness are mostly dried at reduced warmth. The mushrooms should be dried in a warm, airy spot so the water delivered vanishes promptly without wetting the paper towels. This should be possible by turning the oven to 200°F (93°C) and putting the plate with the mushrooms on top of the oven, not inside the oven. Mood killer the oven following 30 minutes. Not many hours after the fact, when the oven has cooled, rehash the way toward warming the oven and turning it off. The plate on top of the oven with the mushroom cuts get scarcely warm to the touch, however this is sufficient warmth to dissipate the water from the mushrooms without delivering fluid water. During the drying cycle, you should turn over any cuts that are excessively thick and begin twisting up at the edges. The drying cycle may take from 24 to 48 hours.

2.6.5 The Box Fan

A box fan is another extraordinary mushroom drying instrument. The thought is that dampness is ceaselessly removed by moving air. This is an ideal accomplice to the sun drying method. To do this method, basically set everything up as you would if drying in

the sun, and spot a box fan close to your mushrooms. Set the fan on the most elevated setting and as near the pieces as you can. The moving air will dry the mushrooms. Check them for the duration of the day to measure their dampness content. Once more, this method may not get mushrooms wafer dry, so you may need to quickly polish them off with a warming component on the off chance that you are anticipating long haul stockpiling. However, by consolidating a fan and a decent, sunny live with low dampness, you ought to have a great deal of drying achievement.

2.6.6 Freeze drying

Spot cut mushrooms isolated by paper towels in a paper sack in the freezer. After some time, the mushrooms will lose dampness and evaporate on the grounds that the paper sack permits water fume to go through. The cycle can be speeded by putting a revealed, paper-fixed plate with the cuts of mushrooms for the time being in the freezer before moving the frozen cuts to a paper pack. Overnight freezing in an open plate takes out a great deal of the surface dampness and forestalls the mushroom cuts from freezing into a frigid cluster that will take more time to dry out (Artnaseaw, Teerakulpisut, and Benjapiyaporn, 2019). Ice free coolers circle dry air in the freezer compartment utilizing at least one fans. Air dissemination assists with sublimating ice that forms on frozen things.

2.7 Consumer preferences and acceptability for mushrooms

Mushrooms are delicacy with clear food esteem. They have anyway obtained business status practically everywhere on the world because of their temperament of attractiveness and that mushrooms dishes are a typical thing in the greater part of the enormous lodgings

and cafés (Osarenkhoe et al., 2014). There are impressive varieties in taste and appearance. Showcasing capability of dried mushrooms is restricted, however the taste gets more grounded in the wake of drying (Shirur, Ahlawat and Manikandan, 2014). Costs of mushroom change because of the differing demand for mushrooms and the expanded demand for read-to-eat nourishments. Pizza and pie creating organizations have an appeal for cut mushrooms and stores are selling an expanding number of little bunches of cut new mushrooms. The mushroom business supplies around 5 to 25% of its new yield as cuts (Afetsu, 2014).

Over the 1999-2001 periods, mushroom cultivators sold a normal of 859 million pounds which is 3.89986x108kg (Tuno, 2015). The estimation of the 2001-2012 strength mushroom crops in the United States added up to $37 million, up 12% from the 2000–2001 seasons. Once more, deals volume of mushrooms in the United Kingdom was 4.03 million pounds a 11% from 9% in the 2014 with just 51 cultivators delivering 1.94x106kg (Guissou, Lykke, Sankara and Guinko, 2018). In Ghana likewise, singular mushroom ranchers in are making between GH¢5.00 to GH¢20.00 or more daily and selling about 10kg every week (Kumah and Olympio, 2016). Ladies are specialists in the utilization, preparing and promoting of vegetables including mushrooms. This is on the grounds that, these are basic assets to continue the family and guarantee great soundness of the family. Business of selling is a financial endeavor for individuals, particularly ladies having minimal capital, restricted admittance to land and working under work requirements. The livelihoods get from this endeavor contribute fundamentally to food security at the family unit level and empower ladies to accomplish a level of monetary autonomy inside the family spending plan (Bempah, 2011).

Individuals have would in general zero in additional on normal items or feed to have the option to have a solid existence and mushroom is likewise one of the characteristic items. Since mushrooms have numerous restorative properties, for example, cell reinforcement, antimicrobial, anticancer demonstrated by logical examinations (Gürgen, Yildiz, and Yildiz, 2018). Also, 90-95% of the mushrooms are water and so are dietary supplements (Kortei, 2016). Additionally, mushrooms have low fat and high protein, subsequently, making this gathering of nourishments more appealing. Particularly in this sense, mushrooms can be proposed to close the protein absence of veggie lover individuals.

There are a few reasons why mushrooms are liked, purchased and devoured by individuals, likewise with other bought items. Numerous items are created to fulfill limitless consumers' longings and necessities. These individual exercises comprise utilization practices of individuals (Wong et al., 2015). Utilization is really Multi-Criteria Decision Making (MCDM) conduct since it happens by assessing more than one rule. MCDM is the last decision by bringing about the assessment of the subsequent restrictions, for example, order, arranging, and disposal. Mushrooms are favored for it restorative, and wholesome purposes. As per Frempong (2015) before the year 2000, the cost of mushrooms was lower than that of meat, fish and a few vegetables. Additionally, after 2010, the inclination for mushrooms had expanded due halfway to the deficiencies in meats and the imports in fish. Moreover, Kumah and Olympio (2016) referenced that the desire for mushroom may have been because of its promptly accessible particularly in the country and peri-metropolitan networks.

Guissou et al (2018) added that mushroom decrease in certain zones of the world particularly in the non-industrial nations have originated from inaccessibility away

innovations. New mushroom as a forest item takes not many days to rot or ruin henceforth if care isn't taken to appropriately protect it, it might turn sour and may even start food contamination. In this manner the utilization or demand for mushroom were to a great extent upheld by imports from different nations. Nonetheless, with the coming of drying and other preservational methods the demand for mushrooms have seen a flood. In other related investigations, the unexpected expansion in the inclination for mushroom is accepted to have exuded from the embellishing of both nearby and mainland nourishments sold in the different food joints and eateries (Joseph, 2020).

Bamwesigye et al (2019) added that the accessibility of dried and powdered mushrooms in the different shopping centers and the numerous notices on their dietary benefit may have added some nibble to the expanded utilization and acceptability of mushrooms. Shirur et al (2014) additionally placed that the acknowledgment anyway of mushrooms as diets add something to the shading, smell or aroma and the flavor of the food. The investigation additionally referenced the introduction of nourishments that have mushrooms. That is mushroom add to the introduction by making the food more alluring to consumers. Like Shirur et al (2014), Joseph (2020) referenced that the value, nourishment, simple accessibility, restorative properties, bundling and flavor as the most significance factors that impact consumers or customers to acknowledge or lean toward mushrooms over different vegetables of different items.

2.8 Physicochemical parameters of mushroom

The physicochemical parameters of mushrooms identify with the physical and compound parameters of the mushrooms. As indicated by Tian, Zhao, Huang, Zeng and Zheng (2016)

measures that mushroom experiences, for example, drying to be prepared to different items can essentially influences physicochemical properties which incorporates supplements, shading and free unsaturated fats. Yang, Li and Hu (2020) added that the shading is one of the main quality parameters for dried rural items, which fundamentally impacts acknowledgment and estimation of wares by consumers.

2.8.1 Color

Shading is one physicochemical boundary that influences the nature of both handled and natural agrarian produce. Estimation of shading is critical to food fabricates since it helps in the standardization of tones and likewise the change in shading during handling and capacity.

Colorimeter and spectrophotometer are the primary instrument utilized for estimating the shade of products. With the utilization of spectrophotometric rule, the more modest the all-out contrast between the deliberate shading parameters, the closer the shade of the product is to it new example (Yang, Li and Hu, 2020). In an examination by Tiram (2013) found that subsequent to utilizing diverse drying techniques (lab stove, sun dry and low warmth air blow) for drying shellfish mushroom, sun dry had the most noteworthy incentive for splendid shading consequently nearer to shade of new clam mushroom. Freeze drying followed by normal air drying were discovered to be the drying techniques whose tone were discovered to be nearer new clam mushroom tests in an investigation by Yang, Li and Hu (2020).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Research Design

This study employed the experimental research design. Experimental research design offers the best method available to researchers to be able to investigate causality due to high degree of control (Luck & Rubin, 2010).

3.2 Sources of Raw Material

Fresh mushrooms were obtained from a local mushroom grower, in Takoradi, Western Region. Other commodities such as onion, oil, tomato puree, ginger, garlic, salt and mixed spices were also purchased at the Takoradi Market, Western Region.

3.3 Experimental Design

Completely Randomized Design (CRD) was used for the treatments of the method of drying for the oyster mushroom as while as the preparation of the *shito* samples. Oyster mushrooms was dried using three different drying methods (oven, sun and shade) to obtain oyster mushroom powder which was tested at the laboratory for its nutritional composition (protein, fat, fiber, carbohydrate, ash, moisture content, copper, potassium, phosphorus, zinc, magnesium, manganese, iron, calcium, sodium) and then used to prepare oyster mushroom *shito* which was also tested for its physicochemical composition (moisture content, protein, ash, fat, fiber, carbohydrate, free fatty acid and measurement of colour).

3.3.1 Processing of raw materials

Oyster mushroom which is the main ingredient for the preparation of the *shito* was processed into powder using three different drying methods as shown in figures 3.1.

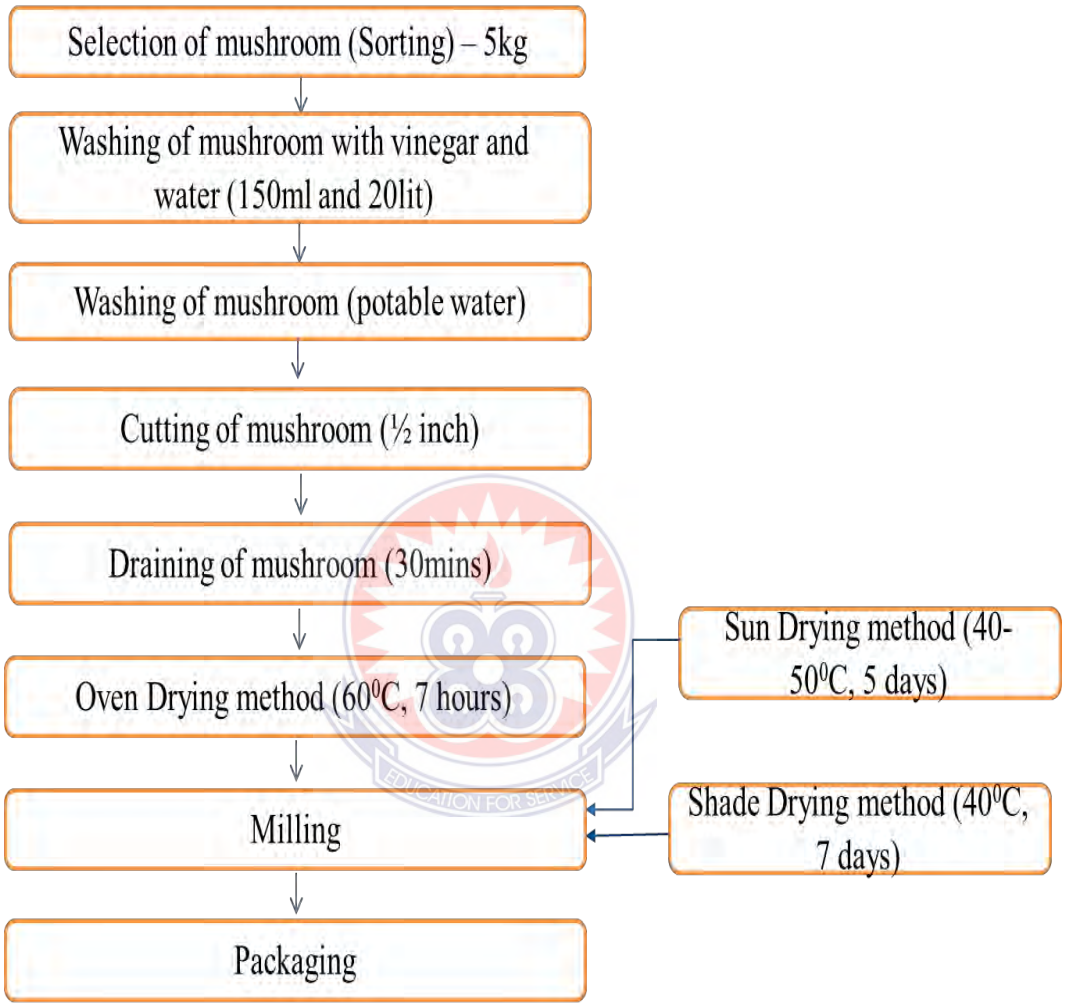

Figure 3.1: Flowchart for the processing of Oyster Mushroom powder

3.3.2 Preparation of samples of shito

Four *shito* samples were prepared as shown in Table 3.1. The *shito* samples were prepared using the method by Ofori (2007) with little modification.

Table 3.1: Samples of shito prepared with oyster mushroom powder

Ingredients	**Samples**			
	C	**T1**	**T2**	**T3**
Tomato puree	200g	200g	200g	200g
Onion	400g	400g	400g	400g
Powdered pepper	25g	25g	25g	25g
Ginger puree	25g	25g	25g	25g
Garlic puree	10g	10g	10g	10g
Shrimps and fish powder	200g	0g	0g	0g
Oven dried mushroom powder (OD)	0g	200g	0g	0g
Sun dried mushroom powder (SD)	0g	0g	200g	0g
Shade dried mushroom powder (ShD)	0g	0g	0g	200g
Vegetable oil	1000ml	1000ml	1000ml	1000ml
Salt	10g	10g	10g	10g
Mixed Spices	10g	10g	10g	10g
Stock cube	10g	10g	10g	10g

C, T1, T2 and T3; represents shrimps and fish powder *shito* (control sample), oven dried oyster mushroom *shito*, sun dried oyster mushroom *shito* and shade dried oyster mushroom *shito.*

3.3.2 Method of Preparation for shito

Onions, ginger and garlic were washed, sliced (1inch) and blended with oil. Oil was put on fire and blended onions, ginger and garlic was added and allowed to cook for one hour, using moderate heat. Stirring was done in fifteen-minute interval. Tomato paste, powdered pepper, stock cube and mixed spices were added, stirred and allowed to simmer for another hour. Mushroom powder(s) / shrimp and fish powder was added and allowed to simmer for one hour. Correction of seasoning was done and allowed to simmer. Stirring continued until a dark brown colour was obtained. Sauces (*shito*) was then removed from the fire, allowed to cool, packaged in sterilized bottles, covered and sealed.

3.4 Consumer Preference Test

Consumer preference and expectation of *shito* in general was conducted using students, lecturers and supporting staff (consumer panelist) of Takoradi Technical University specifically, Department of Hospitality Management. Using the Krejcie and Morgan (1970) sample size determination table as seen in (Table 3.2); a population of 140, the sample size to be used was 103, hence 103 consumer panelist were used.

Table 3.2 Proportionate allocation to Consumer Panelist

Consumer Panelist	Student (third years) Actuals	Prop Alloc.	lecturers Actuals	Prop Alloc.	Supporting staff Actuals	Prop Alloc.	Total Prop Alloc.
Student	115	84					84
Lecturers	20		20	16			16
Supporting Staff	5				5	3	3
TOTAL	140						103

3.4 Sensory Analysis for *shito* samples

Sensory analysis was based on preference test (consumer acceptance). Oyster mushroom *shito* samples were evaluated by 103 untrained consumer panelist. Evaluation was done base on sensory attributes such as colour, aroma (smell), taste (sweetness), taste (spiciness), flavour (taste + smell), smoothness, aftertaste, mouth feel and overall acceptability using a nine-point hedonic scale (9 – Like Extremely; 8 – Like Very Much; 7 – Like moderately; 6 – Like Slightly; 5 – Neither Like or Dislike; 4 – Dislike Slightly; 3 – Dislike; 2 – Dislike Very Much; 1 – Dislike Extremely). Panelist were consumers of mushrooms and *shito*. Each panelist was given four coded (three-digit code) samples to assess. Potable water and cucumber were provided for consumer panelist to rinse mouth in between tasting of samples, serving as a neutralizer.

3.5 Nutritional and Physicochemical Parameters of Mushroom Powder(s)/*Shito* Samples

3.5.1 Protein Determination of Mushroom Powder(s) and *Shito* Samples

The protein content of the oyster mushroom powder samples was determined by the Kjeldahl method (AOAC, 1990). The sample was first digested, followed by distillation then titration.

In a petri dish, 1g of the oyster mushroom powder was oven dried and grounded; this was labelled S. The weighed oyster mushroom powder sample was then passed through a 0.5mm sieve into a 500ml long necked Kjeldahl flask. 10ml of distilled water was added to the mixture in the flask and allowed to stand for 10 minutes. One spatula full of Kjeldahl catalyst (mixture of 1 part Selenium + 10 parts $CuSO_4$ + 100 parts Na_2SO_4) was added followed with 10ml conc. H_2SO_4. Digestion continued until a clear and colourless digest was obtained. It was allowed to cool at room temperature. The digest was put into a 50ml volumetric flask and toped up to the mark on the flask with rinsings from the digestion flask and distilled water. 10ml of an aliquot labelled t, from the digest was transferred with the aid of pipette into the Kjeldahl distillation apparatus, and addition of 90ml distilled water. 20ml of 40 % NaOH was then added. 100ml of the distillate was collected over 10 ml of 4 % Boric acid and three (3) drops of mixed indicator in a 500 ml conical flask for 5 minutes, giving a blue colour. The 100ml distillate collected was titrated with 0.1 N HCl till the blue colour changed to grey and then suddenly flashes to pink.

Calculation

$$\% N = \frac{(a - b) \times 1.4 \times N \times V}{S \times t}$$

Where:

a = ml HCl used in the sample titration b = ml HCl used in the blank titration

N = Normality of standard HCl V = total volume of digest

S = mass of oven dried sample taken for digestion

t = volume of aliquot taken for distillation (10ml)

Therefore, % Crude Protein (CP) = Total Nitrogen (N_T) x 6.25 (Protein factor)

3.5.2 Fat Determination of Mushroom Powder(s) and *Shito* Samples

Soxhlet extraction method according to AOAC (1990) was used for the fat analysis of the samples. A previously dried (air oven at 100°C) 250 ml round bottom flask was weighed first, followed with the weighing of 5.0g of dried the samples to a folded filter paper. 150ml of petroleum spirit (B.P 40-60°C) was added to the round bottom flask containing the sample and the apparatus was assembled. A condenser was connected to the soxhlet extractor and refluxing was done for 4 - 6 hours on the heating mantle. After the extraction, the folded filter paper was removed and solvent recovered by distillation. Heating of the flask and fat was done in an oven at 103°C to evaporate the solvent. The flask and contents were cooled at to room temperature in a desiccator. The flask was weighed and weight of fat collected was determined.

$$\% \text{ Fat} = \frac{(\text{weight of flask} + \text{fat}) - \text{weight of flask}}{\text{Weight of sample}} \times 100$$

3.5.3 Fiber Determination of Mushroom Powder(s) and *Shito* Samples

2g of the sample from crude fat determination was weighed into a 750ml Erlenmeyer flask. 200ml of 1.25% H_2SO_4 was added and the flask was immediately set on hot plate and connected to condenser. After 30 minutes, the flask was removed and immediately filtered through linen cloth in funnel and washade with a large volume of water. The filtrate (containing sample from acid hydrolysis) was washade back into a flask with 200ml 1.25% NaOH solutions. The flask condenser was connected and boiled for exactly 30 minutes. Filtering was done through Fischer's crucible and was washade thoroughly with water and 15ml 96% alcohol was added. Crucible and contents were dried for 2 hours at 105°C. Cool was done in desiccator before weighing. The crucible was ignited in a furnace for 30 minutes, cooled and reweighed.

$$\% \text{ Crude fibre} = \frac{\text{weight of crucible + sample (before – after) ashing}}{\text{Weight of sample}} \times 100$$

3.5.4 Mineral Determination of Mushroom powder(s)

Dry-ashing is used to determine the concentration of the individual nutrient elements in plant materials, of which mushroom is included (Jones & Case, 1990). Labelled 50ml graduated centrifuge tubes were washed and 1g of sample was weighed into a clean ceramic crucible. The weight of sample plus crucible was recorded. One empty crucible was also weighed to serve as a blank. The ceramic crucible and its content were place in a cool

muffle furnace and ramp temperature to 500°C for 2 hours. The temperature remained at 500°C for an additional 2 hours. It was allowed to cool down in the oven. The sample was removed from the oven and the ashed sample was poured into the labelled 50ml centrifuge tubes. The crucible was rinsed with 10ml distilled water into the centrifuge tube. The crucible was again rinsed with 10 ml of aqua regia. The tubes were vortexed (shake) for 5 minutes to ensure proper mixing. The samples were centrifuged for 10 minutes at 3000 rpm. The supernatant was decanted into clean vials for macro (calcium, magnesium, phosphorous sodium and potassium) and micro (iron, copper, zinc and manganese) mineral determination. The minerals were then determined using flame Atomic Absorption spectrophotometer (VGP 210 from Buck Scientific, USA).

3.5.5. Moisture Determination of Mushroom Powder and *Shito* Samples

The oven drying method according to AOAC (1990) was used for the determination of moisture. 5g of sample was dried and transferred into weighed dish. The dish was placed in an oven which is thermostatically controlled at 105°C for 8 hours. The dish was removed and placed in a desiccator to cool at room temperature and weighed. Drying was done again for 30 minutes, cooled and weighed.

Calculations

$$\%\text{moisture (wt/wt)} = \frac{\text{weight of wet sample} - \text{weight of dry sample}}{\text{weight of wet sample}} \times 100$$

3.5.6 Free Fatty Acid Determination of *Shito* Samples

Determination of the free fatty acid was done according to procedures described by Jonfia-Essien (2001) and Jonfia-Essien (2004). The sample was first melted and 5g was weighed into a 250ml conical flask. 25ml of Diethyl Ether and 25ml of Ethanol each was added to the contents in flask. The flask was swirled to mix the content well. Titration was done against 0.1M KOH with phenolphthalein as indicator till a faint pink colour appeared. Tabulation of the results was as follows:

$$\text{Acid Value} = \frac{56.1 \times T \times V}{W}$$

Where T = Concentration of Standardized KOH

V = Volume of KOH used (Titre value)

W = Weight of fat sample used (g)

$$\text{Free Fatty Acid (FFA)} = \frac{\text{Acid Value}}{M}$$

Where M = Molecular weight of fat sample

3.5.7 Colour Determination of *shito* Samples

Colour was measured with the American Spice Trade Association Value (ASTA value) based on the ASTA 20.1 method (ASTA, 1986; Ho-Cheon, 2015). Sample of 100mg was added to 100ml acetone and stored at 0°C for 4 hours with recurrent mixing in order to ensure sufficient extraction. The absorbance of the extract was measured at 460nm using spectrophotometer. The ASTA colour value was calculated as

$$\text{ASTA colour value} = \frac{\text{absorbance of acetone extracts} * 164 * I_f}{\text{Sample weight}}$$

I_f is the correction factor for the apparatus

Extractable colour is expressed in either America Spice Trade Association (ASTA.) value or International Colour (IC) units.

International colour units = ASTA Colour value *40

Thus IC unit are 40 times the ASTA values

3.5.8 Ash Determination of Mushroom Powder and *Shito* Samples

Ashing is defined as the heating of a food substance to leave only non-combustible ash, which is analysed for its elemental composition. The term ash refers to the residue left after the combustion of an oven dried food. Ash is the inorganic residue obtained by burning a sample at 500 ℃ -600℃. Ashing of a feed sample burns off all organic constituents, leaving behind the non-volatile mineral elements. The temperature used for this determination may also affect some elements such as selenium and arsenic, which form volatile oxides when present. These losses can therefore be avoided by addition of known quantities of calcium oxide prior to ashing.

In a porcelain crucible, 10g of sample was weighed into in duplicate. It was then put into furnace for 4 hours at 550℃. Furnace was allowed to cool below 200℃ and maintained for 20 mins. The ash crucible was remove from the furnace, place in desiccator, cool and weigh.

Calculations

(A + B) – A = B

(A + C) - A = C

% Ash = C/B x 100 where A = crucible weight, B = sample weight, C = ash weight.

3.6 Data Analysis

Results were analyzed using Statistical Package for Social Sciences (SPSS) version 22. Statistical significance was determined using Analysis of Variance (ANOVA). Duncan's Test ($p < 0.05$) was used to determine differences between the samples. Graphical representations were done using Microsoft Excel.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Consumer Preference and Expectation of *Shito*

This section gives the various information on consumer preference and expectation of *shito*. Issues discussed included; demographical data of consumers, the intake of *shito* in general, various food taking along with shito, how consumers obtain their *shito*, preference of ingredient in *shito*, sensory quality attribute of expected *shito*, whether consumer want *shito* made from mushrooms, factors affecting consumers' patronage of mushroom *shito* and finally the type of oil consumers want to be used for their *shito*

4.1.1 Demographic Data of Consumers

The socio-demographic variables covered in the study included; gender, age, marital status, religion, nationality and status (rank) of respondents.

Table 4.1: Demographic Data of Consumers

Demographic Data	Frequency (*f*)	Percentage (%)
Gender		
Male	15	15.0
Female	88	85.0
Age in years		
Below 18	0	0.0
18-20	1	1.0
21-30	77	75.0
31-40	15	14.0
41-50	8	8.0
51-60	2	2.0
Above 60	0	0.0
Marital Status		
Single	76	74.0
Married	26	25.0
Divorced	0	0.0
Widow	1	1.0
Religion		
Christian	99	96.0
Muslim	4	4.0
Buddhist	0	0.0
Nationality		
Ghanaian	103	100.0
Non- Ghanaian	0	0.0
Status (Rank)		
Teaching Staff	16	15.0
Non- teaching Staff	3	3.0
Student	84	82.0

Source: field data, 2020

Table 4.1 presents the demographics of the consumers. The gender distribution of the respondents was skewed toward females (85%) and (17%) being males. This could be due to the fact that, respondent used for the studies were from the Department of Hospitality Management which is a female dominated Department because of the programme being offered. For age, majority of the respondents were 40 years and below. This gives an indication that significant number of respondents were in their youthful age. With respect to marital status of respondent, majority (74%) were single, (25%) married whiles (1%) was a widow. From the results it could be seen that, respondent's status in terms of (rank) were student (84%).

In terms of religious affiliation, most (96%) of the respondents were Christian whiles the remaining were Muslims. For nationality all (100%) of the respondents were Ghanaians. In relation to the status (rank) of the respondents, majority (82%) were student as they form the highest population of the university, (15%) were teaching staff whiles the remaining represent the non-teaching staff as shown in (Table 4.1).

4.1.2 "Shito"Preference and Expectation

In order to know the preference and quality expectations of *shito* by consumers, they were asked to indicate if they had eaten *shito* before, the foods they had or usually eat *shito* with and how they do obtain their *shito*; which has been shown in Table 4.2

Table 4.2: General *Shito* Preference

Statement	Frequency	Percentage %
Whether panelist consumes *shito*.		
Yes	103	100
No	0	0.0
The food panelist consumed *shito* with.		
Kenkey and rice dish		
Kenkey, Rice dish and Gari	2	2.0
Kenkey, Rice dish, Gari and Banku	6	6.0
Kenkey, Rice dish, Gari, Banku and Bread	75	73.0
Kenkey, Rice dish, Gari, Banku, Bread & Ampesi	5	5.0
Kenkey, Rice dish, Gari, Banku, Bread, Ampesi, & Spaghetti	14	13.0
How consumer panelist obtained their *shito.*	1	1.0
Self-made	71	69.0
	19	18.4

Source: field data, 2020

From (Table 4.2) respondent were asked whether they take *shito* and overwhelmingly all (100%) respondent affirmed. A combination of food was outlined to know how consumers take *shito* along with these foods, majority (73%) of the respondents do take *shito* with Kenkey, any Rice dish, Gari and Banku and least (1%) do take *shito* along with Kenkey, any Rice dish, Gari, Banku, Bread, Ampesi and Spaghetti. This result confirms the works of Oloruntola & Omolola (2019), that *shito* is a Ghanaian black hot sauce commonly consumed with other foods. With respect to how respondent obtained their *shito*, the result

revealed that, most of the *shito* were self-made representing (69%) the rest were bought or obtained by both which was (18.4% and 12.6%) respectively.

Table 4.3: Preference of ingredients in *shito*

I/N	Ingredients	Rating					
		VI (*f*) 5	IM (*f*) 4	N (*f*) 3	NP (*f*) 2	NVI (*f*) 1	Mean
1	Onion	97	6	0	0	0	4.94
2	Ginger	62	35	4	0	2	4.50
3	Garlic	52	35	10	4	2	4.27
4	Tomato Puree	47	28	16	4	8	3.99
5	Powdered Pepper	71	26	4	2	0	4.61
6	Oil	89	14	0	0	0	4.86
7	Mixed spices	63	34	4	0	2	4.51
8	Salt	60	39	0	0	4	4.46

Source: field data, 2020

Scale: 1 – 1.49 = NVI (Not very Important), 1.5 – 2.49 = NP (Not Preferred), 2.5 – 3.49 = N (Neither important or not important), 3.5 – 4.49 = IM (Important), 4.5 – 5 = VI (Very Important)

When consumers were asked to indicated their willingness to patronize shito prepared from oyster mushroom; it can be seen from figure 4.2, that a greater percentage (81%) of the respondent would like *shito* made from mushroom whiles the remaining (19%) would not like *shito* made from mushroom. The results indicate that most of the respondent will patronize *shito* made from mushroom.

Table 4.4: Factors affecting respondents' patronage of mushroom *shito*

I/N	Factor	Rating					
		NVI (*f*) 1	NI (*f*) 2	N (*f*) 3	IM (*f*) 4	VI (*f*) 5	Mean
1	Drying method use for mushroom	14	16	10	35	28	3.48
2	Price	8	5	10	40	40	3.99
3	Packaging	2	2	8	38	53	4.35
4	Aroma	4	4	2	38	55	4.35
5	Colour	4	6	6	37	50	4.23
6	Taste	2	0	2	26	73	4.64
7	Appearance	2	2	2	30	67	4.54
8	Texture	6	0	8	34	55	4.31
9	Spiciness	6	14	7	33	43	3.93

Source: field data, 2020

NVI = Not very Important, NI= Not Important, N = Neither important or Not Important, IM = Important, VI = Very Important

Based on the results obtained from this section samples of *shito* were prepared for consumer's evaluation and acceptability. Oyster mushroom which served as the main ingredient for the shito was dried and made into powder before it was used to prepare the shito. The oyster mushroom powder obtained from the three different drying methods (oven drying, OD; sun drying, SD and shade drying, ShD) was analysed for its nutritional composition.

4.2 The Effect of Three Drying Methods on the Nutritional composition of Oyster Mushroom Powder

The nutritional composition of mushroom powder produced from three different drying methods are shown in (Table 4.5)

Table 4.5: Nutritional composition of oyster mushroom powder

Composition	Samples		
	OD (60°C)	**SD (40°C - 50°C)**	**ShD (40°C)**
Moisture (%)	11.10±0.005^{b}	9.60±0.52^{a}	9.40±0.51^{a}
Fat (%)	1.00 ± 0.12^{a}	2.50 ± 0.16^{b}	2.00 ± 0.06^{b}
Protein (%)	21.74 ± 0.26^{a}	23.52 ± 0.10^{b}	26.63 ± 0.22^{c}
Fiber (%)	1.59 ± 0.15^{a}	1.50 ± 0.78^{a}	2.63 ± 0.89^{b}
Ash (%)	8.0 ± 0.23^{a}	8.80 ± 0.13^{c}	8.40 ± 0.24^{b}
Carbohydrate (%)	56.57 ± 0.15^{c}	54.08 ± 0.13^{b}	50.94 ± 0.11^{a}
Ca (%)	0.48 ± 0.15^{a}	0.40 ± 0.89^{b}	0.40 ± 1.08^{b}
Mg (%)	0.02 ± 3.88^{a}	0.14 ± 0.90^{b}	0.19 ± 2.37^{c}
P (%)	1.94 ± 0.02^{a}	1.58 ± 0.90^{b}	1.65 ± 0.97^{c}
Na (%)	0.02 ± 0.00^{a}	0.02 ± 0.01^{a}	0.02 ± 0.00^{a}
K (%)	0.55 ± 2.37^{a}	0.62 ± 4.78^{b}	0.56 ± 3.11^{a}
Fe (mg/kg)	154.00 ± 1.77^{a}	167.80 ± 2.46^{b}	272.20 ± 0.51^{c}
Cu (mg/kg)	20.10 ± 1.08^{a}	18.90 ± 1.09^{b}	23.80 ± 0.73^{c}
Zn (mg/kg)	107.80 ± 0.15^{a}	104.20 ± 0.10^{b}	192.10 ± 0.04^{c}
Mn (mg/kg)	53.17 ± 0.89^{a}	66.96 ± 3.88^{b}	97.46 ± 2.37^{c}

*Values on the same row followed by different letters vary significantly from each other based on Duncan's test ($p<0.05$)
OD – Oven dried oyster mushroom powder, SD – Sun dried oyster mushroom powder, ShD – Shade dried oyster mushroom powder

Table 4.5 shows the various nutritional composition found in the three oyster mushroom powders. The moisture content of the products ranged between 9.4% to 11.1%. The highest moisture content of 11.1% was found in Oven dried sample followed by sun dried sample depicting moisture content of 9.60% (Table 4.5). The moisture content of 9.40% was found in Shade dried oyster mushroom lower than sun and oven dried ones which is in agreement

with the findings of Maray *et al*. (2018). This might be because of fluctuating temperature and relative humidity during sun drying than oven drying that employs uniform temperature for effective moisture removal Muyanja *et al.* (2012). In contrast to oven dried oyster mushroom, osmotic dried mushrooms exhibited lower moisture content of 6.23% which might be because of greater water loss during osmosis (Tolera *et al.,* 2017; Sharma and Bhat, 2018).

Oyster mushrooms are very low in fat content. The fat content of the samples ranged from (1% to 2.5%). There was an increase in fat content with a reduction in temperature. The mushroom dried at 60℃ had (1%) fat content, while the sample with a temperature of (40℃) had a fat content of (2%). The study shows that, the drying method used with its associated temperature had an effect on the fat content of the samples. Analysis of variance (appendix C) confirmed significant differences ($p<0.05$) among the fat content of the oyster mushroom powder. There were however no differences between the samples produced at (40℃ and 40 - 50 ℃). The value obtained for this study also lie within the range mentioned by Dickeman *et al.,* (2005). The values of mushroom powder are in accordance with the values mentioned by Bano & Rajarathnian (1988).

The drying methods caused a decrease in crude fat content of oyster mushrooms which might be attributed to oxidative losses as mushroom fat is mainly composed of polyunsaturated fatty acids mainly susceptible to oxidation when mushroom slices are exposed to drying medium (Muyanja *et al.,* 2012). The lesser crude fat loss in shitake mushrooms (Lentinusedodes) was reported by Duan and Xu (2015) subjected to freeze

drying in comparison to oven, microwave and sun drying thus confirming our results. The oven dried samples exhibited lower crude fat content coinciding with the results reported by Tolera and Abera (2017) while studying the impact of different drying methods on quality of oyster mushrooms. The greater decrease in crude fat content during osmotic drying might be attributed to leaching losses taking place during steeping (Tadese *et al.,* 2015).

The protein content of the samples is also shown in Table 4.5, the proteins ranged from (21.74% to 26.63%). The sample that used the oven drying method with the highest temperature (60°C) had the lowest content of protein. The sample with the lowest temperature which is shade drying method also had the highest protein content. Thus, heat had an effect on the protein content of the samples. Analysis of variance confirmed significant differences ($p<0.05$) among the protein content of the oyster mushroom powder. Temperature had an effect on the protein content of all samples.

The average protein content across all samples was (24%). There is wide variation in the amount of protein detected in oyster mushroom. Content as high as (30-40%) has been previously reported by (Mattila *et al.,* 2002). Similar to the current study, Gothandapani *et al.,* (1997) reported protein content of (16.8-26.4%) in oyster mushroom. Variation may be due to differences in mushroom strain and growing conditions. Arumuganathan, Manikantan, Indurani, Rai, and Kamal (2010) reported that temperature in the order of (60°C) could result in denaturation of protein leading to a reduction in protein content of oyster mushroom. However, Yang, Lin, and Mau (2001) reported similar protein content

(23.9%) as compared to this study. The lower protein content of dried oyster mushroom may be due to leaching out during steeping. In general, drying process used caused a considerable decrement in protein content (Hassan & Medany, 2014).

Results of the current study are also consistent with the results of Oni *et al*. (2015) and Munaza (2018) while studying the effect of different drying methods on various botanicals and quince, respectively. During oven drying, the higher temperature employed might be responsible for protein denaturation and consequential protein loss in contrast to freeze drying resulting in better crude protein retention (Tolera and Abera, 2017; Arumuganathan et al., 2010). Ngabo *et al.* (2016) while investigating the impact of drying methods on protein content of mushrooms reported higher protein content in mushroom subjected to freeze drying than the mushrooms subjected to osmotic treatment and oven drying thus confirming our results. The crude protein content of shade dried mushroom was found to be less than the mushroom subjected to oven drying quite consistent with the findings of Tolera and Abera (2017) who reported low protein content in shade treated oyster mushroom than the oven dried mushroom. The leaching of low molecular weight soluble protein fractions during steeping step of shade drying be responsible for greater reduction in crude protein (Maray *et al*, 2018).

The fiber content of the samples is also shown in Table 4.5 Sample SD whose method of drying for the oyster mushroom was sun recorded the least fiber (1.50%). This was followed by sample OD (oven drying method). The sample (ShD) which used shade as the method for drying had the highest fiber content. The study also showed significant

differences ($p<0.05$) among the fiber content of the powders. Duncans test (as shown in appendix) however showed no significant differences ($p<0.05$) between the samples OD and SD respectfully.

Fiber in food facilitates easy digestion in the colon and reduces constipation (Elleuch *et al.,* 2011). The presence of high fiber in food products is essential owing to its ability to facilitate bowel movement (peristalsis), bulk addition to food and prevention of many gastrointestinal diseases in man (Satinder *et al.,* 2011). Again, fiber in food is involved in the enhancement of gastrointestinal tract and cardiovascular health. It also aids in lowering the blood cholesterol level and slows down the process of absorption of glucose thereby assisting in keeping the blood sugar level in control (Anderson *et al.,* 2009). Additionally, it ensures smooth bowel movement leading to easy flushing out of waste product from the body.

These results are in line with the findings of Morais *et al.* (2017) reporting higher crude fiber in peels of oven dried avocado and melons than the samples subjected to freeze drying. Sengupta et al. (2012) and Chauhan et al. (2015) also reported higher crude fiber in microwave dried okra and karonda, respectively, than oven dried one thus confirming our results. This might be because of the increased susceptibility of lignocellulosic substances to enzymatic activity in response to microwaves (Kam, 1991). Similar results were reported by Aishah and Rosli (2013) and Tolera and Abera (2017) while studying the effect of sun and sun drying in oyster mushroom. The oven drying method in comparison to sun and sun drying methods might be responsible for greater cellular disruption leading

to greater susceptibility to enzymatic activity thereby increasing the crude fiber content (Hameed, 2016). The osmotic dried oyster mushroom exhibited lower crude fiber content in contrast to oven dried sample consistent with the findings of Omolayo *et al.* (2016) and Tolera and Abera (2017) reporting decrease in crude fiber content with the osmotic treatment in bitter leaf (Vernonia amygdalina) and oyster mushroom, respectively. This might be attributed to changes in cellular structure like degradation of pectin and diffusion of solutes during osmotic treatment (Tadese *et al.,* 2015).

On assessing the effect of drying methods on the ash content, the highest total ash content was reported in sun dried mushroom corresponding to a value of 8.8% (Table 4.5). Similar results were reported by Sharma and Bhat (2018) while studying the impact of different drying methods on total ash content of oyster mushrooms. This might be because of diffusion of sodium ions from brining/steeping solution into mushroom slices during steeping process as water migrates out of mushroom slices (Maray *et al.,* 2018). The total ash content of oven dried sample was found to be higher (8.0%) than the oven and shade dried samples reflecting total ash values of 8.0 and 8.40%, respectively. This might be because of low temperatures and vacuum employed during shade drying resulting in better retention of minerals and thereby giving higher values of total ash (Gunya et al., 2016). Hsu *et al*. (2003) reported higher ash content in freeze dried yam flour in comparison to oven dried samples compatible with our findings. Ajayi *et al*. (2017) reported higher ash content in oven dried ginger than microwave dried samples indicating higher mineral losses during microwave drying similar to our results. The formation of stable compounds such as aluminium or ferric oxides in response to microwaves might be responsible for greater

mineral loss and consequential low ash content of microwave dried oyster mushroom than the oven dried one (Arslan *et al.,* 2010). The sun dried oyster mushrooms reflected least value of total ash corresponding to value of 8.00 per cent. Eissa et al. (2013) reported low ash content in zucchini (green squash) rings subjected to sun drying than the oven drying thus confirming our findings. Ukegbu and Okereke (2013) while comparing the effect of sun and sun drying on total ash content of okra reported higher values for sun dried samples than the sun dried samples similar to our findings. The relatively lower ash contents of sun and sun dried oyster mushroom in contrast to other drying methods might be attributed to prolonged exposure to air and the fluctuating temperature and humidity leading to greater mineral loss (Chan *et al.,* 1997). Similar results were reported by Muyanja et al. (2012) in oyster mushroom, Chauhan *et al*. (2015) in karonda and Wijewardana *et al.* (2016) in bael fruit.

Carbohydrate content in the various samples ranged from 50.94 to 56.67%. The highest carbohydrate content was found in Oven dried samples and the least in shade dried samples. Carbohydrate content of samples was significantly ($p < .05$) affected by the method of drying (Table 4.5). These results are in line with the findings of Morais *et al.* (2017) reporting higher carbohydrate in peels of oven dried avocado and melons than the samples subjected to freeze drying. Sengupta et al. (2012) and Chauhan et al. (2015) also reported higher carbohydrate in microwave dried okra and karonda, respectively, than oven dried one thus confirming our results. This might be because of the increased susceptibility of lignocellulosic substances to enzymatic activity in response to microwaves (Kam, 1991). Similar results were reported by Aishah and Rosli (2013) and Tolera and Abera (2017)

while studying the effect of sun and sun drying in oyster mushroom. The osmotic dried oyster mushroom exhibited lower crude fibe content in contrast to oven dried sample consistent with the findings of Omolayo *et al.* (2016) and Tolera and Abera (2017) reporting decrease in crude fiber content with the osmotic treatment in bitter leaf (Vernonia amygdalina) and oyster mushroom, respectively. This might be attributed to changes in cellular structure like degradation of pectin and diffusion of solutes during osmotic treatment (Tadese *et al.,* 2015).

The mineral content of the mushroom powder(s) with three different drying methods is shown in table 4.5 Results from the study show that there was an increase in Iron, copper, zinc and manganese with a reduction in temperature for the drying method used in the production of the mushroom powder(s). Analysis of variance for the minerals showed significant differences ($p<0.05$) between the temperature for the drying method used in the production of the mushroom powder(s) and calcium, magnesium, phosphorus, potassium, iron, copper, zinc and manganese. There were however no significant differences ($p>0.05$) between temperature for the drying method and sodium.

The study also found a decrease in the content of calcium, magnesium, potassium and sodium with a reduction in temperature in the dying method in the production of mushroom powder(s). There was however an increase in the potassium content with a reduction in temperature in the dying method in the production of mushroom powder.

Oyster mushroom powder sodium content was the same (0.02mg/kg) across all treatments. Vetter (2003) found that K, P and Mg decreased after mushroom had been washed and dried. In the studies, the decrease in some mineral elements after blanching was attributed to leaching. Some mineral elements have been shown to increase after cooking or blanching (Manzi *et al.,* 2001) as a result of decreased water content thus a concentration of the mineral nutrients. Calcium, K, Mg, Na and S are the mineral found in the most quantities in mushroom (Kalac, 2009). Even though different treatments affected mineral nutrition, the quantities were still found in amounts that would be beneficial in the human diet making oyster mushroom a good source of mineral nutrients.

The different drying methods affected the mineral content of oyster mushroom to different extents (Table 4.5). The shade dried mushrooms displayed higher values of mineral components than the oven dried oyster mushroom quite consistent with the findings of Tyagi and Pal (2015) reporting higher values of calcium, magnesium, phosphorus and iron content in shade dried amla fruit in contrast to samples subjected to other drying techniques. The higher retention of minerals in shade dried oyster mushroom might be because of low temperature and vacuum employed that minimised the biochemical and microbial reactions leading to mineral losses. Furthermore the greater loss of minerals in oven dried mushroom in contrast to freeze dried samples could be co-related with the biochemical modifications like occurrence of side reactions induced by high temperature (Gunya *et al.,* 2016). Sun drying resulted in lesser mineral retention than the oven drying which is similar to the results reported by Arslan *et al*. (2010) while working on peppermint. This might be because of incidence of side reactions leading to formation of

stable metallic oxides like iron oxide resulting in their losses and better solubility of minerals in oven drying because of convective energy linked with the oven drying (Arslan *et al.* 2010). The osmotic dried mushrooms reflected minerals in lesser amounts than the oven dried samples which might be because of leaching of minerals from cell membranes of food matrix during osmotic treatment (Tripura *et al.,* 2017). The least mineral content was recorded for sun dried samples consistent with the findings of Leghari *et al* (2013) reporting higher amounts of calcium in oven dried mango powder than the sun dried one. Eissa *et al*. (2013) reported higher iron content in oven dried green squash rings than the sun dried sample similar to our results. Chauhan *et al*. (2015) also reported higher calcium, phosphorus and iron content in microwave dried karonda fruit than the sun dried one hence supporting our findings. The higher mineral content was reported for sun dried sample than the sun dried sample which might be because of higher temperature, lower humidity and shorter drying time in sun drying than the sun dried mushroom. Similar trend was reported by Ukegbu and Okereke (2013) while comparing the mineral content of amaranth leaves affected by sun and sun drying.

4.3 Sensory quality and acceptability of samples of *shito* by consumers

This section outlined the various sensory attributes of the *shito* samples. The four (4) samples were C, T1, T2 and T3; representing shrimps and fish powder *shito* (control sample), oven dried mushroom *shito*, sun dried mushroom *shito* and shade dried mushroom *shito* respectively. A sample with the top mean value receives the highest acceptability from the respondents (see Figure 4.5)

sweetness and spiciness) and flavour (Taste and smell) the sample made from shrimps and fish powder (control) had the highest mean (7.81, 7.27 and 7.60) ranking compared to the other three samples. Shade dried oyster mushroom *shito* was ranked second (7.15, 7.10 and 7.39) followed by Oven dried oyster mushroom *shito* (6.78, 6.74 and 7.02) and sun dried oyster mushroom *shito* (6.27, 6.26 and 6.71) respectively.

In relation to the smoothness of *shito* samples, shade dried oyster mushroom *shito* recorded the highest mean value of (7.44), the second ranked *shito* was the control sample with a mean value of (7.34), oven dried oyster mushroom *shito* was ranked third with a mean value of (7.26) and sun dried oyster mushroom *shito* being the fourth ranked with a mean value of (6.89). It can therefore be said that the smoothness of the shade dried mushroom *shito* was very much accepted by respondents as compared to the other samples.

For the attributes such as, aftertaste, mouthfeel and overall acceptability, the *shito* made from shrimps and fish power (control) again was the most acceptable *shito* by the respondents. It recorded respective mean response values of (7.48, 7.32 and 7.85). The seconded ranked *shito* was shade dried oyster mushroom *shito* with mean values of (7.18, 7.00 and 7.24) followed by oven dried oyster mushroom *shito* with mean values (7.05, 6.85 and 7.03) and sun dried oyster mushroom *shito* being the fourth ranked *shito* with mean values of (6.41, 6.44 and 6.64). The total mean values recorded show that the sample made from shrimps and fish powder (control sample) was the most acceptable *shito* by the respondents in terms of all the attributes considered. It recorded a total mean of (68.29). The second most acceptable *shito* was the shade dried oyster mushroom *shito* with a total

mean value of (65.66). The third ranked acceptable *shito* was the oven dried oyster mushroom *shito* with a total mean of (63.78) and sun dried oyster mushroom *shito* being the fourth ranked acceptable *shito* recording a mean of (59.71). It can therefore be concluded that all the four samples were liked by the respondents but the control sample was the most liked. This can be attributed to the fact that the control sample is what consumers are familiar with (see figure 4.5).

With regards to respondent's decision to buy oyster mushroom *shito* in commercial quantities, analysis of variance (ANOVA) test was performed to find out if difference existed in the decision to buy the *shito* samples. ANOVA (appendix C) confirmed that difference exist in the decision of consumers to buy the shito samples because the p value (0.000) obtained from the ANOVA test was less than the significant value ($p<0.05$) which implied there is significant difference in respondents' decision to buy at least three of the four samples of the *shito*. Hence, multiple comparison test was done by the use of Post Hoc analysis (Tukey), and this was necessary to find out the specific difference between the four samples of *shito*.

From the Post Hoc analysis (appendix C), there is significant difference between the decision of respondents to buy shrimp powdered *shito* (control) and sun dried mushroom *shito*; oven dried mushroom *shito* and sun dried mushroom *shito*; then shade dried mushroom shito and sun dried mushroom *shito*, since the p values (0.000, 0.002 and 0.14 respectively) were less than the significant value (0.05). However, there was no significant difference between the decision of respondents to buy shrimp powdered *shito* (control),

oven dried mushroom *shito* and shade dried mushroom *shito* since the p value (0.788, 0.430 and 0.937) were greater than the significant value (0.05).

4.4 Physicochemical Parameters of Oyster Mushroom *Shito*

This section shows the physicochemical composition of oyster mushroom *shito* produced from three dying method as shown in table 4.6.

Table 4.6: Physicochemical Parameters of Three samples of oyster mushroom *shito*

Sample	Moisture %	Fat %	Protein %	Fibre %	Ash %	Carb %	FFA	Colour
T1	22.30^{a}	62.50^{c}	6.21^{a}	3.75^{a}	4.40^{b}	0.84^{b}	0.06^{a}	16.40^{a}
T2	24.40^{b}	61.65^{b}	7.10^{b}	2.53^{a}	4.20^{a}	0.12^{a}	0.17^{b}	16.40^{a}
T3	17.30^{c}	58.57^{a}	8.43^{c}	3.12^{a}	4.60^{c}	7.98^{c}	0.32^{c}	16.40^{a}

*Values on the same column followed by different letters vary significantly from each other based on Duncan's test ($p<0.05$)

T1- Oven dried oyster mushroom *shito*, T2- Sun dried oyster mushroom *shito*, T3- Shade dried oyster mushroom *shito*

The Table 4.6 shows a different percentage (s) in the moisture content of the three samples of *shito*, this can be attributed to the fact that the samples adopted three different dying method with varying temperatures for the drying of the oyster mushrooms. The highest reduction in moisture was found in sample 034 (sun drying method 60^{o}C). The least was found in sample 045 (shade drying method 40^{o}C). Analysis of variance also showed significant ($p<0.05$) difference between temperature used for the drying method and

moisture. Duncans test (as shown in appendix) further revealed that there were differences in temperature for the drying method used for the mushroom powder (s) and moisture for all samples. It is apparent that the drying rate decreased with drying time for oven drying, sun drying, and shade drying. The drying rate also decreased continuously with decreasing moisture content or for increasing drying times. This might be because of fluctuating temperature and relative humidity during sun drying than oven drying that employs uniform temperature for effective moisture removal Muyanja *et al.* (2012). In contrast to oven dried oyster mushroom, osmotic dried mushrooms exhibited lower moisture content of 6.23% which might be because of greater water loss during osmosis (Tolera et al., 2017; Sharma and Bhat, 2018). These findings are in the agreement with previous studies (Togrul and Pehlivan, 2002; Yaldiz and Ertekin, 2001; Yaldiz et al., 2001).

The fat content also varied from (58.57% to 62.50%). These values were higher than those found in the oyster mushroom powder(s) because of the oil used in the preparation of the *shito*. There was a reduction in fat with a corresponding decrease in temperature for the method of drying used in the mushroom powder(s). There were significant differences among fat ($p<0.05$) for all *shito* samples. The drying methods caused a decrease in crude fat content of oyster mushrooms which might be attributed to oxidative losses as mushroom fat is mainly composed of polyunsaturated fatty acids mainly susceptible to oxidation when mushroom slices are exposed to drying medium (Muyanja et al., 2012). The lesser crude fat loss in shitake mushrooms (Lentinusedodes) was reported by Duan and Xu (2015) subjected to freeze drying in comparison to oven, microwave and sun drying thus confirming our results. The oven dried samples exhibited lower crude fat content

coinciding with the results reported by Tolera and Abera (2017) while studying the impact of different drying methods on quality of oyster mushrooms. The greater decrease in crude fat content during osmotic drying might be attributed to leaching losses taking place during steeping (Tadese et al., 2015).

The protein content of the samples of *shito* also ranged from (6.21% to 8.43%). It be seen that there is a reduction in protein content of samples of *shito* as compared to the oyster mushroom powders (21.74% - 26.63%). This is because other ingredient were added to the *shito* during preparation thereby increasing the weight of the *shito* and reducing the protein content. Sample (045) had the highest protein content (8.43%) whiles sample (023) had the lowest (6.21%). The protein content of the powders was however higher than that of the *shito*. Analysis of variance showed significant differences ($p<0.05$) among the protein contents of the *shito* produced. Similar to the current study, Gothandapani et al., (1997) reported protein content of (16.8-26.4%) in oyster mushroom. Variation may be due to differences in mushroom strain and growing conditions. Arumuganathan, Manikantan, Indurani, Rai, and Kamal (2010) reported that temperature in the order of (60°C) could result in denaturation of protein leading to a reduction in protein content of oyster mushroom. However, Yang, Lin, and Mau (2001) reported similar protein content (23.9%) as compared to this study. The lower protein content of dried oyster mushroom may be due to leaching out during steeping. In general, drying process used may causes a considerable decrement in protein content (Hassan & Medany, 2014). According to Morris et al. (2004), heating generally improves the digestibility of foods, making some nutrients more available as in the case of proteins in legumes, which become more digestible after heating

because of the inactivation of anti-nutrients such as trypsin inhibitors. During oven drying, the higher temperature employed might be responsible for protein denaturation and consequential protein loss in contrast to freeze drying resulting in better crude protein retention (Tolera and Abera, 2017; Arumuganathan *et al.,* 2010). The uniform exposure and short drying times associated with oven drying might be responsible for lesser protein deterioration in contrast to sun and sun drying (Agoreyo *et al.,* 2011).

Table 4.6 also shows the fiber content of the *shito* produced. The study revealed a reduction in the fiber content with a decrease in the temperature of the drying method used in the production of the oyster mushroom powder(s). It can be seen that, in the preparation of *shito* other ingredient like ginger, garlic, onions, tomato puree were added in the preparation of the *shito* thereby increasing the amount of fiber content (2.53% -3.75%) as compared to the oyster mushroom powders (1.50% -2.63%). Sample (034) had the lowest fiber content (2.53%) whiles sample (023) had the highest (3.75%). The changes in the dietary fiber composition may be attributed partly to the redistribution of the insoluble and soluble components of dietary fiber. An increased temperature breaks weak bonds between polysaccharide chains and split glycosidic linkages in the fiber polysaccharides (Selvendran and Robertson, 1994). As consequence, the architecture of the fiber matrix may be modified and insoluble fiber solubilized (Margarita and Nyman, 2003). These results are in line with the findings of Morais *et al*. (2017) reporting higher crude fiber in peels of oven dried avocado and melons than the samples subjected to freeze drying. Sengupta et al. (2012) and Chauhan *et al*. (2015) also reported higher crude fiber in microwave dried okra and karonda, respectively, than oven dried one thus confirming our

results. This might be because of the increased susceptibility of lignocellulosic substances to enzymatic activity in response to microwaves (Kam, 1991). Similar results were reported by Aishah and Rosli (2013) and Tolera and Abera (2017) while studying the effect of sun and solar drying in oyster mushroom. The oven drying method in comparison to sun and sun drying methods might be responsible for greater cellular disruption leading to greater susceptibility to enzymatic activity thereby increasing the crude fiber content (Hameed, 2016).

The effect of drying methods on the ash content of the *shito* produced revealed the highest total ash content was reported in sun dried mushroom corresponding to a value of 4.6% (Table 4.6). Similar results were reported by Sharma and Bhat (2018) while studying the impact of different drying methods on total ash content of oyster mushrooms. This might be because of diffusion of sodium ions from brining/steeping solution into mushroom slices during steeping process as water migrates out of mushroom slices (Maray *et al.,* 2018). The total ash content of oven dried sample was found to be higher than the oven and shade dried samples reflecting total ash values of 4.40 and 4.20%, respectively. This might be because of low temperatures and vacuum employed during shade drying resulting in better retention of minerals and thereby giving higher values of total ash (Gunya *et al.,* 2016). Hsu et al. (2003) reported higher ash content in freeze dried yam flour in comparison to oven dried samples compatible with our findings. Ajayi *et al*. (2017) reported higher ash content in oven dried ginger than microwave dried samples indicating higher mineral losses during microwave drying similar to our results. The formation of stable compounds such as aluminium or ferric oxides in response to microwaves might be responsible for greater

mineral loss and consequential low ash content of microwave dried oyster mushroom than the oven dried one (Arslan et al., 2010). The sun dried oyster mushrooms reflected least value of total ash corresponding to value of 8.00 per cent. Eissa et al. (2013) reported low ash content inzucchini (green squash) rings subjected to sun drying than the oven drying thus confirming our findings. Ukegbu and Okereke (2013) while comparing the effect of sun and solar drying on total ash content of okra reported higher values for solar dried samples than the sun dried samples similar to our findings. The relatively lower ash contents of sun and solar dried oyster mushroom in contrast to other drying methods might be attributed to prolonged exposure to air and the fluctuating temperature and humidity leading to greater mineral loss (Chan et al., 1997).

Carbohydrate content in the various samples ranged from 0.12 to 7.98%. The lowest carbohydrate content was found in sun dried samples and the highest in shade dried samples. Carbohydrate content of samples was significantly ($p < .05$) affected by the method of drying (Table 4.6). Sengupta *et al*. (2012) and Chauhan et al. (2015) also reported higher carbohydrate in microwave dried okra and karonda, respectively, than oven dried one thus confirming our results. This might be because of the increased susceptibility of lignocellulosic substances to enzymatic activity in response to microwaves (Kam, 1991). Similar results were reported by Aishah and Rosli (2013) and Tolera and Abera (2017) while studying the effect of sun and solar drying in oyster mushroom. This might be attributed to changes in cellular structure like degradation of pectin and diffusion of solutes during osmotic treatment (Tadese *et al.,* 2015).

Free fatty acid content of the samples was different. Sample (023) thus had the lowest free fatty acid content (0.06). The highest free fatty acid content was recorded by sample (045). There were significant changes in the free fatty acids of all samples of *shito* produced ($p<0.05$). Free fatty acids is affected by humidity, moulds and exposure to oxygen. Eatty acids in oil are usually in triglycerides form but are hydrolysed into free fatty acids during processing. The higher amount of free fatty acids interpret into decreased oil quality (Choudhary and Graver, 2013). During the air drying, the water content decreases, while the lipid content became a proportionally larger part of the sample. Hence, it is not surprising to observe an increase in FFA formation during drying, due to the high temperatures [36] and the raw materials' exposure to oxygen (Fellows, 1988)

The colour of all samples were 16.4 (ASTA colour). The study showed that there was no difference in the colour of all samples. Colour could vary based on the type and quantity of ingredients added during preparation (Ogundele et al., 2015). The colour of flour due to the presence of polyphenolic compounds, ascorbic acid, carotenes and other chemical compounds has impact on quality. Any pigmentation in the flour is carried over to the final product (Galvez and Resurreccion, 1993). From the study it could been seen that quantities of ingredients used were the same with different drying method adopted which had varying temperature(s), the temperature had no effect on the colour of all samples of shito. Greenwood and Mackenzie, (1963) suggested that, short wavelengths produce high energy which cleave starch molecules and cause caramelization of the monosaccharides. All flours used in the study may have produced same wavelengths which resulted in the same value for colour.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings, it was concluded that;

Consumer panelist (81%) want *shito* to be produced from oyster mushroom powder based on preferred ingredients which includes onion (4.94), oil (4.86), powdered pepper (4.61), mixed spices (4.51), ginger (4.50), salt (4.46), garlic (4.26), tomato puree (3.98) and the sensory quality expectation of *shito* should be aftertaste (4.18), tastiness (3.17), spiciness (3.11) and mouthfeel (2.93)

Oyster mushroom powder produced by the use of three different drying methods had varying nutritional composition with the exception of Sodium (Na) which had the same nutritional composition for the three samples. The drying method that had effect on the nutritional composition was oven drying method (60°C)

Based on consumers sensory quality attributes and acceptability on samples of *shito*, consumer panelist preferred shade dried oyster mushroom *shito* from all the other samples of *shito* produced from oyster mushroom powder

Samples of oyster mushroom *shito* had varying physicochemical composition with the exception of fibre and measurement of colour which was in the same range

5.3 Recommendations

In view of these research findings:

- more studies should be conducted using different drying method on the mushroom to evaluate the effect of that drying method on the nutritional composition.
- vitamins components should also be ascertained to know the benefits with the product in that aspect.
- full microbiological analysis must be done on the product to assure consumer of it safety
- shelf life study should also be carried out to know how long the product can stay on the shelf.

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APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

FACULTY OF VOCATIONAL EDUCATION

DEPARTMENT OF HOSPITALITY AND TOURISM

Questionnaire for Assessment of Consumer Preference and Quality Expectation of *Shito*

Please read and answer the questions below. You are assured that this is for research purposes only and your responses will be treated confidentially.

DEMOGRAPHIC DATA

1. Gender

   Male [ ] Female [ ]

2. Age

   Below 18yrs [ ] 31 – 40yrs [ ]

   18 – 20yrs [ ] 41 – 50yrs [ ]

   21 – 30yrs [ ] 51- 60yrs [ ]

   Above 60yrs [ ]

3. Marital Status

   Single [ ]

   Married [ ]

   Divorced [ ]

4. Nationality _____.

5. Religion

Christian [ ] Muslim [ ]

Buddhist [ ] Others Please Specify _____.

6. Status

Teaching Staff [ ]

Non-teaching Staff [ ]

Student [ ]

Consumer Preference and Quality Expectation of *shito*

7. Do you take *shito*?

Yes [ ] No [ ]

8. Which of the following food do you take *shito* with?

Kenkey [ ] Any rice dish [ ] Gari [ ]

Banku [ ] Bread [ ] Ampesi (boiled yam, plantain) [ ]

Others Please Specify _____.

9. How do you obtain your *shito*?

Self-made [ ]

Bought [ ]

Others please specify…….

10. Indicate your preference of the following ingredient in your shito

5 – Very important; 4 – Important; 3 – Neither important or Not Important;

2 – Not Preferred; 1 – Not Very Important

INGREDIENT	1	2	3	4	5
Onion					
Ginger					
Garlic					
Tomato Puree					
Powdered Pepper					
Oil					
Spices					
Salt					

11. Please indicate how you would want your *shito* to be like?

SPICINESS

1 – Not very spicy 2 – Not Spicy 3 – Neither Spicy or Not Spicy

4 – Spicy 5 – Very Spicy

PRODUCT	1	2	3	4	5
Shito					

MOUTHFEEL

1 – Very Smooth 2 – Smooth 3 – Undecided

4 – Rough 5 – Very Rough

PRODUCT	1	2	3	4	5

Shito					

TASTINESS

1 – Not Very tasty 2 – Not tasty 3 – Neither tasty nor very tasty

4 – Tasty 5 – Very tasty

PRODUCT	**1**	**2**	**3**	**4**	**5**
Shito					

AFTERTASTE

1 – Not Very Sweet 2 – Not Sweet 3 – Bitter

4 – Sweet 5 – Very sweet

PRODUCT	**1**	**2**	**3**	**4**	**5**
Shito					

12. Would you want *shito* from mushrooms?

Yes [ ]

No [ ]

13. How would the following factors affect your patronage of mushroom *shito*

1 –Not Very important; 2 – Not Important; 3 – Neither important or Not Important;

4 – Important; 5 – Very Important

Factor	**1**	**2**	**3**	**4**	**5**	**Comment**

Drying method use for mushrooms						
Price						
Packaging						
Odur						
Colour						
Taste						
Appearance						
Texture						
Any other please specify						

14. Which type of oil do you prefer to be used for your *shito*?

(Please choose one)

Olive oil [ ]

Coconut oil [ ]

Canola oil [ ]

Sunflower oil [ ]

Groundnut oil [ ]

Any other, please specify…….

From the above oil selected, do you want the oil……

Fresh [ ]

Used oil [ ]

APPENDIX B

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

FACULTY OF VOCATIONAL EDUCATION

DEPARTMENT OF HOSPITALITY AND TOURISM

Questionnaire for assessment of consumer acceptability of formulated *shito*

Please read and answer the questions below. You are assured that this is for research purposes only and your responses will be treated confidentially.

DEMOGRAPHIC DATA

1. Gender

Male [ ] Female [ ]

2. Age

Below 18yrs [ ] 31 – 40yrs [ ]

18 – 20yrs [ ] 41 – 50yrs [ ]

21 – 30yrs [ ] 51—60yrs [ ]

Above 60yrs [ ]

3. Marital Status

Single [ ]

Married [ ]

Divorced [ ]

4. Nationality _____.

5. Religion

Christian [ ] Muslim [ ]

Buddhist [ ] Others Please Specify _____.

6. Status

Teaching Staff [ ]

Non-teaching Staff [ ]

Student [ ]

Instructions. You have been provided with four (4) samples of *shito* . Please evaluate your acceptability based on the sensory quality attributes listed below and indicate how much you like or dislike using scale 1 – 9 (Hedonic) below. Please rinse your mouth in between samples.

Scale Interpretation

9 – Like Extremely; 8 – Like Very Much; 7 – Like; 6 – Like Slightly; 5 – Neither Like or Dislike 4 – Dislike Slightly; 3 – Dislike; 2 – Dislike Very Much; 1 – Dislike Extremely

Attributes	**Sample Code**			
	012	**023**	**034**	**045**
Colour				
Aroma (Smell)				
Taste (Sweetness)				
Taste (Spiciness)				

Flavour (Taste/Smell)				
Smoothness				
Aftertaste				
Mouthfeel				
Overall Acceptability				

Will you buy these products if they were commercially available?

Decision	**Sample Code**			
	012	**023**	**034**	**045**
Yes				
No				

What is the most important quality attribute that you want in this product?

S/N	**Attributes**	**(Please tick only one attribute)**
1	Appearance	
2	Colour	
3	Aroma	
4	Smoothness	
5	Taste (sweetness)	
6	Taste (spiciness)	
7	Flavour (Taste +Smell)	

8	Mouthfeel	
9	After taste	
10	Overall Acceptability	

Comments / Recommendation

_____

_____

_____

_____

APPENDIX C

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Fat	Between Groups	10283.722	1	10283.722	4.606E3	.000
	Within Groups	22.327	10	2.233		
	Total	10306.049	11			
Protein	Between Groups	840.348	1	840.348	284.792	.000
	Within Groups	29.507	10	2.951		
	Total	869.855	11			
Fiber	Between Groups	1902.097	1	1902.097	.914	.000
	Within Groups	20809.436	10	2080.944		
	Total	22711.533	11			

Protein

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05		
		1	2	3
60	2	21.74		
50	2		23.5250	
40	2			26.6300
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Fibre

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05	
		1	2
60	2	1.5900	
50	2	1.5000	
40	2		2.6300
Sig.		1.000	1.000

Fat

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05	
		1	2
50	2	2.5000	
40	2	2.0000	
60	2		1.0000
Sig.		1.000	1.000

Means for groups in homogeneous subsets are displayed.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Iron	Between Groups	16643.243	2	8321.622	4.755E4	.000
	Within Groups	.525	3	.175		
	Total	16643.768	5			
Copper	Between Groups	26.670	2	13.335	1.334E3	.000
	Within Groups	.030	3	.010		
	Total	26.700	5			
Zinc	Between Groups	9908.013	2	4954.007	1.564E5	.000
	Within Groups	.095	3	.032		
	Total	9908.108	5			
Manganese	Between Groups	2054.955	2	1027.477	4.403E6	.000
	Within Groups	.001	3	.000		
	Total	2054.955	5			
Calcium	Between Groups	.009	2	.004	21.333	.017
	Within Groups	.001	3	.000		
	Total	.009	5			

Magnsium	Between Groups	.031	2	.015	76.333	.003
	Within Groups	.001	3	.000		
	Total	.031	5			
Phosphrus	Between Groups	.147	2	.074	490.778	.000
	Within Groups	.000	3	.000		
	Total	.148	5			
Sodium	Between Groups	.000	2	.000	.139	.875
	Within Groups	.000	3	.000		
	Total	.000	5			
Potassium	Between Groups	.007	2	.004	23.444	.015
	Within Groups	.000	3	.000		
	Total	.007	5			
FFA	Between Groups	.071	2	.035	354.500	.000
	Within Groups	.000	3	.000		
	Total	.071	5			
Colour	Between Groups	.000	2	.000	.000	1.000
	Within Groups	.015	3	.005		
	Total	.015	5			

Iron

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05		
		1	2	3
60	2	1.5450E2		
50	2		1.6785E2	
40	2			2.7230E2
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Copper

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05		
		1	2	3
50	2	18.9500		
60	2		20.1500	
40	2			23.9000
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Zinc

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05		
		1	2	3
50	2	1.0435E2		
60	2		1.0785E2	
40	2			1.9225
Sig.		1.000	1.000	1.0

Means for groups in homogeneous subsets are displayed.

Manganese

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05		
		1	2	3
60	2	53.1750		
50	2		66.9750	
40	2			97.4700
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Calcium

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05	
		1	2
50	2	.4100	
40	2	.4100	
60	2		.4900
Sig.		1.000	1.000

Means for groups in homogeneous subsets are displayed.

Magnesium

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05		
		1	2	3
60	2	.0300		
50	2		.1500	
40	2			.2000
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Phosphorus

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05		
		1	2	3
50	2	1.5900		
40	2		1.6550	
60	2			1.9500
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Sodium

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05
		1
40	2	.0235
50	2	.0240
60	2	.0290
Sig.		.663

Means for groups in homogeneous subsets are displayed.

Potassium

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05	
		1	2
40	2	.5550	
60	2	.5600	
50	2		.6300
Sig.		.710	1.000

Means for groups in homogeneous subsets are displayed.

FFA

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05		
		1	2	3
60	2	.0650		
50	2		.1750	
40	2			.3300
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Colour

Duncan

Method of drying and Temperature Used	N	Subset for alpha = 0.05
		1
60	2	16.4500
50	2	16.4500
40	2	16.4500
Sig.		1.000

Means for groups in homogeneous subsets are displayed.

ANOVA *SHITO*

Table 4. 4.1 ANOVA test of respondents' decision to buy oyster mushroom *shito* in Commercial Quantities.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.291	3	2.764	7.714	.000
Within Groups	146.175	408	.358		
Total	154.466	411			

Significant at $p<0.05$

Source: field data, 2020

Table 4.4.2: Post Hoc test of multiple comparisons of samples of *shito* based on respondents' decision to buy

(I) *Shito* Samples	(J) *Shito* Samples	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	Oven dried mushroom *shito*	-.07767	.08341	.788	-.2928	.1375
	Sun dried mushroom *shito*	-.37864*	.08341	.000	-.5938	-.1635
	Shade dried mushroom *shito*	-.12621	.08341	.430	-.3414	.0889
Oven dried mushroom *shito*	Control	.07767	.08341	.788	-.1375	.2928
	Sun dried mushroom *shito*	-.30097*	.08341	.002	-.5161	-.0858
	Shade dried mushroom *shito*	-.04854	.08341	.937	-.2637	.1666
Sun dried mushroom *shito*	Control	.37864*	.08341	.000	.1635	.5938
	Oven dried mushroom *shito*	.30097*	.08341	.002	.0858	.5161
	Shade dried mushroom *shito*	.25243*	.08341	.014	.0373	.4676

Shade dried mushroom *shito*	Control	.12621	.08341	.430	-.0889	.3414
	Oven dried mushroom *shito*	.04854	.08341	.937	-.1666	.2637
	Sun dried mushroom *shito*	-.25243*	.08341	.014	-.4676	-.0373

*. The mean difference is significant at p< 0.05

Source: field data, 2020

Decision to Buy Shito

Tukey HSD[a]

Shito Samples	N	Subset for alpha = 0.05	
		1	2
Control	103	1.0485	
Oven dried mushroom shito	103	1.1262	
Shade dried mushroom shito	103	1.1748	
Sun dried mushroom shito	103		1.4272
Sig.		.430	1.000

Means for groups in homogeneous subsets are displayed.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Moisture	Between Groups	384.201	1	384.201	67.520	.000
	Within Groups	56.902	10	5.690		
	Total	441.102	11			

Ash	Between Groups	51.253	1	51.253	573.731	.000
	Within Groups	.893	10	.089		
	Total	52.147	11			
Fat	Between Groups	10283.722	1	10283.722	4.606E3	.000
	Within Groups	22.327	10	2.233		
	Total	10306.049	11			
Carbohydrate	Between Groups	7768.359	1	7768.359	727.191	.000
	Within Groups	29.507	10	2.951		
	Total	869.855	11			
Fibre	Between Groups	1902.097	1	1902.097	.914	.362
	Within Groups	20809.436	10	2080.944		
	Total	22711.533	11			
	WITHIN GROUPS	**106.827**	**10**	**10.683**		
	TOTAL	**7875.185**	**11**			

APPENDIX D