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Development of mushroom based sausage.

By
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Declaration.

The worked describe in this thesis, development of mushroom based sausage, its microbiological testes, sensory analysis was carried out in Food Research Units' Laboratory by me under the supervision of Dr K. H. Sarananda Head, Food Research Unit, Department of Agriculture , Gannoruwa and its proximate analysis and self life evaluation was carried out in laboratory of Food Science Department by me under the supervision of Dr K.K.D.S.Ranaweera Head, Department of food science and Technology, Coordinator, Food science and Technology post graduate, programs University of Sri Jayewardenepura Gangodawila Nugegoda and the report on this has not been submitted in whole or in part to any other institution for another degree.

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We hereby certify that the above statement made by the candidate is true and this thesis suitable for submission to the University for the purpose of evaluation.

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CONTENT

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Abstract

Oyster mushroom (*Pleurotus ostreatus)* is a common mushroom cultivated in Sri Lanka and is prized for its edibility and texture. Oyster mushroom has a high nutritional value due to its high level of vitamins and proteins and its non-saturated fatty acids. The consumption of Oyster mushroom reduces cholesterol levels remarkably and has also been attributed anticancer properties. Diversification of value added products of mushrooms can be one of the successful approaches to popularize mushroom consumption among Sri Lankans.

A study was carried out to develop a mushroom based vegetable sausage formula and to determine its self life/keeping quality, microbial quality and proximate analysis.

Oyster mushroom was dehydrated and made powder, dehydrated flesh rehydrated with hot water and then made pulp and pulp of fresh Oyster mushroom were used to prepare the sausage formula. According to the analysis of microbiological and sensory quality, the final product kept in cold room storage for more than four months, it has been revealed that the ingredients used were complementarily suitable to each other and the conditions used to store were appropriate for the final product. Self life of the final product is longer for more than two months and seems to be much longer. According to quality characteristics of final product, it can be assumed that the mushroom formula satisfies the sensory assessments.

New processing operations like use of pre cooked mushroom flesh with spices mixture are recommended to introduce to enhance the flavor profile of the final product.

Chapter 01

1. Introduction.

Production and consumption of sausages have been started over many centuries ago and still their major raw ingredients are simply meat fish or both. Meat or fish based sausages can be therefore consumed only by consumers who consume meat or fish but cannot be a commodity suitable for vegetarians. On the other hand, people tend to become vegetarians due to many reasons.

Hence, there is potential for developing vegetable based sausages which can be of high demand in both non-vegetarians and vegetarians. In order to achieve this, it is necessary to identify ingredients suitable for the sausage formula, which are also locally available. The other major requirements are that the product developed should be nutritious and palatable. The cultivation of raw materials should be easy and cheaper.

Mushrooms can be used as a suitable raw material which meets the above requirements and requires a smaller space for its cultivation. On the other hand, this value addition method will minimize the postharvest losses of the commodity. Especially, Oyster mushroom (*Pleurotus ostreatus*) is a common mushroom cultivated in Sri Lanka and is prized for its edibility and texture. Oyster mushroom has a high nutritional value due to its high level of vitamins and proteins and its non-saturated fatty acids. The consumption of Oyster mushroom is said to reduce cholesterol levels and has also been attributed anticancer properties. Very-low-density lipoproteins and low-density lipoproteins are reported to be reduced in the total reduction of serum cholesterol. Cholesterol content in high-density lipoproteins was not significantly affected by oyster mushroom.

Therefore, the main objectives of the study were to develop a mushroom based vegetable sausage formula and to determine its self life/keeping quality, microbial quality and proximate analysis.

Chapter 02.

2.0 Literature review.

2.1. Mushroom.

A mushroom is the fleshy, spore-bearing fruiting body of a fungus, typically produced above ground on soil or on its food source. The standard for the name "mushroom" is the cultivated white button mushroom, *Agaricus bisporus*, hence the word mushroom is most often applied to fungi (Basidiomycota, Agaricomycetes) that have a stem (stipe), a cap (pileus), and gills (lamellae, sing. lamella) on the underside of the cap just as do store-bought white mushrooms. However, "mushroom" can also refer to a wide variety of gilled fungi, with or without stems, and the term is used even more generally to describe both the fleshy fruiting bodies of some Ascomycota and the woody or leathery fruiting bodies of some Basidiomycota, depending upon the context of the word. Forms deviating from the standard form usually have more specific names, such as "puffball", "stinkhorn", and "morel", and gilled mushrooms themselves are often called "agarics" in reference to their similarity to Agaricus or their placement in the order Agaricales. By extension, "mushroom" can also designate the entire fungus when in culture or the thallus (called a mycelium) of species forming the fruiting bodies called mushrooms. (Alice Beetz and Michael Kustudia 2003)

2.1.2. Edible mushrooms.

Agaricus bisporus, also known as champignon and the button mushroom. This species also includes the portobello and crimini mushrooms.

Agaricus campestris - Meadow mushroom.

Auricularia polytricha or *Auricularia auricula*-judae (Tree ear fungus), two closely related species of jelly fungi that are commonly used in Chinese cuisine.

Flammulina velutipes, the "winter mushroom", also known as enokitake in Japan.

Hypsizygus tessulatus (also *Hypsizygus marmoreus*), called shimeji in Japanese, it is a common variety of mushroom available in most markets in Japan. Known as "Beech mushroom" in Europe.

3, also known as shiitake, oak mushroom. *Lentinus edodes* is largely produced in Japan, China and South Korea. Lentinus edodes accounts for 10% of world production of cultivated mushrooms. Common in Japan, China, Australia and North America.

Pleurotus species - *Pleurotus* is a genus with a number of distinct species and strains. *Pleurotus* species are characterized by a white spore print, attached to decurrent gills, often with an eccentric (off center) stipe or no stipe at all. The oyster mushroom and king trumpet mushroom and is popular and delicious. *Pleurotus* mushrooms are the second most important mushrooms in production in the world, 25% of total world production of cultivated mushrooms. The common name "oyster mushroom" comes from the white shell-like appearance of the fruiting body, not from the taste. The taste of the oyster mushroom varies from very mild to very strong. It varies in texture from very soft to very chewy, depending on the strain. *Pleurotus* mushrooms are world-wide, China is the major producer. Several species can be grown on carbonaceous matter such as straw or newspaper. In the wild they are usually found growing on wood. It contains Vc, and microelements such as P, K , Te, Zn, Cu, Co. Mo, and abundant amino acids --especially glutamic acid. Besides being eaten, it can be used to ease the body, decrease cholesterin, lower blood pressure, guard against arteriosclerosis and against tumors.

Pleurotus ostreatus (common oyster mushroom).

Pleurotus ostreatus (common oyster mushroom) forms shelves or clusters of fairly long-stemmed fungi whose caps are cream to taupe and rounded or spoon-shaped. This mushroom ranges in size from a gumdrop to a saucer, covering sharp gills. All varieties are relatively tender and mild when cooked. These are by far the easiest and least expensive to grow; however, many growers are now using straw as the growth medium. This results in a loss of flavour, texture, and shelf-life. The natural host is wood of varying, yet similar, types, which produce a more defined body and character.

Different substrates can be used to cultivate *Pleurotus ostreatus* and to get a successful yield (Baysal, et al 2003; Reddy, R 2000).

Rhizopus oligosporus - the fungal starter culture used in the production of tempeh. In tempeh the mycelia of R. oligosporus are consumed. *Sparassis crispa* - recent developments have led to this being cultivated in California. *Tremella fuciformis* (Snow fungus), another type of jelly fungus that is commonly used in Chinese cuisine.

Tuber species, (the truffle), Truffles belong to the ascomycete grouping of fungi. The truffle fruitbodies develop underground in mycorrhizal association with certain trees e.g. oak, poplar, beech, and hazel. Being difficult to find, trained pigs or dogs are often used to sniff them out for easy harvesting.

Ustilago maydis (Corn smut), a fungal pathogen of the maize plants. Also called the Mexican truffle, although not a true truffle.

Volvariella volvacea (the "Paddy straw mushroom.") Volvariella mushrooms account for 16% of total production of cultivated mushrooms in the world.

2.2. Cultivation.

2.2.1. How are mushrooms grown.

There are many ways to grow mushrooms, but productions always occurs in three general steps—spawn run, pinning, and fruiting. Spawn run is the complete colonization of a suitable substrate following inoculation of the substrate, called spawning. The second step, pinning, is the stage of growth when pinheads are initiated. Pinheads are knots of mycelium that eventually develop into mushrooms. All species of mushrooms require a set of environmental conditions for pinning that are different from the conditions for optimum mycelial growth. Most, if not all, cultivated mushrooms fruit at lower temperatures than the optimum for substrate colonization. The last step, fruiting, is the development of the pins into mature mushrooms.

Step I. Spawn Run: After the substrate is prepared and sterilized in the plastic bag or other suitable container, spawn is aseptically added. Spawn is typically grown on sterilized grain (usually rye or millet) and is either produced by the cultivator or purchased from a mushroom supply house. Purity of the spawn is absolutely critical. In most specialty mushrooms, spawn is added at a rate of 2.5% or more of the dry weight of the substrate. After the bag is hermetically sealed, the spawn is evenly distributed throughout the sawdust by shaking the bag. Depending on the species of mushroom, the substrate is usually fully captured by the mycelium within 2 to 6 weeks. Spawn run temperatures should be 21-24°C.

Step II. Pinning: To initiate mushroom formation, temperatures are dropped for 2 days to 2 weeks, CO_2, levels are lowered by introducing fresh air, and light is provided (if you can read by it, there is enough light). Often, the bags are simply opened and moved to the growing room.

Step III. Fruiting: The colonized bag of substrate is placed in a growing room maintained at cool temperatures (63°F is a good average for most mushrooms) and high relative humidity (85-95%). Although the common button mushroom does not require light, all of the other mushrooms described here need some light for proper development. For most specialty mushrooms, the bag may be removed from the sawdust block after spawn run is complete. It is often desirable, however, to remove only the top half of the bag so the sides of the bag reduce air movement across the top of the block, thus maintaining high humidity. In the production of Oyster and Lion's Mane mushrooms, holes are cut in the plastic bag and the mushrooms are allowed to grow through the holes. In Shiitake production, the plastic bag is usually completely removed since this mushroom develops a tough skin on the surface of the sawdust substrate.

2.3. Usage

Fresh.

Dehydration and dehydrated powder of mushroom.

Product.

Medicinal and pharmaceutical.

2.3.1. Value and nutrition.

Main articles: Edible mushrooms, Mushroom hunting, and Fungi culture.

Edible mushrooms are used extensively in cooking, in many cuisines (notably Chinese, European, and Japanese). Though mushrooms are commonly thought to have little nutritional value, many species are high in fiber and provide vitamins such as thiamine, riboflavin, niacin, biotin, cobalamins, ascorbic acid. Though not normally a significant source of vitamin D, some mushrooms can become significant sources after exposure to ultraviolet light, though this also darkens their skin. Mushrooms are also a source of some minerals, including iron, selenium, potassium and phosphorous.

2.4. Ingredients for sausages production.

Here major ingredients are fresh mushrooms and other ingredients are commonly known as binders, fillers, and extenders. Many countries have restrictions on type, amount, and quality of ingredients used in sausages production.

2.4.1. Binder.

Binders are protinaceous agent which changing water binding properties which help binding together different material in sausage product. Sometime they also contribute to the fat emulsification.

2.4.2. Filler.

Carbohydrate products which are used to absorb excessive water and not much affect to emulsification properties. Common fillers are cereal flour, starches derived from corn, rice, potato etc.

2.4.3. Salt.

Salt is an essential ingredient of any sausage formulation. Salt is used to preserve the product, enhance the flavor, and or solubilize the meat proteins in order to improve the binding properties of the formulation. Since the advent of refrigeration, the preservative properties are the least important use of salt, though dry sausages still use salt for preservation. The most important use of salt in a sausage product is its ability to solubilize

proteins. This enhances the product texture and improves water and fat binding. Since sodium chloride (NaCl) salt has been linked to hypertension, other non-sodium salts, such as potassium and calcium chlorides, are sometimes substituted for a portion of the sodium chloride.

2.4.4. Sugar.

Sugars are used in sausage formulations to reduce the flavor intensity of the salt and flavorings, and to provide a food source to enable microbial fermentation. Sugars used in sausage products include sucrose and dextrose.

2.5. Microbiology.

2.5.1. .Coliform.

Coliform is a leading cause of food borne illness. Coliform organisms can be eliminated from cooked sausages by proper cooking processes.

2.6. Casing.

Regenerated collagen sausage casings are made from collagen extracted from cattle hides and hog skins in a process called regeneration. The extracted collagen is dissolved, and then hardened, washing, swelled with acid, and finally formed into the tubular casing shape in an extrusion process. This final shape is then fixed in an alkali bath. These types of lower strength casings are typically used for smaller diameter products. Synthetic or artificial casings are made from special papers impregnated with cellulose, saran casings made from synthetic plastics, and hydro-cellulose casings made from regenerated cellulose. Cellulose casings are created from dissolved fibers extracted from cotton seeds or paper pulp. Each of these types of casings is available in a wide range of sizes and characteristics and is easy to handle, however, these types of casings are not edible and must be removed from the sausage prior to consumption. Artificial casings provide high strength and are available with excellent permeability to moisture and smoke, or as impermeable casings for use in producing water-cooked products such as braunschweiger.