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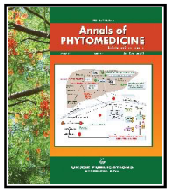

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Preparation and characterization of physicochemical, functional and antioxidant properties of oyster mushroom, *Pleurotus ostreatus* (Jacq. ex Fr.) P. Kumm. powder

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Abstract

The oyster mushroom is also known as 'dhingri' in India. The farming of oyster mushrooms in India started recently but because of its highly perishable nature, the post-harvest loss is high. Drying is a good method to preserve the oyster mushroom to reduce losses after harvesting. Therefore, this study was conducted to prepare oyster mushroom powder and to analyse its physicochemical, functional and antioxidant properties of the dried oyster mushroom powder. The freshly procured oyster mushrooms were washed, sliced and subjected to drying in hot air oven in 60°C for 8 h. The dried mushrooms were finely powdered. The analysis of physical properties found that the weight, volume and bulk density of oyster mushroom powder was 10.02 g, 22.55 ml and 0.44 g/ml. The oyster mushroom powder had the colour values L*, a*, b* and chroma values as 71.93, 7.13, 20.82 and 20.80, respectively. The functional properties like water and oil absorption capacity and swelling power of oyster mushroom powder were found 2.86 g/g, 2.50 g/g and 2.60 ml/g. The oyster mushroom powder contained 8.07% moisture, 21.09% protein, 2.82% crude fat, 20.29% crude fiber, 10.56% ash, 57.45% total carbohydrate, 37.16% available carbohydrate and 339 kcal energy. As being a good source of protein, fiber and ash content, oyster mushrooms can be a nutritious and functional ingredient that can be incorporated into different food products after drying.

1. Introduction

The current situation, in which the world population is growing daily, is accompanied by a rise in the demand for food. It is critical to boost food production to fulfil the population's demand for wholesome food and to lower global food waste, particularly post-harvest losses. Demand for plant-based, vegan and healthy protein sources is rising worldwide. Mushrooms are one type of food source that falls within this category. Although, the mushrooms have a substantial quantity of protein, their high moisture content causes more post-harvest losses, which prevents the general public from consuming them.

According to Feeney *et al.* (2014), mushrooms are the "forgotten source of nutrients." The class Basidiomycota includes a type of fungus known as mushrooms. About 1200 species of fungi are classified as mushrooms and 200 of those species are exploited as edible food sources. With their significant nutritional and medicinal properties, mushrooms are also known as "white vegetables" or "boneless vegetarian meat." They are frequently referred to as nutraceuticals (Schachter *et al.*, 2005). While there are more than 2000 different kinds of edible mushrooms, consumers are most familiar with those belonging to the *Agaricus bisporus* species, which includes portabella, crimini and white button mushrooms, which are the most consumed in the world. Other commercial species include oysters, *Pleurotus ostreatus* (Jacq. Ex Fr.) P. Kumm., enoki (*Flammulina ostreatus*), paddy straw (*Volvariella volvacea*), and shiitake (*Lentinus edodes*). Seasonal species are harvested in the wild and sold at farmer's markets in retail stores. Examples of these species are: morels (*Morchella esculenta*) and chanterelles (*Cantharellus cibarius*) (Feeney *et al.*, 2014).

After *Agaricus bisporus*, oyster mushrooms are the second most widely grown edible mushrooms globally (Sanchez, 2010). Depending on the species, the fruit bodies of this mushroom have a unique shell or spatula form and come in various colours like white, cream, grey, yellow, pink or light brown. The term "oyster" stands for "shellfish," with characteristics like the appearance of sporophores, or fruiting bodies. Oyster mushrooms have a protein content that ranges from 1.5% to 2.6% and are high in vitamins B complex and vitamin C (ascorbic acid). A small number of mushroom species also show health-promoting qualities like antiageing, antioxidant, antifungal, antibacterial, antiviral, anticancer and neuroprotective qualities (Choudhary *et al.*, 2023). The content of niacin (B3) in mushrooms is ten times higher than that of all other vegetables. Oyster mushrooms also contain folic acid and vitamin B12, which aid in the treatment of anemia (Karuppiah *et al.*, 2021).

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Oyster mushrooms are high in moisture (8-87.5%), protein (20-25%), fiber (13-24% on a dry basis), lipids (4-5%), carbohydrate (37-48% on a dry basis) and ash content (8-13%) (Khan *et al*., 2008). The oyster mushroom has little calories, no fat, no cholesterol, no gluten, and very little sodium content and good potassium content. Increasing the consumption of oyster mushrooms appears to decrease the risk of obesity, diabetes, cancer, heart diseases and increase the immunity system of the body (Singh *et al*., 2018). The preparation and characterization of the physicochemical, functional, and antioxidant properties of oyster mushroom (*P. ostreatus*) powder was the goal of the current study.

2. Material and Methods

2.1 Procurement of oyster mushroom

Freshly harvested oyster mushrooms, *Pleurotus ostreatus* (Jacq. ex Fr.) P. Kumm. were procured from a local entrepreneur named Om Shri Satya Sai Oyster Mushroom Center in Dharwad, Karnataka.

2.2 Preparation of oyster mushroom powder

The protocol for the preparation of oyster mushroom powder is given in the Figure 1.

i. The fresh oyster mushrooms were cleaned by removing the waste part carefully.

ii. The mushrooms were weighed and then washed thoroughly under running water.

iii. The mushrooms were kept on cotton cloth for 15 min to drain excess water. After that, the mushrooms were placed on mesh trays at a constant distance.

iv. The cabinet drier was pre-heated at 60 ± 5°C for 30 min. The trays were kept in cabinet driers when the set temperature reached.

v. The mushrooms were kept for 8 h to dry completely. The mushrooms were turned in between to dry uniformly from both sides.

vi. After drying the oyster mushrooms were ground using grinder into a fine powder which was packed into an airtight container for further use and analysis.

Figure 1: Preparation of oyster mushroom powder.

2.3 Physical characteristics of oyster mushroom powder

Physical properties define the quality of ingredient which affects the quality parameters of the final product. Therefore, it is important to analyse the physical characteristics of any ingredient before incorporation into products.

2.3.1 Weight

The weight of the powder was measured using an electronic weighing balance with a sensitivity of 0.01 g.

2.3.2 Volume

To determine the volume of the sample. Ten gram of sample was poured to a 25 ml measuring cylinder. The cylinder was tapped on the surface 10 times from 8-10 cm of height. Volume was noted in ml.

2.3.3 Bulk density

The Okaka and Potter (1979) method was utilized to analyze the bulk density of the sample. Using the following formula, the bulk density (g/ml) was determined as the sample weight divided by the sample volume.

Bulk density = Weight of the flour (g)/Volume of the flour (ml)

2.3.4 Colour

A Konica Minolta spectrophotometer, model CM 2600/2500d, was used to assess color. The L* value, which represents lightness/ darkness or 0 (black) to 100 (white), the a* value, which represents redness (+a) to greenness (-a), and the b* value, which represents yellowness (+b) to blueness (-b), were used to evaluate the three chromatic components (CIE, 2004).

2.4 Functional characteristics of oyster mushroom powder

2.4.1 Water absorption capacity

Quin and Paton's (1983) method was used to analyze the water absorption capacity. Sample weighing 5 g was added to a centrifuge tube (W1) that had been previously weighed. 30 millilitres of water were added to this and stirred for 5 min using a glass rod. After letting the material stand for half an hour, it was centrifuged for 25 min at 11,000 rpm. The unbounded water was discharged. After wiping the inner side of the tube with tissue paper, the centrifuge tube's weight was recorded once again (W2). The following formula was used to determine the water absorption capacity. The three replicates' average values were expressed as a percentage (%), denoting the grams of water bound per 100 g (g/100 g) of the sample. The water absorption capacity was calculated using the following formula. The average values of three replicates were reported as in percentage (%) which signifies the grams of water bound per 100 g (g/100 g) of the sample on a dry basis.

Water absorption capacity (%) = [(W2 – W1)/Weight of the sample] × 100

2.4.2 Oil absorption capacity

Sathe and Salukhe (1981) method was used to calculate oil absorption capacity. In a mixer, 1 g of sample and 10 ml of oil were combined for thirty seconds. After the sample was centrifuged for 30 min at 5000 rpm after being left to stand at room temperature (27°C), the volume of the supernatant was recorded in a 10 ml graduated cylinder. The following formula, which indicates the grams of oil bound per 100 g of the sample on a dry basis, was used to calculate the oil absorption capacity in terms of percentage.

Oil absorption capacity (%) = (Volume of oil absorbed/Weight of the sample) × 100

2.4.3 Swelling power

Swelling power is a measure of starch's ability to hydrate. Five grams of the dehydrated sample were added to 100 millilitres of distilled water to determine it. It was left at room temperature (20-30°C) for the entire night. After that, the swelling index was computed using the formula provided by Rasper (1979). It had a ml/g notation.

Swelling power (ml/g) = Change in Volume (ml)/Weight of sample (g)

2.5 Chemical composition of oyster mushroom powder

Proximate composition includes macronutrients, micronutrients, phytochemicals and antioxidants.

2.5.1 Moisture estimation

To ascertain the sample's moisture content, 10 g of the powdered material was placed in a moisture cup and dried at 105°C until the moisture cup's weight remained constant. Every time, the moisture cup was cooled in desiccators prior to weighing. The sample's moisture content is given as g/100 g of the sample (AOAC, 2019).

Moisture content (%) = [{original weight (g) - final weight (g)}/ weight of the sample (g)] × 100

1.5.2 Protein estimation

Using the Micro Kjeldhal method, the protein content of the dried sample was calculated as a percentage of total nitrogen (AOAC, 2019). The sample was digested using the Kelplus-Classic Dx (Pelican equipment) digestion unit. The Kelplus Classic Dx (Pelican equipment) automatically carried out the distillation. Using the following formula, the nitrogen content was determined:

Nitrogen content (%) = [(1.4 × Normality of the acid × titrant value) / Sample weight (g)] × 100

By multiplying the nitrogen content (%) by the nitrogen-to-protein conversion factor, or 6.25, the protein content (%) was calculated as per the formula as given below:

Protein content (%) = 6.25 × Nitrogen content (%)

2.5.3 Fat estimation

The solvent extraction method was used to determine the sample's fat content. The 5 g dry sample was precisely weighed into a thimble, which was then filled with sample. After being put in a Socs Plus device, the thimble was extracted using anhydrous ether for roughly an hour. Following the ether evaporation, the residue in the flask was dried in an oven between 80-100°C then cooled in desiccators and weighed (AOAC, 2019).

Fat content (%) = [{The beaker's final weight (g)–its initial weight (g)}/Weight of the sample (g)] × 100

2.5.4 Crude fiber estimation

Using the gravimetric method, the sample's crude fiber content was estimated. The fat-free sample was first hydrolyzed with acid, then with alkali. The residue that was left over after the last filtration was

weighed, burned, or ashed until a pale ash was produced. It was then allowed to cool and was weighed once more. The crude fiber content of sample was determined by following formula (AOAC, 2019):

Crude fiber (%) = [(Wt. after oven drying - Wt. after ashing in muffle furnace)/Weight of the sample (g)] × 100

2.5.5 Ash estimation

By adding approximately 5 g of the sample to a crucible, the total amount of ash was calculated. The crucible is set up on a clay pipe triangle and heated. It is then cooled and weighed after being heated for 4-5 h at 600°C in a muffle furnace. The ash was nearly white or greyish white after this was repeated twice with the same weights (AOAC, 2019).

Ash content (%) = [(crucible weight before ashing – crucible weight after ashing)/Sample weight (g)] × 100

2.5.6 Carbohydrate estimation

By subtracting the total of the values for moisture, protein, fat, ash and crude fiber from 100, the carbohydrate content was determined using the difference method (AOAC, 2019).

g/100 g of total carbohydrates = 100 – [Fat + Protein + Ash + Moisture]

g/100 g of available carbohydrates = 100 – [Fat + Protein + Ash + Crude Fiber + Moisture]

2.5.7 Total calorific energy

The calorific value was derived by multiplying carbohydrates, protein and fat contents of the sample with at water constants, *viz.*, 4, 4 and 9, respectively, and expressed as per 100 g basis (AOAC, 2019).

Total energy = [(4 × Carbohydrate%) + (9 × Fat %) + (4 × Protein%)]

2.5.8 Dietary fiber estimation

An enzymatic-gravimetric method was used to analyse the soluble, insoluble, and total dietary fiber fractions. To estimate it, amyloglucosidase enzyme was used (AOAC, 2019).

2.6 Mineral estimation

2.6.1 Macromineral

By precipitating the calcium as calcium oxalate and titrating the oxalate solution in diluted acid against standard potassium permanganate, the calcium content was determined (AOAC, 2019).

Calcium (mg/100 g) = [(volume × 0.2004 × titre value)/(sample weight x aliquot)] × 100

2.6.2 Microminerals (mg/100 g)

Wet digestion with the triacid mixture was used to estimate the trace elements (iron, zinc, copper and manganese). An atomic absorption spectrophotometer was used to measure the microminerals (Cu, Mn, Zn and Fe) in a known aliquot of the test sample that had been diluted (AOAC, 2019). Commercial standards were used for calibration.

2.7 Estimation of antioxidant components

2.7.1 Tannins

By measuring the blue color produced by the reduction of phosphotungstomolybdic acid in the Folin-Denis reagent in an alkaline solution, tannins were quantified calorimetrically using the Folin-Denis reagent (FDR). Defatted sample had been extracted using 85% methanol and 1% hydrochloric acid for 30 min with periodic shaking then the extract was filtered and at 760 nm, the absorbance of the filterate was measured. The standard used was tannic acid, and the results were expressed in terms of tannic acid equivalent (Schander, 1970).

2.7.2 Total phenolic content (TPC)

The Folin-Ciocalteau reagent was used to estimate total phenol content. 80% ethanol was used to extract the sample. After being evaporated, the supernatant was utilized for estimation. Sample absorbance was measured at 650 nm. Results were expressed in terms of gallic acid equivalent (Ranganna, 1986).

2.7.3 Total antioxidant capacity (TAC)

The DPPH (2, 2-diphenyl-1-picryl-hydrazyl) free radical scavenging activity, which is based on electron transfer and results in a violet solution in methanol, was used to analyze the total antioxidant capacity. An antioxidant activity was carried out using the spectrophotometric approach with DPPH (AOAC, 2019).

2.7.4. Data analysis

The statistical analysis of the data was carried out using MS-Excel and SPSS software version 22 and the data is presented in the terms of mean and standard deviation.

3. Results

3.1 Physical characteristics of oyster mushroom powder

The present study reported that the weight, volume and bulk density of oyster mushroom powder were 10.02, 22.55 ml and 0.44 g/ml (Table 1). The bulk density of oyster mushroom powder was found on par with the 0.483 g/ml reported by Oluwafemi *et al.* (2016).

The oyster mushroom powder had the colour values. L^*, a^*, b^* and chroma values as 71.93, 7.13, 20.82 and 20.80, respectively (Table 1). More lightness is indicated by a larger L* value, more redness is indicated by a larger a* value, and more yellowness is indicated by a larger b* value (CIE, 2004). The on-par results were found by Aishah and Rasoli (2013) who reported 73.63, 2.76 and 25.98 for L^*, a^* and b^* values for the oyster mushroom powder dried in the lab oven.

Table 1: Physical characteristics of oyster mushroom powder

Physical characteristics		Oyster mushroom powder
Weight (g)		10.02 ± 0.02
Volume (ml)		22.55 ± 0.05
Bulk density (g/ml)		0.44 ± 0.002
Colour Values	L* (lightness)	71.93 ± 0.01
	a* (Redness)	7.13 ± 0.01
	b* (yellowness)	20.82 ± 0.01
	C* (Chroma)	20.80 ± 0.02
	H° (Hue)	71.04 ± 0.01

The values represent the average of three replications ± standard deviation.

3.2 Functional characteristics of oyster mushroom powder

The functional characteristics of raw ingredients of any product affects it's the processing parameters and the sensory qualities. Hence, it is important to find out these properties to meet the requirements of processing. The degree of utilisation in ingredient formulation and food product development is significantly influenced by the functional properties of flours. Understanding the functional characteristics such as oil absorption capacity, water absorption capacity, mushroom flours capacity for absorption, emulsification, foaming and gelification in order to maximize the use, and gain consumer acceptance (Adebowale, 2004).

The water absorption capacity (WAC), oil absorption capacity (OAC) and swelling power (SP) of oyster mushroom powder were found 2.86 g/g, 2.50 g/g and 2.60 ml/g (Table 2). Khatoniar and Das (2020) reported lower water absorption capacity (WAC), oil absorption capacity (OAC) and swelling power (SP) were 1.14 ml/g, 1.16 ml/g and 4.56 per cent. Ghavidel and Prakash (2006) state that because some polysaccharides are hydrophilic, the carbohydrate composition may also have an impact on the flours ability to hold water. Higher fiber content increases the capacity to absorb water and oil, while higher starch content increases the swelling power.

Table 2: Functional characteristics of oyster mushroom powder

Functional characteristics	Oyster mushroom powder
Water absorption capacity (g/g)	2.86 ± 0.01
Oil absorption capacity (g/g)	2.50 ± 0.10
Swelling power (ml/g)	2.60 ± 0.10

The values represent the average of three replications ± standard deviation.

3.3 Chemical composition of oyster mushroom powder

The following provides information of an analysis of the oyster mushroom powder's proximate composition, including moisture, protein, crude fat, crude fiber, ash, total carbohydrate, available carbohydrate and energy. 8.07 per cent moisture, 21.09 per cent protein, 2.82 per cent crude fat, 20.29 per cent crude fiber, 10.56 per cent ash, 57.45 per cent total carbohydrate, 37.16 per cent available carbohydrate and 339 kcal energy were found in the oyster mushroom powder, according to the current study (Table 3). Similar findings were published by Alam *et al*. (2008) who discovered that oyster mushroom powder contained 22.63% protein, 4.41% fat and 22.87% fiber. According to Aishah and Rasoli (2013), the percentages of moisture (8-9%), protein (20.01-23.84%), fat (1.71-1.33%) and ash (7.48-7.2%) were reported.

The fruiting body of *P. ostreatus* contains important nutritional values and extremely valuable protein concentrates (Cruz-Solorio *et al.,* 2018). On an approximate dry weight basis, edible mushrooms have a high and high-quality protein content of 20-40 g/100 g (Farzana and Mohajan, 2015) found to have a higher protein content than the majority of food sources, with the exception of meat (Chang *et al*., 1989). In addition, the mushroom contains phenylalanine, lysine, isoleucine, leucine, valine, histidine, threonine, methionine, glutamic acids, and aspartic acid, which are all important to humans (Wang *et al.,* 2014). Accordingly, the two necessary amino acids that give mushrooms their umami flavor are glutamic and aspartic (Tsai *et al.,* 2008). As a result, mushrooms offer diet-balancing chemicals in sufficient quantities for human health.

Oleic (C18:1), palmitic (C16:0), and linoleic (C18:2) are the three main fatty acids that are present in mushrooms (Valverde *et al.,* 2015). Aremu *et al.* (2009) examined mushroom also contained a small amount of crude fiber (2.8-3.5 g/100 g). It follows that species differences as well as environmental influences affect the nutritional value of mushrooms. Mushrooms are a good source of both non-digestible carbohydrates (mannans, chitin, and β-glucan) and digestible carbohydrates (trehalose, mannitol, glycogen, and glucose) as determined by Samsudin and Abdullah (2019). Following that, the greater share of the total carbohydrates is composed of both of these carbohydrates.

Table 3: Chemical composition of oyster mushroom powder

Chemical composition (%)	Oyster mushroom powder
Moisture	8.07 ± 0.73
Protein	21.09 ± 0.90
Crude fat	2.82 ± 0.03
Crude fiber	20.29 ± 0.26
Ash	10.56 ± 0.26
Total carbohydrate	57.45 ± 0.50
Available carbohydrate	37.16 ± 0.38
Energy (kcal)	339 ± 4.0

The values represent the average of three replications ± standard deviation.

3.4 Dietary fiber profile of oyster mushroom powder

The most significant active components among others, in the opinion of Elleuch *et al.* (2011) are polysaccharides, particularly dietary fibers. Therefore, dietary fiber, which can provide functional properties, is thought to be associated with several medicinal and pharmacological properties of *Pleurotus* spp.

In the present study, it was found that the oyster mushroom powder had 3.49 per cent soluble dietary fiber, 33.60 percent insoluble dietary fiber and 37.08 per cent total dietary fiber (Table 4). Aishah and Rasoli (2013) reported 37.50 per cent dietary fiber in oven-dried oyster mushroom powder. Manzi and Pizzoferrato (2004) also found on-par results and reported that commercial mushroom has higher insoluble dietary fiber than soluble dietary fiber. As oyster mushrooms are a powerful source of dietary fiber, dried mushrooms are frequently used to make quick soups and sauces (Sufer *et al*., 2016). It can also be incorporated in pasta, noodles, extruded and bakery products as well.

Table 4: Dietary fiber profile of oyster mushroom powder

Type of dietary fiber (%)	Oyster mushroom powder
Soluble dietary fiber	3.49 ± 0.14
Insoluble dietary fiber	33.60 ± 0.13
Total dietary fiber	37.08 ± 0.27

The values represent the average of three replications ± standard deviation.

Additionally, oyster mushrooms can be used to make fermented milk beverages. *Pleurotus* extracts are a great source of prebiotics, owing to the elevated concentration of soluble fiber (Aida *et al*., 2009; Synytsya *et al.,* 2009). *Streptococcus thermophilus* and *Lactobacillus bulgaricus* are two beneficial microorganisms that grow more readily when an aqueous extract from *P. ostreatus* is added to yoghurt, according to research done by Pelaes Vital *et al*. (2015).

3.5 Mineral composition of oyster mushroom powder

For every 100 g of dry oyster mushroom powder examined in this study, the oyster mushroom powder contained 23.10 mg of calcium, 3.59 mg of iron, 8.59 mg of zinc, 0.94 mg of copper, and 1.22 mg of manganese (Table 5). In 100 g of dry oyster mushrooms, Stamens (2005) found 20 mg of calcium, 1.69 mg of copper and 9.1 mg of iron. Nayak *et al*. (2020) reported 26.66 mg calcium and 4.54 mg iron per 100 g dry oyster mushroom average results. A slight variation in the mineral content could be attributed to the growing medium and species differences.

Table 5: Mineral composition of oyster mushroom powder

Minerals (mg/100 g)	Oyster mushroom powder
Calcium (Ca)	23.10 ± 0.12
Iron (Fe)	3.59 ± 0.06
Zinc (Zn)	8.59 ± 0.10
Copper (Cu)	0.94 ± 0.03
Manganese (Mn)	1.22 ± 0.04

The values represent the average of three replications ± standard deviation.

3.6 Antioxidant properties of oyster mushroom powder

The primary naturally occurring antioxidant components in wild edible mushrooms are total polyphenols, which have a high capacity to scavenge because of their hydroxyl groups (Mujic *et al.,* 2010; Keles *et al.,* 2011). The five main phytochemicals were found in the native wild oyster mushroom species: saponin, tannin, flavonoids, alkaloids, and cardiac glycosides. According to Table 6 of the current study, oyster mushroom powder has a tannin content of 32.92 mg tannic acid equivalent per 100 g, 25.73 mg gallic acid equivalent per 100 g, and 58.33% DPPH per cent inhibition activity. According to Arbaayah *et al*. (2013), the oyster mushroom (*P. ostreatus*) dry-weight extract had a phenolic content of 43.91 mg tannic acid equivalent per gram. Devisetti *et al*. (2018) reported that the phenolic content of oyster mushroom powder was 0.24 mg gallic acid equivalent per gram.

The highest activity has been shown by ethanol extracts from the fruiting bodies of this species due to the high total concentration of phenolic compounds (Lee *et al*., 2007). Investigations conducted by Jaworska *et al*. (2015) found that the total phenolic content in *P. ostreatus* fruiting bodies amounted to 708 mg 100 g-1 D.M., in which the flavonoid content amounted to 170 mg 100 g-1 D.M. According to G'secka *et al.* (2016), ferulic acid and p-coumaric acid are the chief phenolic acids in oyster mushrooms, additionally, antioxidant elements such as phenolics, carotenoids and ascorbic. The main components of mushroom fruit bodies, mycelium, and cultures are found to contain various nutrients such as acid, tocopherols, ergosterol and polysaccharides.

All edible mushrooms contain phenolic compounds, including myricetin, quercetin, caffeic acid, catechin and pyrogallol, as reported by Sanchez (2017). Eating meals that contain antioxidant substances found in mushrooms can delay the ageing process, guard against disease and shield cells from damage caused by free radicals as reported by Sanchez (2017). Due to their high antioxidant content, mushrooms have been shown to be beneficial in preventing diseases like cancer, hypertension and high cholesterol (Mujic *et al.*, 2010). Zekovic *et al.* (2005) report that β-glucans from mushrooms have been shown to have different effects (*i.e.,* antitumor, immune-booster) than β-glucans from oats and barley (*i.e.,* lowering blood sugar and cholesterol).

Table 6: Antioxidant properties of oyster mushroom powder

Antioxidants	Oyster mushroom powder
Tannins (mg TAE/100 g)	32.92 ± 2.32
Total phenolic content (mg GAE/100 g)	25.73 ± 1.62
Antioxidant capacity (% DPPH inhibition activity)	58.33 ± 2.25

The values represent the average of three replications ± standard deviation. TAE-Tannic acid equivalent, GAE-Gallic acid equivalent, DPPH-2, 2-Diphenyl-picryl-hydrazyl.

4. Discussion

It is feasible to develop functional foods with an enormous effect on human health through the utilization of oyster mushrooms (Wakchaure *et al*., 2010; CarrascoGonzalez *et al*., 2017; Piska *et al*., 2017). Oyster mushroom boosts the protein and fiber content of products made from cereals, such as breads, pastries, noodles, tortillas, *etc.*, when incorporated to these items (Aishah and Wan Rosli, 2013). According to research, the addition of oyster mushrooms did not negatively impact the sensory assessment of products, if its percentage was under 10% (Adebayo-Oyetoro *et al*., 2010). The nutritional profiles and compositions of the many varieties of mushrooms vary. When oyster mushroom powder is added to new products, oyster mushrooms (*P. ostreatus*) can be used as a novel functional ingredient because of their good physical and functional qualities. The ash content, fiber and protein content of oyster mushroom powder are excellent for vegans. Consequently, it can be said that drying oyster mushrooms is a good and simple way to preserve them with good nutritional value, and it may also be a way to add them to food products to enhance the protein and fiber content of any food.

Incorporation of oyster mushroom powder to processed food products can convert them into functional foods which impart many health benefits to the consumers. The protein, fiber and antioxidant content are the most desirable nutrients required on any food products. The preparation of oyster mushroom powder should be carried out carefully taking the temperature, time and moisture content of the powder into consideration. To avoid spoilage and retain good protein content the oyster mushroom should be dried at low temperature for longer time to reduce the moisture less than 10%.

5. Conclusion

It can be concluded that the physical, functional and antioxidant properties of oyster mushrooms are good enough and it could be the potent vegan source of protein, fiber and antioxidants which can be

a part of any novel or traditional foods to enrich them. The drying of oyster mushroom is an easy and cheaper way to reduce post-harvest losses. The preparation of oyster mushroom powder will make it easier to incorporate in any ready-to-eat products.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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