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Pleurotus sajor-caju (PSC) Improves Nutrient Contents and Maintains Sensory Properties of Carbohydrate-based Products

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Abstract**—**The grey oyster mushroom, *Pleurotus sajor-caju* (PSC), is a common edible mushroom and is now grown commercially around the world for food. This fungus has been broadly used as food or food ingredients in various food products for a long time. To enhance the nutritional quality and sensory attributes of bakery-based products, PSC powder is used in the present study to partially replace wheat flour in baked product formulations. The nutrient content and sensory properties of rice-porridge and unleavened bread (*paratha*) incorporated with various levels of PSC powder were studied. These food items were formulated with either 0%, 2%, 4% or 6% of PSC powder. Results show PSC powder recorded β-glucan at 3.57g/100g. In sensory evaluation, consumers gave higher score to both rice-porridge and *paratha* bread containing 2-4% PSC compared to those that are not added with PSC powder. The *paratha* containing 4% PSC powder can be formulated with the intention in improving overall acceptability of *paratha* bread. Meanwhile, for rice-porridge, consumers prefer the formulated product added with 4% PSC powder. In conclusion, the addition of PSC powder to partially wheat flour can be recommended for the purpose of enhancing nutritional composition and maintaining the acceptability of carbohydrate-based products.

Keywords**—***Pleurotus sajor-caju* (PSC), nutrient contents, sensory evaluation

I. INTRODUCTION

MUSHROOMS have been placed in a kingdom of their own called Myceteae. In the fungal classification system, almost edible mushrooms are members of the subdivision Basidiomycotina and Ascomycotina [1]. Traditionally, edible mushrooms have been used for both medicinal and culinary properties in Asian and many parts of the world. There are more than 10000 known species of mushrooms, of which at least 700 are reported to be edible [2]. Mushroom cultivation is a profitable agribusiness world-wide. Presently, there is significant interest in the use of edible mushrooms extracts as dietary supplements based on the facts that they have a lot of bioactive compounds. Pharmaceutically bioactive mushroom constituents continue to be the main focus of most scientists, including chemical structures, isolation and efficacy experimentations *in vivo or in vitro*. Mushrooms have been linked with various medicinal and pharmacological properties by both western and eastern medicinal groups.

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They range from strengthening the immune system against diseases including viral ones, lowering blood pressure, reducing cholesterol, improving liver function and combating tumors [3]. Freshly harvested edible mushrooms were reported to contain low fat content in average ranged from 0.38% to 2.28%, indicated low calorific value (kcal) contribution of mushrooms on total daily energy intake [4].

Edible mushrooms are considered to be healthy because they are low in calories, sodium, fat and cholesterol level. It also contain appreciable amount of dietary fibre and β-glucan, vitamin B groups, D and other useful nutrients. β-glucans are associated with its ability to show significant immonumodulative properties, possess better antioxidant activities and exhibits scavenging capacities against free radicals [5]. The dietary fibres present in the mushroom are associated with the speeding up of the transit time of bowel contents, increases bulk, frequency and ease of faecal voiding. They are also said to protect the body from irritable bowel syndrome and colon cancer.

The addition of processed PSC in chicken and beef patties was documented in our previous experiments [6-8]. However, the acceptability of PSC in baked-based products was not explored and thoroughly discussed. Thus, the incorporation of PSC as partial flour replacemnet in the present study is intended to enhance the nutritional value and maintaining sensory qualities while reducing formulation cost in bakery-based products. This intention therefore necessitate that a thorough study to be done to determine nutritional composition, fibre content and sensory properties of some popular bakery-based products added with oyster mushroom (*Pleurotus sajor-caju*).

II. MATERIALS AND METHODS

A. Preparation of oyster Mushroom

Freshly harvested PSC was supplied by the National Kenaf and Tobacco Board of Malaysia from Bachok district of Kelantan State in Peninsular Malaysia. Fully-grown mushrooms with the pileus cap diameters between 9 to11 cm were used throughout the study. PSC was prepared in the Nutrition Laboratory of the School of Health Sciences, Universiti Sains Malaysia Health Campus. Other dry materials were purchased from local suppliers. Dried PSC were ground to produce fine powder before its being added into rice-porridge and *paratha* (unleavened bread) formulations with different level of dried mushroom powders (0, 2, 4 and 6%).

B. Proximate analyses

Soluble dietary fibre (SDF), insoluble dietary fibre (ISF), total dietary fiber (TDF) were conducted using AOAC [10] and β-glucan using Megazyme enzymatic kits Mixed-Linkage Beta glucan (Streamlined Method) AOAC Method 995.16, AACC Method 32-23 and ICC Standard Method No. 168.

C. Sensory Evaluation

Sensory evaluations were carried out by 60 untrained consumers consisting of students and staff of the School of Health Sciences, Universiti Sains Malaysia Health Campus. They evaluated samples for aroma, colour, appearance, elasticity, flavor and overall acceptance on a 7 point scale (0 = dislike extremely and 7 = like extremely) [9]. Significance was established at $P \leq 0.05$ using statistics outline below.

D. Statistical Analysis

Data obtained were tested for significance using ANOVA and Duncan Multiple Range Test with SPSS, Version 18 [10]. All measurements were carried out in triplicate.

III. Results And Discussion

The dietary fibres and β-glucan compositions of dried PSC is shown in Table 1. Dried oyster mushroom contains 35.6g/100g of TDF with IDF being the highest component (35.4g/100g) while SDF had the lowest value (0.2g/100g). The present result was in agreement with the dietary fibre content of the fruiting body of other mushroom species which ranged from 30-40% dry weight [11]. Meanwhile, dried PSC powder had lower water activity (a_w) at 0.49. Higher a_w substances tend to support more microorganisms. Bacteria usually require at least 0.91, and fungi at least 0.7. A lower a_w value confer better storage capability of the dried products.

Table II shows nutrient composition of the *paratha* bread formulated with dried PSC. The concentration of protein was increased proportionally with the level of PSC powder used in *paratha* bread formulation. *Paratha* bread formulated with 6% PSC powder recorded the highest protein concentration (9.39%) followed by *paratha* containing 4% and 2% PSC powder, respectively (9.15% and 8.95%). On the other hand, the concentration of fat was decreased in line with the level of PSC used in the *paratha* formulation. *Paratha* bread formulated with 6% and 4% PSC powder significantly ($p<0.05$) recorded lower content of fat at 1.99% and 2.71%, respectively as compared to control (5.25%). On the other part, the percentage of ash in all treatments were ranged from 1.33 -1.64 %. However, the concentration of moisture was proportional to the PSC powder level in all *paratha* samples. *Paratha* bread formulated without PSC powder (control) recorded the lowest concentration of moisture at 22.60%. While all PSC-based *Paratha* recorded moisture content ranging from 25.66-29.50%.

TABLE I
DIETARY FIBRES AND Β-GLUCANS COMPOSITIONS OF DRIED PSC

Nutrient Composition	Concentration
Soluble dietary fibre (SDF)	0.2 (g/100g)
Insoluble dietary fibre (IDF)	35.4 (g/100g)
Total dietary fibre (TDF)	35.6 (g/100g)
β-glucan	3.57 (g/100g)
Water activity	0.49 (orbituary unit)

TABLE II
NUTRIENT COMPOSITION OF *PARATHA* ADDED WITH PSC

Proximate Composition	PSC Level (%)			
	0	2	4	6
Moisture	22.60 ± 5.13^b	25.66 ± 3.67^{ab}	27.01 ± 0.49^{ab}	29.50 ± 0.82^a
Ash	1.33 ± 0.58^b	1.39 ± 0.12^{ab}	1.45 ± 0.06^{ab}	1.64 ± 0.22^a
Fat	5.25 ± 0.25^a	4.43 ± 1.29^a	2.71 ± 0.16^b	1.99 ± 0.29^b
Protein	8.83 ± 0.08^b	8.95 ± 0.27^b	9.15 ± 0.17^{ab}	9.39 ± 0.25^a

Table III shows the sensory evaluation scores for *paratha* bread (unleavened bread) incorporated with PSC. Apparently, the scores of all sensory attributes were in the range between 3.72-5.22 with the *paratha* bread containing 4% of dried PSC received the highest score as perceived by untrained panellists. The present sensory data also shows that all *paratha* bread formulated with 2, 4 and 6% PSC were not significantly different ($P>0.05$) compared to control *paratha* for all attributes. However, among all PSC-based *paratha* treatments, *paratha* containing 2% PSC had the highest scores for all sensory attributes. It can be suggested that *paratha* containing 2% PSC powder can be formulated with the intention in improving overall acceptability of *paratha* bread.

Table IV shows the sensory evaluation scores for rice-porridge incorporated with PSC. Generally, panelists gave the similar score for overall acceptance of the rice-porridge prepared with 2, 4 and 6% PSC and without PSC (control). Rice-porridge formulated with PSC received higher scores for aroma, colour, appearance and overall acceptability compared to control treatment. Among rice-porridge added with PSC powder, consumers prefer porridge added with 4% OMP. This treatment received the highest scores for appearance (4.49), flavor (4.05) and overall acceptance (4.41) attributes. On the other result, rice-porridge added with 6% PSC powder had the highest score for aroma attribute.

TABLE III
SENSORY ATTRIBUTES OF *PARATHA* ADDED WITH PSC (N= 60)

Sensory Attibute	**PSC Level (%)**			
	0	**2**	**4**	**6**
Aroma	4.63 ± 1.16^a	5.06 ± 1.24^a	4.72 ± 1.30^a	4.97 ± 1.18^a
Colour	4.63 ± 1.21^a	5.22 ± 1.10^a	4.63 ± 1.48^a	4.69 ± 1.23^a
Appearance	4.50 ± 1.17^a	4.94 ± 1.22^a	4.56 ± 1.44^a	4.78 ± 1.29^a
Elasticity	3.72 ± 1.29^a	4.59 ± 1.21^a	3.94 ± 1.24^a	4.56 ± 1.54^a
Flavour	4.09 ± 1.40^a	4.81 ± 1.26^a	4.03 ± 1.40^a	4.47 ± 1.46^a
Overall acceptance	4.13 ± 1.21^a	4.84 ± 1.08^a	4.22 ± 1.31^a	4.53 ± 1.24^a

a-b Mean values within the same row bearing different superscripts differ significantly ($P<0.05$)

TABLE IV
SENSORY ATTRIBUTES OF RICE-PORRIDGE ADDED WITH PSC (N= 60)

Sensory Attibute	**PSC Level (%)**			
	0	**2**	**4**	**6**
Aroma	3.81 ± 1.27^b	4.49 ± 1.19^a	4.46 ± 1.17^a	4.68 ± 1.36^a
Colour	4.11 ± 1.64^a	4.49 ± 0.99^a	4.43 ± 1.28^a	4.57 ± 1.26^a
Appearance	4.05 ± 1.15^a	4.32 ± 1.16^a	4.49 ± 1.15^a	4.32 ± 1.27^a
Elasticity	4.78 ± 1.34^a	4.24 ± 1.28^a	4.49 ± 1.19^a	4.46 ± 1.24^a
Flavour	3.95 ± 1.22^a	3.73 ± 1.24^a	4.05 ± 1.43^a	3.70 ± 1.29^a
Overall acceptance	4.05 ± 1.37^a	4.19 ± 1.02^a	4.41 ± 1.34^a	4.39 ± 1.20^a

a-b Mean values within the same row bearing different superscripts differ significantly ($P<0.05$)

These data indicated that consumers accept both *paratha* bread and rice-porridge prepared with all level of PSC powder.It seems that the maximum level of PSC powder to be added with the purpose in improving nutritional composition is 6%.

IV. Conclusions

PSC powder recorded appreciable amount of β-glucan at 3.57g/100g. Dried oyster mushroom contains 35.6g/100g of TDF with IDF being the highest component (35.4g/100g) while SDF had the lowest value (0.2g/100g). The consumers prefer both rice-porridge and *paratha* bread containing 2-4% PSC compared to those that are not added with PSC powder. The PSC powder at 2% is recommended to be formulated with the intention in improving overall acceptability of *paratha* bread. Meanwhile, consumers prefer the rice-porridge added with 4% PSC powder. In conclusion, the addition of PSC powder to partially wheat flour can be recommended for the purpose of enhancing nutritional composition and maintaining the acceptability of carbohydrate-based products.

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