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Effect on the addition of *Pleurotus sajor-caju* (PSC) on physical and sensorial properties of beef patty

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Abstract: Mushrooms are well known to be healthy because they are low in calories, fat and cholesterol level but rich in vitamin and other essential nutrients. The grey oyster mushroom, *Pleurotus sajor-caju* (PSC), is a common edible mushroom and is now grown commercially around the world for food and food products. The ability of PSC in changing physical characteristics and sensory properties of beef patty formulated with this fungus were investigated. Result shows beef patty added with 50% ground PSC recorded the highest concentration total dietary fibre (TDF) at 9.95 g/100g compared to beef patty containing 25% of PSC (7.00 g/100g) and control (3.90g/100g). Beef which was replaced with 25% of PSC, recorded the highest cooking yield (76.62%) and moisture retention (59.80%) respectively. On the other physical traits, beef patty containing 25% PSC recorded fat retention at 89.04% and was not significant ($P<0.05$) with control patty (88.59%). However, the fat retention was proportionally decreased with the increment of PSC content in patty formulations. There were no differences recorded in all sensory attributes of PSC-based patties perceived by panelists. The addition of PSC at 25% can be recommended for incorporation in beef patties and permit a reduction of the formulation cost without affecting sensory descriptors of the product to which the consumer is familiarized.

Keywords: ***Pleurotus sajor-caju*, chemical composition, physical traits, sensory evaluation**

Introduction

Oyster mushrooms signify a type of specialty fungi that is commonly consumed world widely and gaining popularity in the Asian countries. This fungus is regularly cultivates on a decayed organic material and produce edible portion on the surface of the substrate. Dried mushrooms are nutritive and are richer in protein and total carbohydrate but contain less crude fat (Agrawal *et al.,* 2010). Mushrooms are well known to be healthy because they are low in calories, sodium, fat and cholesterol level (Manzi *et al.,* 2004). In addition, some medicinal value such anti-viral and anti-cancer properties (Liu *et al.,* 2005) as well as cholesterol-reducing effects have been observed (Bobek *et al.,* 1997). It also contain appreciable amount of dietary fibre and β-glucan, vitamin B and other useful nutrients. Apart from that, they have traditionally been used in the treatment and prevention of diabetes, hypertention, constipation and cancer (Agrawal *et al.,* 2010). In addition, shitake mushroom have been reported to exhibit medicinal effects including antitumor and immune-potentiating activities (Israilides *et al.,* 2008).

Pleurotus species are universally known as oyster mushrooms and consists of 40 species. Oyster mushrooms now rank second among the important cultivated mushrooms in the world *(Imran et al.,* 2011). *Pleurotus sajor caju* is easily cultivated and done so widely in tropical regions and other parts of the world. It is reported to possess distinctive nutritional and medicinal values, palatial and with its characteristic aroma. Mushrooms are highly perishable commodities and they start deteriorating immediately after harvesting. This edible fungus is presume to possess considerable importance in the human diet as they are rich in non-starchy carbohydrates, dietary fibre, β-glucans, minerals, vitamin-B and are low in fat content. β-glucans, also a components of soluble or insoluble dietary fibre (SDF, IDF) is present in appreciable amounts in mushrooms and are linked to the ability to lower blood cholesterol levels and glycemic response. Due to the low fat and high fibres content in edible mushroom, it is recommended as an ideal food item to be consumed for dietary prevention of atherosclerosis (Schneider *et al.,* 2011).

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. Carbohydrates and fibre from plant based materials have been used in reducing formulation cost, enhancing texture while reducing formulation cost (Pinero *et al.,* 2008). Dietary fibre can also

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provide several functional properties to food. They improve oil holding capacity, water holding capacity, emulsification and gel formation. Another functional property of dietary fibre are it able to modify textural properties, stabilize high fat food, improve shelf-life and avoid seneresis (Elleuch *et al.,* 2011).

Various types of dietary fibres from cereal and legumes have been utilized in an attempt to improve nutritional quality and at the same time reducing production cost of meat based patties. These included the usage of oat (Inglett *et al.,* 2005) and oyster mushroom (Chockchaisawasdee *et al.,* 2010). Extensive studies have been done in the use of various types of fat replacer and plant dietary fibre in processed meat and poultry products in attempts at increasing dietary fibre and lowering of fat content. The effect of utilization of tapioca starch, oat fibre *(Dongowski et al.,* 2003), cereal and fruit fibres (García *et al.,* 2002) on the physical characteristics and sensory properties of low-fat beef patties has been studied previously. The addition of pea fiber concentrate (PFC) and wheat fiber concentrate (WFC) in beef burger formulation improves their cooking properties, i.e., increases the cooking yield and decreases the shrinkage, and minimizes production cost without affecting the sensory properties (Besbes *et al.,* 2008). Recently, researchers found that dietary grape pomace concentrate and grape antioxidant dietary fibre could be successful in retarding lipid oxidation of chilled and long-term frozen stored of raw and cooked chicken patties (Sayago-Ayerdi *et al.,* 2009). In another study, antioxidative effect of added tea catecins on susceptibility of cooked red meat, poultry and fish patties has been reported earlier (Tanga *et al.,* 2001). Recently it was discovered that cornsilk has improves nutrient content and cooking characteristics in processed beef patty (Wan Rosli *et al.,* 2011).

Thus, the present study was conducted to observe the ability of *Pleurotus sajor-caju* (PSC) in confering changes in physical traits and sensory evaluation of beef patty. This non-meat ingredient incorporation was intended to reduce formulation cost and enhancing the physical characteristics of beef patties.

Materials and Methods

Oyster mushroom (PSC) was supplied by the National Kenaf and Tobacco Board of Malaysia from Bachok Kelantan, Malaysia. Fully-grown mushrooms with the pileus cap diameters between 9 to11 cm were used throughout the study. The mushroom was prepared by rinsing with clean water, blanched and ground for 30 seconds. The prepared mushroom was then incorporated partially to replace beef hind quarters in patty formulations.

Beef patty formulation

Three beef patty formulations were compared. Each of them contains either 0 (control), 25 and 50% of ground PSC. The percentages of other ingredients are unchanged compared to the control sample, whereas the percentage of beef (hind quarter) decreases with the increase of ground PSC content. The ground PSC was incorporated into the beef patties using the formulations described in Table 1. The finished beef patties were stored in a freezer at -18^{o}C while waiting for further analysis. PSC was prepared in the Nutrition Laboratory of the School of Health Sciences, Universiti Sains Malaysia Health Campus. Beef was purchased from local wet market. Other dry materials were purchased from local suppliers.

Processing

The beef (hind quarter) was manually cut using a cleaver and minced through a 4 mm-diameter grinder plate. The minced beef flesh was stored at –18^{o}C until processing time. Isolated soy protein was blended with water and shortening at a ratio of 1:5:5 using a Hobart mixer (N-50 Canada). The emulsion prepared (called pre-emulsion) was kept in a chiller (2-5^{o}C) until ready for use. Salt was added to the frozen minced beef and mixing was carried out using a Hobart mixer for 3 min. Water mixed with spices, potato starch, textured vegetable protein and oyster mushroom were added and mixed for another 2 min. The pre-emulsion was then added and mixing continued for another 2 min. The finished beef batters were then weighed into 70g portions, and then manually moulded to produce a uniform patty. The raw beef patties were then frozen in a freezer at –18^{o}C until further analyses.

Cooking procedure

Beef patties were thawed at 4 °C for 12 h. Beef patties were then cooked on a pan-fried electric skillet (Model KX-11K1, Sharp Corporation, Japan) for 7-8 min until an internal temperature of 72 ± 1^{o}C was achieved.

Proximate composition

Proximate composition was conducted using (AOAC, 1996) for moisture, ash, soluble dietary fibre (SDF), insoluble dietary fibre (ISF), total dietary fiber (TDF), protein by nitrogen conversion factor of 6.25 [Kjeldahl method, (AOAC, 1996) and crude fat content using the semi-continuous extraction [Soxhlet] method (AOAC, 1996). All measurements were carried out in triplicate (n = 3).

Cooking yield

Cooking yield of beef patties were determined by measuring the weight of six patties for each treatment/batch and calculations of weight differences for patties before and after cooking, were as follows (El-Magoli *et al.,* 1996):

$$\text{Cooking yield (\%)} = \frac{(\text{cooked weight} \times 100)}{\text{Raw weight}}$$

Moisture and fat retention (percent)

The moisture and fat retention values represent the amount of moisture and fat retained in the cooked product per 100 g of raw sample, These values were calculated according to the following equations (El-Magoli *et al.,* 1996):

Moisture retention

$$= \frac{(\text{percent yield} \times \text{\% moisture in cooked patties})}{100}$$

Fat retention (%)

$$= \frac{(\text{cooked weight} \times \text{percent fat in cooked beef patties}) \times 100}{(\text{raw weight} \times \text{percent fat in raw beef patties})}$$

Diameter reduction (%)

Change in beef patties' diameter was determined using the following equation:

Diameter reduction (%)

$$= \frac{\text{raw beef patties diameter} - \text{cooked chicken patties diameter} \times 100}{\text{raw beef patties diameter}}$$

Sensory evaluation

All beef patty samples were evaluated by each untrained consumers according to the hedonic scaling method outlined by Piggott (1989). 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. The cooked patty samples were equally divided into 6 portions. Each portion of product sample was placed in sensory cups with lids coded with 3 digit random numbers. Permutation sample presentation is applied to the patties before presented to the panellists. They evaluated samples for colour, juiciness, elasticity, flavour and overall acceptance on a 7 point scale (1 = dislike extremely and 7 = like extremely). Significance was established at P ≤ 0.05 using statistics outline below.

Table 1. Beef patty formulated with different level of ground PSC

	PSC level (%)		
Ingredients (%)	Control (0)	25	50
Beef (hind quarter)	54.0	40.5	27.0
Fat	9.0	9.0	9.0
Water	26.0	26.0	26.0
Potato starch	6.0	6.0	6.0
Ground PSC	0.0	13.5	27.0
Isolated soy protein	3.0	3.0	3.0
Salt	1.0	1.0	1.0
Spices and seasoning	1.0	1.0	1.0
Total	100	100	100

Statistical analysis

Data obtained were tested for significance using ANOVA and Duncan Multiple Range Test with SAS version 6.12 (SAS, 1989). All measurements were carried out in triplicate (n = 3). The experiments were replicated twice.

Results and Discussion

Table 2 shows chemical composition of the cooked beef patty formulated with ground PSC. The concentration of protein was decreased proportionally with the level of fresh PSC used in cooked beef patty. Cooked beef patties formulated without PSC (control) significantly (P<0.05) recorded the highest protein concentration (22.73%) followed by beef patty with 25% and 50% fresh PSC (19.37% and 15.22%). The same trends of fat content were recorded in cooked beef patties. Beef patty formulated with 25% and 50% fresh PSC significantly (P<0.05) recorded lower content of fat at 12.07% and 11.57%, respectively as compared to control.

The percentage of ash in all cooked beef patties were ranges from 2.34 -2.47 % and not significant amongst treatments. The concentration of moisture was proportional to the fresh PSC level in cooked beef patty. Cooked beef patty formulated without PSC (control) recorded the lowest concentration of moisture at 56.46%. All cooked patty incorporated with PSC recorded moisture content ranging from 58.16-60.61%. Generally, the concentration of total dietary fibre (TDF) was increased in line with the level of ground PSC (Table 3). Beef patty added with 50% ground PSC had the highest concentration of total dietary fibre (TDF) at 9.95 g/100g compared to beef patty containing 25% of PSC (7.00 g/100g) and control (3.90g/100g). Previous study documented that TDF value of the *Pleurotus ostreatus* mushroom at 34.5% are close to the values of *Pleurotus sajor-caju* at 33.1% (Synytsya *et al.,* 2008). In the present study, the low soluble dietary fibre (SDF) of 50 mg/100g was detected in beef patty added with 50% of ground PSC. However the SDF was not detected both in beef patty containing 0% (control) and 25% PSC, respectively. Among samples, beef patty containing 50% ground PSC had the highest insoluble dietary fibre (IDF) at 9.90 g/100g while beef containing 0% ground PSC had the lowest value at 3.9 g/100g. Beef patty containing 50% PSC had β-glucan content of 0.78% and significantly (P<0.05) higher than control patty (0.66%). Even though beef patty containing 25% ground PSC recorded higher value of β-glucan but was not different with control beef patty.

Physical characteristics of cooked beef patties added with PSC are presented in Table 4. Apparently, cooking yield and moisture retention properties were decreased in line with the level of PSC in beef patty formulations. Among all mushroom-based patties, beef which was replaced with 25% of PSC, recorded the highest cooking yield (76.62%) and moisture retention (59.80%) respectively. Beef patty which was replaced with 50% of PSC recorded the lowest cooking yield and moisture retention values at 73.27% and 54.04%, respectively. There was an inverse relationship between cooking yield and moisture retention with the level of PSC used in the beef patty formulations. This is probably due to the inability of PSC fibre to create a tridimensional matrix within the patties due to the high moisture content. The PSC used in this work is high in moisture content (89%) (Wan Rosli *et al.,* 2011). In control burgers, fat was easily removed during cooking, probably due a low density meat protein matrix, along with a high fat instability. This is in agreement with previous study (Suman & Sharma, 2003) who investigated the effect of grind size and levels on the physico-chemical and sensory characteristics of low-fat ground buffalo meat patties.

On the other result, beef patty containing 25% PSC recorded fat retention at 89.04% and was not significant (P<0.05) with control patty (88.59%). However, the fat retention was proportionally decreased with the increment of PSC content in patty formulations. There was no difference between fat retention at 0% and 25%. The lower amount of fat retention only resulted in higher addition of PSC (50%). Dietary fibres increased cooking yield because of their high ability to keep moisture and fat in the matrix. This finding is supported by the previous effort by (Turhan *et al.,* 2005), who utilized wheat fibres and hazelnut pellicles, respectively in beef patty formulations.

Diameter reduction was decreased with the level of PSC in patty formulations. Beef patty formulated with 25 and 50% PSC had diameter reduction at 12.45% and 11.95% respectively, while beef patty without PSC had 12.95%. Even though these cooking trait values were lower in all mushroom added beef patty but they were not significantly different (P > 0.05) with control patty. These findings were similar to the study done by Pinero *et al.* (2008) who reported that there were no significant in diameter reduction of low-fat patty containing oat's soluble fibre and control. The retention of the size and shape of mushroom-added beef patty during cooking could be due to the binding and stabilizing property of mushroom fibre, which held the meat particle together and resisted changes in the shape of the product.

Table 2. Chemical analyses of cooked beef patty incorporated with PSC

Chemical Compositions (%)	PSC Level (%)		
	0 (control)	25	50
Protein	22.73 ± 0.12^{a}	19.37 ± 0.21^{b}	15.22 ± 0.26^{c}
Fat	13.38 ± 0.02^{a}	12.07 ± 0.03^{b}	11.57 ± 0.43^{c}
Moisture	56.46 ± 0.12^{c}	58.16 ± 0.11^{c}	60.61 ± 0.29^{b}
Ash	2.47 ± 0.21^{a}	2.34 ± 0.22^{a}	2.40 ± 0.21^{a}

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

Table 3. Soluble (SDF), insoluble (IDF) and total dietary fibre (TDF) concentrations (g/100g) of beef burger added with different level of ground PSC

Dietary Components (%)	PSC Level (g/100g)		
	0	25	50
SDF	0.00 ± 0.00^{b}	0.00 ± 0.00^{b}	0.05 ± 0.00^{a}
IDF	3.90 ± 0.08^{c}	7.00 ± 0.05^{b}	9.90 ± 0.04^{c}
TDF	3.90 ± 0.08^{c}	7.00 ± 0.05^{b}	9.95 ± 0.04^{a}
β-glucan (%)	0.66± 0.04^{b}	0.67 ± 0.03^{b}	0.78± 0.06^{a}

$^{a-g}$ Mean values within the same column bearing different superscripts differ significantly (P<0.05

Table 4. Physical traits of beef patties formulated with different level of PSC

Physical Traits (%)	PSC Level (%)		
	0	25	50
Cooking Yield	79.86±0.49^{a}	76.62±0.12^{b}	73.67±1.47^{c}
Moisture Retention	65.20±0.40^{a}	59.80±0.09^{b}	54.04±1.03^{c}
Fat Retention	88.59±1.98^{a}	89.04 ± 0.33^{a}	84.91 ± 2.49^{b}
Diameter Reduction	12.95±0.64^{a}	12.45±0.07^{a}	11.95±0.64^{b}

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

Table 5. Sensory attributes of cooked beef patties as influenced by the addition of PSC (n=60)

Sensory attribute	PSC Content (%)		
	0	25	50
Colour	3.92 ± 0.94 ^{a}	3.97 ± 1.03 ^{a}	3.92 ± 1.16 ^{a}
Juiciness	4.15 ± 1.09 ^{a}	4.30 ± 1.14 ^{a}	4.62 ± 1.08 ^{a}
Elasticity	4.62 ± 1.10 ^{a}	4.85 ± 1.03 ^{a}	4.77 ± 1.06 ^{a}
Flavour	4.31 ± 1.07 ^{a}	4.15± 1.16 ^{a}	3.85± 1.04 ^{a}
Overall acceptance	4.80 ± 1.07 ^{a}	4.93 ± 1.00 ^{a}	4.08± 1.10 ^{a}

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

In the present study, the percent of cooking yield during cooking was comparatively similar than other study. For instance, Sheard *et al.* (1998) reported that cooking loss of grilled and fried beef patties contained 9-30% of fat were ranging from 22 – 36% and Pinero *et al.* (2008) reported the cooking loss of 25 and 29% respectively in beef patties incorporated with oat fibres. This present study only used 15% fat in patty formulation and the cooking loss was less than 30% as compared to those reported by Sheard *et al.* (1998). From this result, it can be suggested that cooking loss increased proportionally with fat content used in patty formulation.

Sensory evaluations of beef patty formulated with PSC

Table 5 shows the sensory evaluation scores for beef patties incorporated with PSC. It appears that, the scores of all sensory attributes were ranges between 3.85-4.93 with the patty containing 25% PSC obtained the highest score as perceived by untrained panellists. The present sensory data also shows that all beef patties formulated with 25 and 50% PSC were not significantly different (P>0.05) compared to beef patty without PSC for all attributes. Among all PSC-based patty treatments, patties containing 25% PSC had the highest scores for all sensory attributes except for juiciness attribute. Beef patty containing 25% PSC had 4.85 and 4.93 score values of elasticity and overall acceptability, respectively but was not significant (P>0.05) compared to other treatments. The result shows that juiciness attribute was increase in line with the level of PSC used in the patty formulation. Even though beef patties formulated with 25% and 50% PSC had slightly higher scores (4.30 and 4.62) for juiciness attributes but were not significantly different with that of control. On the other attribute, the higher scores for elasticity attribute was observed in patties added with PSC (4.77-4.85) compared to control treatment (4.62). This higher score could be attributed to the rubbery structural arrangement of the PSC in beef protein systems (Wan Rosli *et al.,* 2011). Previous researchers have reported that the dilution effect of nonmeat ingredients in meat protein systems primarily accounted for soft texture (Tsai *et al.,* 1998). To summarize, consumers were unable to differentiate colour, juiciness, elasticity, flavour and overall acceptance of beef patties made from different levels of PSC. This data indicated that consumers accepted the patties prepared with all level of PSC level.

Conclusion

Incorporation of ground PSC in beef patties resulted in decreased of protein and fat content significantly. On the other hand, the TDF and IDF concentration was increase in line with PSC level in beef patty formulation. Beef patty added with 50% ground PSC recorded the highest concentration TDF at 9.95 g/100g compared to beef patty containing 25% of PSC (7.00 g/100g) and control (3.90g/100g). In the sensory evaluation, there were no differences recorded in all sensory attributes of PSC-based patties perceived by panelists. This novel food item for incorporation in beef patties could permit a reduction of the formulation cost without affecting sensory evaluation attributes. The addition of PSC at 25% to partially replace beef meat can be recommended for the purpose of lowering production cost and fat content without affecting sensory descriptors of the product to which the consumer is familiarized.

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