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RESEARCH ARTICLE

EFFECT OF DIFFERENT DRYING TEMPERATURES ON THE NUTRITIONAL QUALITY OF EDIBLE WILD MUSHROOM, *Volvariella volvacea* OBTAINED NEARBY FOREST AREAS

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Abstract

This study was conducted to investigate the effect of different drying temperature to the nutritional compositions of edible wild mushroom (*Volvariella volvacea*) and to determine the best drying temperature suitable for post-harvest handling without compromising their nutritional value. The fresh wild mushroom was obtained from the rural area near to the forest area around Sandakan. The mushroom samples (fresh and treated with 40, 50, 60°C) were tested for proximate analysis (moisture, ash, total crude fibre, fat, protein and carbohydrate content). The fresh mushroom contained high protein (12.38%) and carbohydrate (13.51%); but low in fat content (0.77%) as compared to the commercial one (*Lentinus edodes* and *Agaricus bisporus*). All the samples exhibited reducing trend ($P<0.05$) for the parameters tested (moisture, fat, crude fiber and carbohydrate content) when treated at respective temperatures, except for the ash and crude fiber content. Mushroom treated at 60°C has comparable high energy (1468.73kj) and calorie (346.04kcal) content. The current study revealed that the treatment using 60°C is suitable to dry the edible wild mushroom as it preserves most nutritional values. Future study will focus on the effect of heat treatments to the bioactive components that might present in this edible wild mushroom.

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INTRODUCTION

Mushrooms have been consumed for century as food or food supplement due its delicate taste, flavor and therapeutic effects (Chockchaisawasdee et al. 2010). Literally, there are less than 25 species of edible mushroom out of more than 2000 species that exists. Some of the edible ones especially *Agaricus bisporus*, *Pleurotus* spp., *Lentinula edodes* are cultivated for commercial purposes (Barros et al. 2007). Mushrooms have been proven to possess good quality of proteins, unsaturated fatty acids, fibers, minerals and vital vitamins that we need in our daily diet (Ouzouni et al. 2009b; Hung and Nhi, 2012). In fact, studies revealed that *Agaricus bisporus*, *Hericiumerinaceus*, *Flammulinavelutipes*, *Lentinus edodes* and *Pleurotus ostratus* exhibit potential antioxidative effect in preserving food or as anti-aging agent (Kim et al. 2001; Lee et al. 2003).

Edible wild mushroom are used for centuries by people as food or traditional medicines to cure certain diseases (Chang and Lee, 2004). Studies showed that some of the edible wild mushrooms possessed potential anti-carcinogenic, anti-cholesterolaemic and anti-viral properties (Emilia et al., 2006; Roman et al., 2006). Sabah, due to its strategic location is rich in natural resources and biodiversity. Its high humidity surrounding with appropriate weather promotes the growth of many wild mushrooms within the tropical forest of Sabah (Chong et al., 2007). Several edible wild mushrooms that commonly found in the rural or forest areas in Sabah include *Pleurotus*, *Lentinus*, *Hygrocybe* and *Volvariella*, *Schizophyllum* spp. and some of them even high in nutritional value as well as antioxidant activities (Chye et al., 2009). Among all, the *Volvariella volvacea* or locally known as '*kulat kelapa*

sawit' is commonly found in the dumped site of empty fruit bunch within oil palm estate or forest around Sabah region. The fruiting body of this wild mushroom is bigger than others as it grow on the abundant empty fruit bunches or wooden materials in the forest which may provide superior nutrients or minerals for fruit body development. Indigenous people usually sell them freshly to the market without any post-harvest treatments. However, the mushrooms started to spoil with undesirable smell, texture and odor after harvested for 6-7 hours. This indirectly create economic loses to the indigenous people who rely it for livelihood.

Drying is normally carried out to extend food or agriculture commodities shelf life. In fact, excessive exposure to the heat might have impact on the nutritional or physiological of the end products. Until present, information on the impact of heat on nutritional composition of this edible wild mushroom, *Volvariella volvaceae* is very limited. Therefore, this study is carried out to investigate the effect of different drying temperatures towards the nutritional value and to determine the best drying temperature suitable for post-harvest handling without compromising their nutritional value of *Volvariella volvacea*.

MATERIAL AND METHODS

Sampling of edible wild mushroom

Fresh *Volvariella volvacea* mushrooms were obtained from indigenous people staying nearby to the forest around Sandakan, Sabah. The fresh mushrooms were dig out carefully using sterilized scalpel before put in sterilized sampling bag. The sampling bag was then kept in cooling box which contain ice block (6-8^{o}C) and brought back to Microbiology Laboratory, Faculty of Sustainable Agriculture, Universiti Malaysia Sabah – Sandakan Campus for further analysis.

Authentication and identification of mushroom

The wild mushroom specimens together with the empty fruit bunch were collected and authenticated by mycologist, Associate Professor Dr. Marcus Atong. Further identification of the mushroom species was done based on the guide book by Alan et al. (1997). The species was identified as *Volvariella volvacea*.

Sample preparation

The identified mushroom samples were then undergo cleaning and part separation steps. An approximately 500-600g of cleaned mushrooms will be uprooted and stalk will be separated from the cap with a sterile scalpel. Then, the separated part will be divided into four portions and each was placed on stainless steel tray for further treatment. The first tray was the fresh sample or as the control whiles the second, third and fourth trays were treated at 40, 50 and 60^{o}C using oven for 24 hours.

Proximate analysis

All the treated mushroom samples were analyzed for proximate analysis (moisture, crude protein, crude fat, ash, crude fiber and carbohydrate content) using standard procedures according to the Association of Official Analytical Chemists (AOAC, 2002). All the analysis were done triplicately.

Statistical analysis

All the experiment was done in triplicate. Data were shown in mean and subjected to analyses of variance (one way ANOVA) significance was accepted at the 5% probability level using the Statistical Package for Social Science (SPSS) Program 18 version. Duncan Test was run to determine significance difference between means.

RESULT AND DISCUSSION

Comparison of Proximate compositions between Edible Wild Mushrooms and Commercial Cultivated Mushrooms

The nutritional composition of edible wild mushroom, *Volvariella volvaceae* is compared with some cultivated mushrooms that found in Sabah, namely the *Lentinus edodes*, *Pleurotus* sp. and *Agaricus bisporus* (Table 1). The moisture content for fresh *Volvariella volvaceae* (72.28%) is comparatively lower than cultivated commercial mushrooms. Therefore, fresh mushroom is considered as high perishable foods and susceptible to rapid deterioration and enzyme activity (Adejumo and Awesanya, 2005).

Table 1: Comparison of proximate compositions between edible wild mushrooms and commercial cultivated mushroom

Parameter (%)	Edible wild mushroom	Commercial cultivated mushrooms		
	Volvariella volvaceae	***Lentinus edodes***	***Pleurotus* sp.**	***Agaricus bisporus***
Moisture content	72.28±0.05[b]	78.63±0.12[c]	73.80±0.07[a]	75.50±0.18[d]
Ash	1.06±0.08[d]	4.75±0.05[c]	5.50±0.12[b]	6.70±0.08[a]
Crude fat	0.77±0.05[d]	1.92±0.08[a]	1.70±0.15[c]	1.80±0.23[b]
Crude fibre	3.77±0.18[d]	11.52±0.24[a]	7.80±0.28[c]	9.50±0.31[b]
Protein	12.38±0.25[b]	8.32±0.11[d]	11.50±0.15[c]	11.90±0.21[a]
Carbohydrate	13.51±0.19[a]	6.38±0.09[b]	7.50±0.13[c]	3.60±0.17[d]

Means with different letters within a row are significantly different ($p<0.05$)

Meanwhile, the ash content of fresh *Volvariella volvaceae* is the lowest (1.06%) as compared to the cultivated mushrooms. Literally, the cultivated mushrooms may have higher ash content because of the use of organic fertilizer, chemicals or even growth hormone which intentionally for rapid cultivation of mushrooms. Hence, this mineral content will increase and remain as the residue in the mushrooms (Kalac, 2009; Reis et al., 2011). Meanwhile, *Volvariella volvacea* has the least fat content among tested mushrooms (0.77%) which enables them to be used for healthy diet.

Moreover, the protein content of *Volvariella volvaceae* (13.38%) is slightly lower than the cultivated mushroom, *Agaricus bisporus* (16.90%). This phenomenon related to the source of nutrient feed as cultivated mushrooms get maximum food resource from its nutritious media as compared to wild mushrooms. This allows the cultivated mushrooms to grow optimally and synthesize complete amino acids. Besides, the difference within the mushroom species, development stages, nitrogen level and growing habitat will have influence to their protein levels (Longvah and Deosthale, 1998). In this study, the carbohydrate content of *Volvariella volvaceae* is the highest (13.51%) among all tested samples. The current result is contrast to the findings of Chang and Miles (2004) who recorded lower carbohydrate content value among the tested edible mushrooms. In fact, there are some studies revealed that the *Volvariella volvaceae* does contain exceptional nutritional value for carbohydrate and protein content which makes them as potential functional food or food supplement (Chukwu, 2000; Moore and Chi, 2005).

Changes in nutritional value of mushroom on different drying temperatures

There are few studies to report on the effect of heat treatment on the nutritional composition of edible wild mushroom. Table 2 show the effect of different drying temperatures (40, 50 and 60^{o}C) against the nutritional composition of wild *Volvariella volvaceae*. According to Imaobong and Bassey (2012), the range of drying temperatures being used is common to dehydrate foods that will not be detrimental to the mushroom as the nutrient still can be preserved.

Excessive water content will affect the stability of food products as it promotes microbial growth. When the *Volvariella volvaceae* was treated at 40°C, the moisture content was reduced significantly ($P<0.05$) to 55.42±0.03% as compared to the fresh sample (control). However, greater water loss (8.3±0.2%) was achieved when the sample was dried at 60°C. With this regards, the removal of excessive moisture in the mushroom will reduce the risk of microbial spoilage or deleterious effects caused by enzyme, but it might have profound effect on the texture or sensory attributes of the food (Shewfelt, 2009). In another study shown by Aishah and Rosli (2013), they discovered that the use of different drying techniques do reduce the moisture content and water activity of the cultivated *Pleurotus sajor-caju* (Oyster mushroom).

Generally, the crude fat of mushrooms may consist of all classes of lipid components such as free fatty acid, mono-, di- and triglycerides, sterols esters and phospholipids. Nevertheless, the fat content in mushroom is considered very low which enables them to recognize as nutritious and healthy food. However, the crude fat content at 60 ^{o}C was highest (1.56±0.22%) among treated samples. The increase of the crude fat content after treated by different drying temperature might due to the availability of high number of unsaturated fatty acids or lipids. Besides, the use of organic solvent in the soxhlet fat extraction indirectly breaking down certain polyglycerides into smaller

components such as the fatty acids or lipids (Nielsen, 2002). According to Kalac (2009), the proportion of unsaturated fatty acid especially the linoleic acid level will increase if mild heat treatment is applied during post-harvest of mushroom.

Similar to other hi-fibre foods, mushroom contains high dietary fibre. In fact, the fibre content may vary among mushroom species due to their growing location or nutritional intake throughout fruiting cycle. The total crude fibre content for the control sample (untreated) is low (approx. 3.77%) as compared to the treated ones. However, the total crude fibre content of this edible wild mushroom reduced significantly after dried at 40, 50 and 60 ^{o}C respectively (Table 2). The reduction in the crude fiber content can be associated with the nature of the mushroom fibre that dissociate when they are heated at certain temperature. Besides, the breakdown and solubilize of hemicellulose components especially the arabinogalactan, water soluble pectins and hydrocolloids also facilitate the reduction in crude fiber content (Hassan et al. 2007).

Table 2: Effect of different drying temperatures on the nutritional quality of *Volvariella volvaceae*

Parameter	control	Temperature (^{o}C)			Changes
		40	50	60	
Moisture (%)	73.08±0.05^{a}	55.42±0.03^{b}	18.86±0.08^{c}	8.3±0.02^{d}	Reduce
Ash (%)	1.16±0.08^{d}	5.33±0.12^{c}	6.75±0.16^{b}	7.14±0.20^{a}	Increase
Fat (%)	0.87±0.05^{d}	1.3±0.10^{c}	1.65±0.15^{a}	1.56±0.22^{b}	Reduce
Total crude fibre (%)	3.25±0.10^{d}	21.78±0.11^{a}	18.22±0.09^{b}	16.77±0.07^{c}	Reduce
Protein (%)	11.48±0.22^{c}	22.75±0.18^{d}	29.4±0.13^{a}	33.35±0.09^{b}	Increase
Carbohydrate (%)	13.41±0.17^{a}	15.20±0.23^{b}	42.34±0.21^{c}	49.65±0.15^{d}	Increase
Energy (kcal)	107.39±0.16^{b}	163.50±0.05^{a}	301.81±0.11^{c}	346.04±0.21^{d}	Increase
Energy (kJ)	455.32±0.22^{b}	693.25±0.13^{a}	1280.51±0.15^{c}	1468.73±0.18^{d}	Increase

*Same alphabet horizontally shows no significance difference at 0.05

Mushroom has been widely consumed due to its high protein and carbohydrate value compared to those found in meats, milks, eggs, fishes and legumes. Some mushroom species contains excellent amino acids content which is essential to our body metabolism. It is notably that different drying temperatures do affect the protein content of the wild *Volvariella volvacea*. The mushroom sample that treated at 60^{o}C exhibited highest protein content (33.35%) as compared to the control or other treatments used in this study (Table 2). This result is in agreement with Audrey et al. (2004), which stated that protein content increased when heat is applied. In fact, the increase of protein content after being heated at various temperatures might due to the presence of mushroom proteins that tolerate to heat abuse within this species.

Being a good source of protein and carbohydrate, mushrooms are well recognized as nutritious food that complement to our daily intake for various nutrients. Meanwhile, it is suitable used as food ingredients for low-calorie diets due to its low fat and energy content. The determination of energy content in food is important to know its supplement to our daily intake. Usually, the requirement of calorie intake for man is between 1500-2000 kcal to fulfill our basic daily intake. The present study shows that 100g of fresh mushroom will gives 455.32 kJ energy. Fresh mushrooms are popular for low-calorie diet (107.39 kcal) compared to other food which is high fat. This study also shows that both the energy and calorie content increased when treated at risen temperatures. Mushroom treated at 60^{o}C gave highest energy or calorie content ($p<0.05$) compared to tested samples (Table 2). On contrary, mushroom that treated at low temperature (40 ^{o}C) is said to have comparable low energy (693.25 kJ) and calorie (163.5 kcal), but it does not remove the excessive water from the mushroom which is not that suitable for extended storage.

CONCLUSION

Current findings revealed that the nutritional value of the selected edible wild mushroom, *Volvariella volvaceae* is comparable to the cultivated mushroom species used in this study. The fresh *Volvariella volvacea* with high protein and carbohydrate; but low in fat content enable them to be consumed as nutritious and healthy food. The best drying temperature to preserve its nutritional value is at 60^{o}C as the protein and carbohydrate content is well preserved. Besides, samples that contain less water are more preferable for extended shell-life storage with stable quality.

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