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Comparative study on some Chemical compounds of Button Mushroom's (*Agaricus Bisporus*) Cap and Stipe during the first to third flushes

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ABSTRACT

Today, as the main sources of food are limited, the importance of efficient use of different sources and also reduction of wastes seems necessary. Button mushroom (Agaricus bisporus) is a rich source of food and its stipe is usually considered as wastes. The purpose of this study is to determine some chemical compounds and nutrient materials of stipe in comparison with cap of button mushroom in three different flushes. Mushrooms were harvested in three different flushes and some chemical characteristics such as moisture, protein, carbohydrate, fat, fiber and ash were analyzed for cap and stipe separately. All tests were performed in three replicates. From the first to the third flush, the amount of moisture, carbohydrate and fat decreased significantly and the protein and fiber content showed significant increase in cap. The behavior of moisture and fat content in different flushes for cap and stipe was similar. Moisture and fat content of stipe, same as cap decreased significantly ($p<0.05$) from first flush to the third flush. The fiber content of stipe was significantly ($p<0.05$) higher than cap and the average of fiber content in three different flushes reported as 27.11 for cap and 38.51 for stipe. According to our results, both parts of mushroom (cap and stipe) are valuable sources of nutrition and using both parts in diet might be effective in human health. Also the stip part of button mushroom can be applied as a valuable food source for quantitative and qualitative provision of some human needs, and help the economy of the country by applying agriculture.

Key words: Button Mushroom, Chemical Compounds, Nutritional Value, Stipe Agricultural Waste, Flush

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INTRODUCTION

The edible *Agaricus bisporus* button mushroom is a category of *Basidiomycetes* that has specified the most amount of cultivation and consumption among edible mushrooms to itself [1]. Usually mushrooms are harvested 2–3 day period in a 7–10-day cycle called flushes or breaks [2]; Based on existing statistics, the worldwide production of edible mushroom was about 6 million tons in 1997 and increased to 22 million tons in 2009, from which more than 37% related to edible *Agaricus bisporus* button mushroom [3]. The stipe of mushroom is usually considered waste and is used to feed animals [4]. More than 3500 million tons of agricultural waste and less valued remains are produced thought the world [5]. From nutritional value point of view, mushrooms are ranked after meat and before vegetable; The results of experiments indicates that button mushroom contains 91.5% moisture, 3.7% protein, 4.2% carbohydrate, 0.3% fat and 1.25% ash [6]. The protein of mushroom is in the range of 24 to 44% on dry bases that contains 9 essential amino acids [5]. The amount of fat and calorie in button mushroom is low and it can be considered as a good source of vitamins and materials especially iron, zinc, selenium, potassium, and phosphor [7, 8].

In addition to high nutritional value, button mushrooms' medicinal properties are proved. It is suggested that the reason for these properties might be related to the dietary fiber compounds especially chitin and beta glucan which

can be find in button mushroom [9]. Mushroom also has anti oxidant properties because of phenolic compounds which will reduce the risks related to free radicals [10]. The existence of a food stuff in addition to providing food needs and having high nutritional value has used the least limited existing sources and has the most output in comparison to agricultural and animal items and could be used as an opportunity for providing a part of human needs. The stipe of button mushroom which is rich in protein, fiber, calcium, vitamin and other essential nutrients is a cheap and by-product for human nutrition and can have basic role in performing such responsibility [4, 11].

[12], introduced edible mushrooms as human healthy food. He did researches on a number of different kinds of edible mushrooms and reported that the protein content in mushrooms is higher than fruits and vegetables. In many researches, the chemical compounds and existing nutrient value in stipe of edible mushroom are evaluated [7, 13, 14, 15, 16, 17].

[18], studied and compared some existing nutrients in the stipe and cap part of three common edible mushrooms in Nigeria. For this purpose the cap was separated from stipe and some chemical compounds were measured in both parts. According to the findings, protein, fat and ash content in cap is significantly more than stipe ($p<0.05$), while fiber and carbohydrate conent in stipe is significantly more than cap ($p<0.05$).

Many studies have been done to determine nutrient value of button mushroom but rare study has been done about nutrient value of mushroom stipe as an inexpensive and by-product [4].

The importance of efficient use of different sources and also reduction of wastes is quite obvious, because of limitation of food sources. For this purpose, it seems necessary to determine chemical compounds and nutrient materials in the stipe in comparison with cap of button mushroom in three different flushes.

MATERIALS AND METHODS

Sample Preparation

Fresh button mushrooms with 92.5% moisture content which used in this study were supplied in three different flushes from Malard agro-industry Karaj-Iran. After cleaning, cap was separated from stipe and the samples were dried under vacuum condition at 70°C for 12 hours.

Chemical Compounds Measurement:

All laboratory materials used in this study were of analytical grade and prepared form Merck, Germany. Moisture content of cap and stipe was determined based on ISO 1096. The fat content of cap and stipe was determined gravimetrically by Soxhlet extraction with petroleum ether according to AOAC 948.22. The Kjeldahl method according to AOAC 992.23 was used to determine protein of the samples. The nitrogen factor was considered 4.38. Ash content was determined by ignition at 550 °C up to constant weight, according to AOAC 923.03. Fiber content was analysed based on ISO 5498.Total carbohydrates determined based on standard CODEX 234 and calculated by difference according to existing methods [15, 17, 19].

Statistical Analysis:

All data were obtained by triplicate analyses. Results were statistically analyzed by SPSS 17 software via analysis of variance and Duncan test. A level of significance of $P<0.05$ was used throughout the analysis.

RESULTS AND DISCUSSION

Cap analysis in Successive Flushes

The chemical compounds of cap including moisture, fat, protein, fiber, ash and carbohydrate in three successive flushes are presented in table 1. There is significant difference ($p<0.05$) between moisture content in different flushes which varies in flushes 1 to 3 between 90.7% to 92.8%. [17] studied the chemical compounds of button mushroom in different stages of growth; according to their results, the moisture of this mushroom was in the range of 89.3-92.3% which the mushrooms harvested during last stages had the least moisture which is similar to our results. Also, [20] evaluated the nutrient value of mushroom in Japan in 4 flushes and concluded that the moisture factor in successive flushes were approximately fixed and is about 90%.

There is significant difference ($p<0.05$) in the protein content of cap in three flushes. While [9] reported the protein content of wild *Agaricus bisporus* about 16% (db), the protein content reported on the bases of [17] results was 21.3-27% (db) that is slightly inconsistent. [20], showed that the amount of protein in sequence flushes is different. Also according to [15], the protein content in button mushroom is 22.67% (db). The protein content of edible mushroom is often variable and this difference might be due to the type of mushrooms, the duration of sample collection up to

experiment, the moisture content, a part of mushroom from which sample is taken, harvesting time, substrates, culture conditions, and even the analysis method used [21].

Table 1- Chemical composition of cap during three successive flushes of button mushroom.

flushes	Moisture	Protein	Carbohydrate	Fat	Fiber	Ash
1	92.85±0.09c*	29.09±0.20a	26.88± 0.04c	8.39± 0.19c	24.60 ±0.19a	11.04± 0.21c
2	92.00±0.23b	34.50±0.17c	22.76± 0.95b	4.37± 0.14b	28.62± 0.35b	9.75± 0.29a
3	90.76±0.32a	33.65±0.15b	20.59± 0.27a	2.48± 0.20a	33.11± 0.11c	10.17± 0.20b

***** *Data explain analyses of triplicates ± standard de viation and the mean difference is significant at the (P < 0.05) level.*
*******All factors except the moisture, were calculated based on dry weight.*

The amount of carbohydrate in cap has decreased significantly ($p<0.05$) in sequential flushes (Table 1). [17] reported the carbohydrate content of cap during different stages of growth in the range of 49.9-38.3% (db).

According to statistical analysis, fat content of caps from flush 1 to 3 has decreased significantly ($p<0.05$). [17] reported the total amount of fat from 2.5 to 3.9% (db). [13], stated the amount of measured fat 2.74% (db) which is in accordance with our results.

The fiber content increased significantly ($p<0.05$) from first to the last flush. Polysaccharides are the major component of cell wall of mushrooms and constitute about 80-90% of their dry weight. Fibers are also considered as part of Polysaccharides that the most important existing fibers in edible mushroom are chitin and lignin [11]. According to the surveys that have been done by [17], the ranging of measured fiber was announced 17.7-23.3% (db) which is a little less than of what resulted from this research. The amount of fiber reported by [15] is in accordance with our results; they reported total fiber of button mushroom about 27.53% (db). [11], surveyed the chitin content of cap and stipe of *Agaricus bisporus* button mushroom in three different flushes. According to his results, chitin content in cap during first to the third flush decreases.

The highest ash content in the cap of button mushroom was for first flush by 11.04% (db). Second and third flushes contain 9.75% and 10.17% (db) respectively and there was significant difference ($p<0.05$) between ash content of all the flushes. [15] reported the ash content of button mushroom about 11.4% (db) and [17], stated the amount of ash in ranging 7.77-11.0% (db) that the highest amou.,nts belonged to the first phase of growth.

Stipe analysis in Successive Flushes

The chemical compounds of stipe including moisture, fat, protein, fiber, ash and carbohydrate in three successive flushes are presented in table 2. The behavior of moisture content in different flushes in cap and stipe was similar. Moisture content of stipe, same as cap decreased significantly ($p<0.05$) from first flush to the third flush. Moisture content of stipe for different flushes were 92.1%, 91.62% and 90.01% respectively.

Table 2- the comparison of chemical compsition of stipe during third flushes of the button mushroom

flushes	Moisture	Protein	Carbohydrate	Fat	Fiber	Ash
1	92.1± 0.24c*	24.05±0.21b	21.66± 0.25b	6.07± 0.09c	37.72± 0.19a	10.5± 0.20b
2	91.62±0.23b	24.82±0.12c	18.40± 0.15a	3.57± 0.19b	39.73± 0.24b	13.48± 0.20c
3	90.01±0.24a	19.01±0.24a	31.41± 0.42c	2.00 ±0.24a	38.08± 0.18a	9.5± 0.22a

***** *Data explain analyses of triplicates ± standard de viation and the mean difference is significant at the (P < 0.05) level.*
*******All factors except the moisture, were calculated based on dry weight.*

The amount of stipe protein in successive flushes differs significantly ($p<0.05$) and ranging from 19.01 to 24.82% (db), which the highest protein content of stipe is related to second flush by 24.82% (db). According to [22], the protein content of stipe was reported 24.6% (db) which is in accordance with the results of our research.

The stipes of button mushrooms from all three flushes were analyzed considering their carbohydrate contents and it was observed that the stipe in third flush has the highest amount of carbohydrate and there is a significant difference ($p<0.05$) between carbohydrate contents of three flushes. Based on table 2, carbohydrate content of samples ranges from 18.4 to 31.41% (db).

Fat content of stipe decreased significantly ($p<0.05$) from first to the third flush same as cap. Total fat content of mushroom presented by [13], was 1.1% (db) which is less than acquired results.

The fiber content of stipe was in the range of 37.72 to 39.73% (db). The higher amount of fiber was respectively related to flush 2, 3 and 1 respectively and there was no significant difference ($p>0.05$) between third and first flush. According to [11] researches, the measured amount of chitin in stipe part ranged 6.94-7.61% (db) that the highest

amount related to second flush and no significant differences were observed among flushes 1 to 3($p>0.05$). These results are in accordance with the finding of this experiment, also [22], reported the amount of fiber about 44.5% (db).

The highest content of ash (13.04% (db)) estimated in button mushroom stipe is related to second flush and there is significant difference ($p<0.05$) among all the flushes.

CONCLUSION

Considering the acquired results, it becomes clear that *Agaricus bisporus* button mushroom is a valuable source of nutrient, not only for its cap because of being rich in nutritional value especially due to its protein, but also its stipe is a valuable nutrient part as well. In today's urban life, due to less mobility and increased diseases, the consumption of these kinds of products as a rich source of fiber which might has direct effect on people's health is suggested. The stipe of mushroom is usually considered as by- product and treated as mushroom's waste, although it might be place in human diet due to its nutrient compounds especially its high amount of fiber.

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