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Examining the Nutritional Composition, Value and Health Benefit of Mushrooms

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Abstract

Mushrooms are consumed by humans as comestibles for their nutritional value and they are occasionally consumed for their supposed medicinal value. Mushrooms consumed by those practicing folk medicine are known as medicinal mushrooms (Ejelonu et al., 2014). Apart from their edibility and nutritional value, mushrooms have potential medicinal benefits (Boa, 2004; Chan, 1981). Such use of mushrooms therefore falls into the domain of traditional medicine. Preliminary research has shown some medicinal mushroom isolates to have cardiovascular, anticancer, antiviral, antibacterial, anti-parasitic, anti-inflammatory and anti-diabetic properties (Sullivan et al., 2006; Chang and Miles, 1989). Currently, several extracts (polysaccharides-K, polysaccharide peptide and lentinan) have widespread use in Japan, Korea and China, as potential adjuvants to radiation treatments and chemotherapy (Borchers et al., 2008; Sullivan et al., 2006). This study, however, sought to examine the nutritional composition, value and health benefit of mushrooms. The findings indicated that, mushrooms is rich in cabohydrates, protein, fats and ascorbic acid. The study concluded that mushrooms or extracts from mushrooms could also be used for home-based treatments for certain diseases, even though unconfirmed in mainstream science and medicine, and so are not approved as drugs or medical treatments (Sullivan et al., 2006).

Keywords: health benefits, mushrooms, nutritional value

1.0 Introduction

Mushrooms are rich in non-starchy carbohydrates, proteins, dietary fibre, and vitamin-B and are quite low in fat value (Dunkwal *et al*., 2007). The dry matter of mushroom fruit bodies is about 5 – 15% and contains 19 – 35% proteins (Synytsya *et al*., 2008). The content of carbohydrates, which are mainly present as polysaccharides or glycoproteins, ranges 50 – 90%; chitin, α- and β-glucans and other hemicelluloses are in abundant in mushrooms (Synytsya *et al*., 2008). Edible mushrooms are good sources of vitamin B2, niacin and foliate, with contents varying in the ranges 1.8 – 5.1, 31 – 65 and 0.30 – 0.64mg/100g dry weight respectively (Mattila *et al*., 2001). Among the mushrooms, Shiitake has been identified as containing a good source of dietary fibre (3.3g/100g fresh weight); while *Agaricus bisporus* and *Pleurotus* spp contained 1.5-2.4g/100g fresh weight (Mattila *et al*., 2001). Compared with vegetables, mushrooms are a good source of many mineral elements. The contents of potassium, phosphorus, zinc and copper varied in the ranges 26.7 – 47.3g/kg, 8.7 – 13.9g/kg, 47 – 92mg/kg and 5.2 – 35mg/kg dw, respectively. *Agaricus bisporus* contain large amounts of Selenium (3.2mg/kg dw), while Cadmium content in shiitake mushrooms is quite high (1.2mg/kg dw) (Mattila *et al*., 2001). Apart from their nutritional value, mushrooms possess medicinal benefits (Chan, 1981). In China, 20 mushroom species have been documented by Li Shi-Zhen of having medicinal property and have been used for treating different kinds of diseases. Notably among these species are *Ganoderma lucidum, Poria cocos,* and *Tremella fuciformis* (Sullivan *et al*., 2006). Because of their low calorie value, intake of mushrooms by the obese help cut down their calorie level (Rai and Arumuganathan, 2008). Being low in fat, but desirable fat devoid of cholesterol, mushrooms are ideal diet for the heart patients. Mushrooms are high in protein with no starch and sugar and are therefore recommended for diabetic patients (Rai and Arumuganathan, 2008). Mushrooms contain anti-carcinogenic substances responsible for reducing and preventing the development and formation of cancer cells in humans (Bernaś and Jaworska, 2008). They enhance macrophage function and host resistance to microorganisms' infection (Lindequist *et al*., 2005). The presence of vitamins, minerals, and iron in addition to protein in the mushrooms help maintains haemoglobin level in humans thereby preventing anaemia (Rai and Arumuganathan, 2008). Rai and Arumuganathan (2008) reported that mushrooms are high in fibre and alkaline elements and are suitable for those suffering from hyperacidity and constipation. Many polysaccharide-bound proteins produced by Basidiomycetes fungi have been classified as anti-tumour chemicals by the US National Cancer Institute (Sullivan *et al*., 2006).

2.0 Determination of Moisture Content in Mushrooms

An empty dish was weighed and 2g of the mushrooms was weighed into the dish and placed in a hot air oven for 24 hours at a temperature of 105°C. The sample was allowed to cool in a desiccator and reweighed to obtain the differences in weight. The percentage moisture loss was calculated as follows:

$$Wt\ of\ \ empty\ dish = a$$

$$Wt\ of\ \ dish + sample\ before\ drying = b$$

$$Wt\ of\ \ dish + sample\ after\ \ drying = c$$

$$Cal.$$

$$Initial\ \ weight = b - a$$

$$Final\ \ weight = c - a$$

$$\%Moisture = \frac{Initial\ \ weight - Final\ \ weight}{Initial\ \ weight}\ x\,100\%$$

3.0 Determination of Ash in Mushrooms

An empty crucible was weighed and 2g of the mushrooms was weighed into the crucible. The samples were placed into an Ikemoto 7182 Automatic Muffle Furnace at temperature of 600°C for 1 hour. The crucibles were removed, covered and allowed to cool at room temperature. The crucibles and the ash were weighed repeatedly to obtain near to constant weight. The percentage ash was calculated from the data obtained as follows:

$$Wt\ of\ \ empty\ crucible = a$$

$$Wt\ of\ \ crucible + sample\ before\ ashing = b$$

$$Wt\ of\ \ crucible + sample\ after\ \ ashing = c$$

$$Cal.$$

$$Initial\ \ weight = b - a$$

$$Final\ \ weight = c - a$$

$$\%Ash = \frac{Initial\ \ weight - Final\ \ weight}{Initial\ \ weight}\ x\,100\%$$

4.0 Determination of Ascorbic Acid in Mushrooms

Two grams (2g) of mushroom powder was ground with 20 ml of 0.4% oxalic acid for 5 minutes and filtered. Five millilitres (5ml) of the filtrate was titrated against blue dye 2:6 dichlorophenol indophenol and the titre value noted. This was duplicated to obtain two more titre values. Based on the results, the ascorbic acid in 2g of the mushrooms was calculated. For example:

$$If\ 1ml\ dye = 0.21mg\ ascorbic\ acid$$

$$Then\ 0.5ml\ dye = x$$

$$x = 0.5 \times 0.21 = 0.105mg$$

5.0 Determination of Fat in Mushrooms

Two grams (2g) of the mushroom sample was weighed into the thimbles. The thimbles were plugged lightly with cotton wool, slipped into the thimble holders and clipped into position in the extraction chamber. Forty millilitres (40 ml) of diethyl ether was added to each chamber to ensure that the sample in the thimbles was completely covered by the solvent. A rubber tube was connected to a running tap to allow water to circulate through the extractor to condense the evaporated ether. The still pots of the extractor were placed on the heaters and the switches of heaters were turned on. The heat generated by the still pots caused the ether in the extraction chamber to boil. The boiling allowed all fats in the mushrooms to dissolve into the ether. Approximately, 40 minutes were allowed between each extraction. The knobs beneath the extraction chambers were turned to drain the ether in the extraction chambers for the next extraction. The thimbles were removed and dried in a desiccator. The thimble and the sample were weighed to determine the amount of fat extracted as follows:

$$Wt\ of\ \ empty\ thimble = a$$

$$Wt\ of\ \ thimble + sample = b$$

$$Wt\ of\ \ thimble + sample + cotton\ (before\ extraction) = c$$

$$Wt\ of\ \ thimble + sample + cotton\ (after\ extraction) = d$$

$$Cal.$$

$$Wt\ of\ \ sample = b - a = x$$

$$Wt\ of\ \ fat = c - d = y$$

$$\%Fat = \frac{y}{x} \times 100$$

6.0 Determination of Carbohydrate and Calories in Mushrooms

The following formulae prescribed by Journal of AOAC International (2000) were used for the calculation of Carbohydrate and Calories.

$$Carbohydrate = Solids - (Protein + Fat + Ash)$$

$$Calories\ (Kcal.) = 9\,(Fat) + 4\,(Protein) + 4\,(Carbohydrate)$$

7.0 Determination of Minerals in Mushrooms

7.1 Digestion of samples for mineral analysis

Dry mushroom sample (0.1g) was weighed into a clean dry 125ml 'pyrex' conical flask. Four millilitres (4ml) concentrated sulphuric acid (H_2SO_4) was added and the flask was swirled carefully to ensure that the acid react with the sample to change it to carbon. The flask (and contents) was heated in a fume hood on an electric hot plate set at "medium" heating (125^oC) for 1 hour. Ten drops of hydrogen peroxide (H_2O_2) was added: adding 3-4 drops slowly at a time to avoid vigorous reaction of the contents. The flask was swirled, keeping the contents at the bottom of the flask and reheated but avoiding excessive heating that causes spattering. Six drops of H_2O_2 was carefully added and the flask was reheated. Addition of 6 drops of H_2O_2 continued until the colour changed from black to dark brown. The burner temperature was increased to 350^oC on the hot plate while heating continued. Six (6) drops of H_2O_2 were again added to the mixture while heating of the flask continued. When the solution stayed colourless from heating, 6 drops of hydrogen peroxide were added and then left for the last time on 'high' burner for 10 – 15 minutes. The colourless solution obtained was an indication that the carbon had changed to carbon dioxide. The content was finally cooled and transferred quantitatively into a 100ml volumetric flask using distilled water. The solution was later brought up to the 100ml mark of the volumetric flask. Besides, 2 blank digests of the same amounts of reagents (H_2SO_4 and H_2O_2) were prepared and all data against mean blank value was corrected. The calcium and zinc values in the mushrooms were determined using Atomic Absorption Spectrophotometer (AAS). For phosphorus, its colour in the sample was developed and read with Pharo 300 Spectrophotometer at a wavelength of 712nm.

8.0 Colour Development of Phosphorus

8.1 Preparation of the Solutions

One hundred and forty millilitres (140ml) of concentrated H_2SO_4 was carefully added to 500ml of distilled water and the solution was allowed to cool. 12g of Ammonium Molybdate was dissolved in 150ml of distilled water. 0.2908g of Antimony Potassium Tartrate was also dissolved in 100ml of distilled water. All the solutions were carefully added together and made up to 2 litres to obtain a stock solution. 1.056g of

L-Ascorbic Acid was weighed, dissolved in the stock solution and made up to 200ml using the stock solution. 0.878g of Potassium Dihydrogen Orthophosphate was dissolved in 1 litre distilled water. The stock solution (Potassium Dihydrogen Orthophosphate solution) was used to prepare standards for calibration of Pharo 300 Spectrophotometer. For calibration, 25ml of the stock solution was diluted to 1 litre. Every 1ml of this solution pipetted contained 5µg P; 2ml contained 10µg P; 3ml contained 15µg P; etc. A graph of concentration was plotted against absorbance to finish the calibration procedures.

8.2 Procedure for Colour Development and Phosphorus Determination

Thirty millilitres (30ml) of distilled water was added to 1ml of pipetted sample solution or digested sample solution. A drop of P-nitrophenol and one or few drops of ammonium solution (the drops are dependent on the concentration of the phosphorus in the sample) was added to turn the colour yellow. 8ml of L-Ascorbic Acid was added to the solution and at least 10 minutes (but not more than 30 minutes) was allowed for the colour to turn blue. The volume was made up to the 50ml mark with distilled water and read on the Spectrophotometer at 712 wavelengths.

8.3 Determination of Calcium and Zinc

Calcium and Zinc were determined using a Perkin Elmer Analyst 400 Atomic Absorption Spectrophotometer (AAS) at the Ecological Laboratory, Department of Geography and Resource Department, University of Ghana, Legon. The instrument was calibrated with known standards. Standard stock solutions of 1000mg/L (1000ppm) were used. From the stock solution of each element, working standard solutions of 0.4ppm, 1ppm and 2ppm were used to plot a graph of concentration against absorbance. After calibration, the solution resulting from the digestion of the samples described above was sucked into the flame of the atomic absorption apparatus. The concentration of the metals (the unknown) to be analyzed in the mushrooms was measured at a specific wavelength in the AAS.

The specification readings of Atomic Absorption Spectrophotometer were calculated using the formulae below:

$$\% \, Zn \; or \; Ca = \left(\frac{AAS \; Red.}{1000}\right) \times \left(\frac{VExt}{1000}\right) \times \left(\frac{100}{Wt}\right)$$

$$\% \, P = \left(\frac{Spec \; Red}{Wt}\right) \times \left(\frac{VExt}{Aliquot}\right) \times \left(\frac{100}{10^6}\right)$$

VExt = Volume of extract i.e. the vol. of solution extracted from 2g of ash sample.

Aliquot = Part of the volume used for determination of minerals in the sample

AAS Red = Atomic Absorption Spectrophotometer Reading

Spec Reading = Spectrophotometer Reading

Wt = Weight of ash taken

9.0 Findings

9.1 Consumer Evaluation

Sensory properties for the four dried mushrooms were evaluated by 50 untrained panelists from the Kpelezo community. Product evaluation was done to obtain subjective data (how well the product is likely to be accepted) from the community. The panelists observed the mushrooms displayed and rated them based on appearance (colour, size, shape and surface texture), odour/aroma, taste, flavour and texture. Score sheets were presented to each participant and the parameters for the four samples were recorded using table of scoring (see Appendix 9).

Attributes	Max-Score	Sample-1 (SD)	Sample-2 (B&D)	Sample-3 (BL&D)	Sample-4 (MOD)
Appearance	30				
Texture	15				
Size	20				
Taste	25				
Aroma	10				
Total score	100				

10. Conclusion

The study concluded that mushrooms or extracts from mushrooms could also be used for home-based treatments for certain diseases, even though unconfirmed in mainstream science and medicine, and so are not approved as drugs or medical treatments (Sullivan et al., 2006).

References

Arés, G., Lareo, C., & Lema, P. (2007). *Modified Atmosphere Packaging for Postharvest Storage of Mushroom*. Global Science Book, Julio Herrera y Reissig 565. C. P. 11300, Montevideo, Uruguay.

Apetorgbor, M. M., Apetorgbor, A. K., & Nutakor, E. (2005). *Utilization and cultivation of edible Mushrooms for rural livelihood in Southern Ghana*. 17th Commonwealth Forestry Conference, Colombo, Srilanka.

Boa, E. (2004). *Wild edible fungi. A global overview of their use and importance to people. Non- Wood Forest Product*, Series no. 17. Rome; FAO. 148

Cha Jae-Soon (2004). Oyster Mushroom Cultivation. Mushroom Growers' Handbook 1. Chungbuk National University, Korea. MushWorld Publication. 1 – 3

Chang S. T., & Tropics M. J. (1991). *Wild edible fungi a global overview of their use and importance to people.* 11, 45

Chang, S. T., & Miles P. G. (1992). *Mushrooms biology* – a new discipline. Mycologist 6, CRC Press, Inc., Boca Raton. 4-5

Dunkwal, V., Jood, S., & Singh, S. (2007*). Physico-chemical properties and sensory evaluation of Pleurotus sajor cajupowder as influenced by pre-treatments and drying methods*. 1 – 2

Obodai, M. (2001). *An Ethnobotanical Study of Mushroom Germplasm and its Domestication in the Bia Biosphere Reserve*, Food Research Institute, Accra-Ghana, 30 – 31

Obodai, M., & Apertorgbor, M. (2009). *Proximate Composition and nutrient content of some Wild and Cultivated mushrooms of Ghana*. CSIR – Food Research Institute, Kumasi. 3 – 5

Oei, P. (2003). *Mushroom Cultivation* 3rd Edition: Appropriate Technology for Mushroom growers. Leiden: Backhuys Publishers

Rai, R. D., & Arumuganathan, T. (2008). *Postharvest Technology of Mushrooms*. Director, National Research Center for Mushroom, Chambaghat, Solan – 173 213 (HP), India, 1 – 2

Sawyerr, L. C. (2000). *Genetic resource aspects of mushroom cultivation on small scale*. In: Proceedings of the 1st International Congress for the characterization, conservation, evaluation and utilization of mushroom genetic resources for food and agriculture, 3

Verma, R. N. (2013) *Indian Mushroom Industry – Past and Present*. National Research Centre for Mushroom, Chambaghat, Solan (H. P.), India, 8 – 15