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Biochemical analysis of fruiting bodies of *Volvariella volvacea* strain V*v pk*, grown on six different substrates

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Abstract

A local strain of Volvariella volvacea Vv pk, locally known as Chinese mushroom was cultivated on six different agricultural wastes including paddy straw, cotton waste, banana leaves, corn stovers, sugarcane baggasse and pulses straw. The study was conducted to know that how much a substrate contributes in the nutritional value of the fruiting bodies of the mushroom harvested from such substrate and to recommend the best substrate for the commercial cultivation of the mushroom with high levels of protein, crude fibre and certain other elements. The biochemical analysis of the fruiting bodies harvested from the substrates was done to estimate the moisture percentage, crude fat, protein, fiber, and ash contents. Maximum protein (34.17%), ash (10.8) and crude fiber percentage (11.9%) was observed in the fruiting bodies harvested from cotton waste. So, cotton waste is recommended as an effective substrate to grow Chinese mushroom on commercial scale.

Keywords: biochemical analysis, cotton waste, nutritional value, *Volvariella volvace*

Introduction

Edible mushrooms have been widely utilized as a human food for centuries. These are liked all over the world due to their delicate taste, flavor and health giving properties. Mushrooms also have some medicinal and tonic properties (Manzi *et al.,* 2001). Mushrooms are also important for the treatment of different diseases in human as is evident from the biochemical analysis of the fruiting bodies of these mushrooms. Many species contain antiparasitic, antibacterial, antiviral, anti-inflammatory, antihypertension, antitumor, hepatoprotective, antiatherosclerosis, antidiabetic and immune modulating atributes (Wasser and Weis, 1999). It has been reported that ingredients obtained from mushroom bodies contain imunostimulatory effects (Chen *et al*., 2008; Ye *et al*., 2011).

Mushrooms are edible and they are a common ingredient in soups and salads, and can also be served as a side dish. The nutritional value of fried mushrooms depends on the type of the agricultural waste used for its production. White mushrooms contain 26 calories of energy per hundred gram of fruiting body. These have 4.3% carbohydrates, less than 1% fat, 3.9% protein, and are also rich in riboflavin, niacin and pantothenic acid (Robinson, 2011). Mushrooms are also a good source of selenium, copper, zinc, calcium, magnesium, potassium and phosphorus (Radulescu *et al*., 2010; Li *et al*., 2011; Robinson, 2011). Some mushrooms are reputed to possess antiallergic, anti-cholesterol, anti-tumour and anti-cancer properties (Ita *et al*., 2006).

Mushrooms are rich source of protein, vitamins, fats, carbohydrates, amino acids and minerals (Jiskani, 2001). In mushroom fruiting bodies all essential amino acids, water soluble vitamins and all the essential minerals are present (Buigut, 2002). Mushrooms are also good sources of vitamins like riboflavin, biotin and thiamine (Chang and Buswell, 1996). These are low in fat, carbohydrates and salts (Genders, 1990). Appreciable amount of dietary fibre is present in their fruiting bodies which are important for the regulation of physiological functions in human beings like regulation of digestive tract (Manzi *et al.,* 2001). Moreover, mushrooms are low in nucleic acid contents which make them an ideal food for patients suffering from diabetes, obesity and hypertension (Anonymous, 2003).

Mushrooms are not only important in human diet due to their high nutritional value but are also accepted as delicious human food due to their uniqueness in color, aroma, texture and taste (Chang and Miles, 1991). Moreover, agricultural wastes may be efficiently recycled through mushroom biotechnology. These agricultural wastes produce an average yield of about 20-35 kg m^{-2} over a cultivation period of 4 to 7 weeks which is acceptable (Buchanan and Barnes, 2003). So, the cultivation of mushroom on commercial scale has gained an incredible interest as modern food in recent decades due to their acceptance as excellent source of high nutritional traits and deliciousness because they contain unsaturated fatty acids, vitamins, good quality protein and minerals (Wahid *et al.*, 1988).

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So, keeping in view the importance of mushroom and efficient utilization of agriculture wastes, research was conducted to evaluate the biochemical properties of mushroom fruiting bodies grown on six different substrates, in order to select the best one for its cultivation which attributes high percentage of certain elements like protein, crude fiber etc.

Materials and Methods

The freshly harvested mushrooms from six different substrates were analyzed for moisture, nitrogen, crude protein, crude fiber and ash contents (AOAC, 1990).

Determination of moisture

A five gram sample of fresh mushrooms was taken in an aluminum dish and placed in an air oven at 67 ºC for 24 hours for drying till constant weight. The following formula was used to calculate the percentage of moisture.

Moisture (%) =
[(Weight of original sample – weight of oven dried sample (g))/ Weight of original sample (g)] x 100

Estimation of crude fat (ether extract)

For crude fat estimation, 3 g of dried mushroom samples were taken in a thimble and put in an extraction tube of Soxhlet apparatus. The temperature of the heater was so adjusted that continuous drops of ether fell on the sample in the extraction tube. The process of extraction was carried out with petroleum ether (B.P. 40-60 ºC) for 16 hours. The sample was removed and the solvent was allowed to evaporate under the fume hood. The extract was completely dried in an air oven for 30 minutes at 105 ºC. The weight of the extract was recorded after cooling in a desiccator. Crude fat was calculated with the help of following formula:

$$\text{Crude fat (\%)} = \frac{\text{Weight of fat in sample (g)}}{\text{Weight of sample (g)}} \times 100$$

Estimation of nitrogen and crude protein

The nitrogen present in the samples was determined using the Kjeldhal's apparatus (Jackson, 1962) and crude protein was calculated by multiplying the nitrogen content with a factor of 6.25 (Thimmaiah, 2004).

Determination of crude fiber

Three grams dried and fat free mushroom sample was taken in a 1000 mL capacity beaker and 200 mL of 1.25% H_2SO_4 were added to it and the level of beaker was marked. The contents of the beaker were boiled for 30 minutes with constant stirring; also the level of the water was supplemented, contents were filtered giving 2-3 washings with hot water (150 mL) until it was acid free. The residue was transferred to a 1000 mL beaker again and 200 mL of 1.25% NaOH were added into it. The contents were again boiled for 30 minutes and volume was made up during boiling. The contents were filtered and 2-3 washings with hot water were given until alkali free. The residue was carefully transferred to a tared crucible and dried in an oven at 100 ºC for 3-4 hours until constant weight was obtained. The contents were heated on oxidizing (blue) flame until the smoke ceased to come out of the sample. Then the sample was placed in a muffle furnace at 550 °C for 4 h until a grey ash was obtained, then cooled in a desiccator and weighed. The difference in weight was reflected as crude fiber as calculated by using the following formula:

$$\text{Crude fiber (\%)} = \frac{\text{Loss of weight after ignition (g)}}{\text{Weight of sample (g)}} \times 100$$

Estimation of ash

Three grams of dried mushroom sample were taken in a crucible and heated on oxidizing flame till smoke subsided. The crucible was transferred to muffle furnace at 550 °C for 6 hours. The sample was cooled in a desiccator and weighed. The ash in the sample was calculated as under.

$$\text{Ash content (\%)} = \frac{\text{Weight of ash in sample (g)}}{\text{Weight of the sample (g)}} \times 100$$

Results

The biochemical analysis of the fruiting bodies obtained showed that fruiting bodies harvested from different substrates varied significantly in nitrogen, crude protein, ash, and moisture percentage.

Data presented in figure 1 revealed that nitrogen percentage of the fruiting bodies harvested from cotton waste was the highest (5.56%) followed by the paddy straw, (4.87%) and sugarcane baggasse (4.45%). The fruiting bodies harvested from corn stovers and banana leaves had almost same nitrogen percentage. The lowest percentage of nitrogen was found in pulses straw (3.22%).

The protein contents (Figure 2) were maximum in the fruiting bodies harvested from cotton waste (34.17%) followed by the sugarcane baggasse (30.51%), paddy straw (28.57%), banana leaves (23.92%), corn stovers (21.77%) and pulses straw (20.25%).

The results regarding ash contents in fruiting bodies of mushroom harvested from different substrates (Figure 3) showed that the ash contents varied significantly from substrate to substrate. Maximum ash contents (10.8%) were observed in cotton waste, followed by banana leaves. The paddy straw and pulses straw gave non-significant results

with each other but significantly different from other substrates.

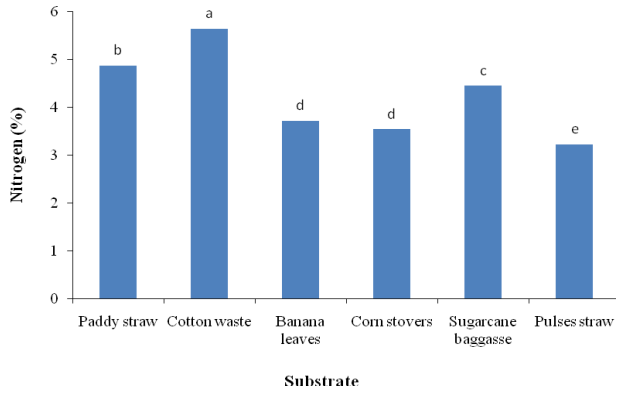

Figure 1: Nitrogen percentage in fruiting bodies of mushroom cultivated on different substrates. Bars with different letters show significant difference as determined by Duncun's Multiple Range Test at p≤0.05

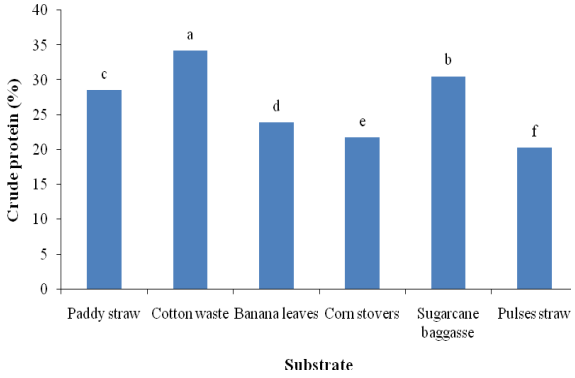

Figure 2: Crude protein percentage in fruiting bodies of mushroom cultivated on different substrates. Bars with different letters show significant difference as determined by Duncun's Multiple Range Test at p≤0.05

The maximum moisture contents were observed in the fruiting bodies harvested from paddy straw but it was non-significant with other substrates however, statistically different from sugarcane baggasse which gave the lowest moisture contents in fruiting bodies (Figure 4). The crude fiber %age was maximum in the fruiting bodies harvested from cotton waste (11.9%) followed by the pulses straw (8.14%), sugarcane baggasse and corn stovers (7.22%) paddy straw and banana leaves (7.88%) as presented in figure 5.

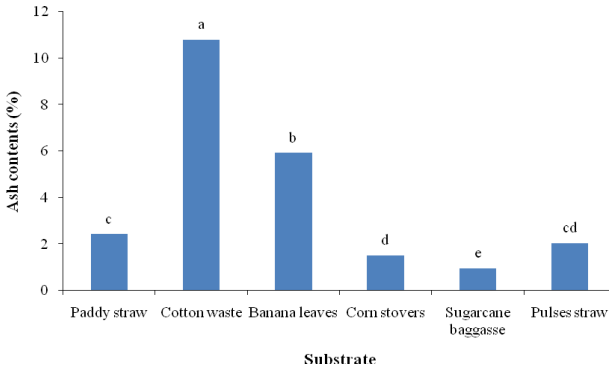

Figure 3: Ash contents (%) in fruiting bodies of mushroom cultivated on different substrates. Bars with different letters show significant difference as determined by Duncun's Multiple Range Test at p≤0.05

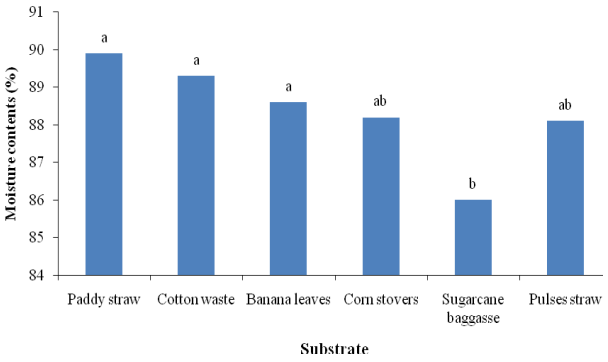

Figure 4: Moisture contents (%) in fruiting bodies of mushroom cultivated on different substrates. Bars with different letters show significant difference as determined by Duncun's Multiple Range Test at p≤0.05

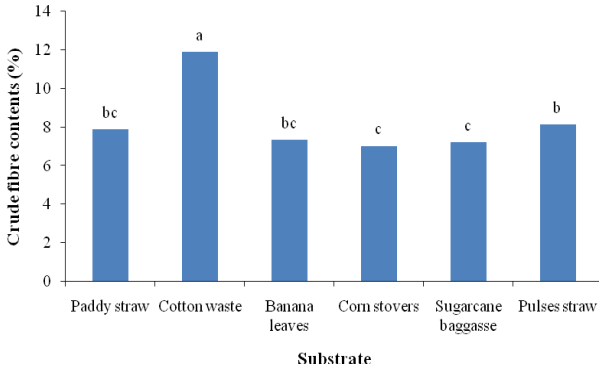

Figure 5: Crude fibre contents (%) in fruiting bodies of mushroom cultivated on different substrates. Bars with different letters show significant difference as determined by Duncun's Multiple Range Test at p≤0.05

Discussion

The biochemical analysis of the fruiting bodies of mushroom grown on different substrates was carried out. It was observed in our studies that fruiting bodies harvested from different substrates varied in their biochemical analysis. It might be due to the variability of the substrates to provide different nutritional elements to mushroom grown on these substrates. Many factors explain variation in the protein content of mushrooms, including the use of particular strains, time of analyses after harvest, the substrate used for the production and stage of development (Bano and Rajarathnam, 1988). Cheung (1997), reported the proximate analysis of *Volvariella volvaceae,* which showed that mushrooms contain 30-43% crude protein, 1-6% crude fat 12-48% carbohydrates, 4-10% crude fiber and ash varied between 5-13%, on dry weight basis, which supported the results obtained in the present research. Mushrooms have been reported to contain 26 calories of energy per hundred gram of fruiting body along with 4.3% carbohydrates, less than 1% fat, 3.9% protein, and are also rich in riboflavin, niacin and pantothenic acid (Robinson, 2011). It has also been reported that mushrooms are also a good source of selenium, copper, zinc, calcium, magnesium, potassium and phosphorus (Radulescu *et al*., 2010; Li *et al*., 2011; Robinson, 2011). Some mushrooms are reported to possess anti-allergic, anti-cholesterol, anti-tumor and anti-cancer properties (Ita *et al*., 2006).

Proximate analysis of Oyster mushroom was carried out in the previous studies on the fruiting bodied of mushroom grown on different substrates and they reported maximum crude fiber percentage in the fruiting bodies harvested from rice straw but they didn't use the cotton waste as substrate (Sharma and Madan, 1993; Singh *et. al,.* 2003; Bonatti *et al.,* 2004). Similarly, maximum ash contents were reported by El-Kattan *et al.* (1991) in mushroom fruiting bodies harvested from Soybean straw.

Present study concludes that Chinese mushroom may be successfully cultivated on cotton waste followed by the rice straw for better nutrition. These two substrates can be recommended for the commercial cultivation of *Volvariella volvacea* to obtain highly nutritious mushrooms.

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