BioCore Exploring Scientific Community

International Journal of Nutritional Science and Food Technology

Research Article ISSN 2471-7371

Effect of Chemical Nutrients (NPK) on Proximate Nutrient and Mineral Content of Oyster Mushroom (*Pleurotus ostreatus*)

AKM Shalahuddin[1], Kamal Uddin Ahmed[2], Md. Nuruddin Miah[2], Md. Mamunur Rashid[3], Md. Maksudul Haque[*4]

[1]*Scientific Officer, Plant Breeding Division, Bangladesh Rice Research Institute, Gazipur 1701, Bangladesh*
[2]*Professor, Department of Biochemistry, Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh*
[3]*Scientific Officer, Farm Management Division, BRRI, Gazipur 1701, Bangladesh*
[4]*Senior Scientific Officer, Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Dhaka 1207, Bangladesh*

Abstract

The study was conducted to the effect of different chemical nutrients (NPK) on the proximate composition of oyster mushroom (Pleurotus ostreatus). Mother culture of oyster mushroom was used as test crop for this experiment. The experiment consists of four different mixers of chemical nutrients. The highest moisture content was found in T_1 (88.57%) treatment, while the lowest moisture content was recorded in T_3 (84.12%).The highest protein content was recorded in T_3(25.54%) treatment and the lowest protein content was observed in T_1 (22.45%). The highest lipid content was observed from T_3 (6.43%) treatment, whereas the lowest lipid content was obtained in T_1 (5.47%). The highest carbohydrate content was recorded in T_1 (39.55%), whereas the lowest was observed in T_3 (34.83%) treatment. The highest Iron (Fe) content was recorded in T_3 (525.48 ppm) and the lowest Iron (Fe) content was observed in T_1 (482.89 ppm). Chemical nutrients (4g NPK) with 10 kg rice straw performed significantly better on growth, yield, nutrient and mineral content of oyster mushroom.

Keywords: Nutrient, Mineral, Proximate And Mushroom *(Pleurotus Ostreatus)*

Corresponding author: Md. Maksudul Haque
Senior Scientific Officer, Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Dhaka 1207, Bangladesh
Email: maksudulhq@gmail.com , maksudulhq@birtan.gov.bd

Citation: Md. Maksudul Haque et al. (2019), Effect of Chemical Nutrients (NPK) on Proximate Nutrient and Mineral Content of Oyster Mushroom *(Pleurotus ostreatus)*, Bangladesh .Int J Nutr Sci & Food Tech. 5:4, 25-30.

Received: April 18, 2019
Accepted: April 28, 2019
Published: May 31, 2019

Introduction

Mushroom nowadays considered as one of the most important functional food with many well-known therapeutic applications (El-Enshasy and Hatti-Kaul, 2013; Soltani et al., 2013; Sarmidi and Enshasy, 2012; Deepalakshmi and Mirunalini, 2014; Ozturk et al., 2015). Over 200 species of mushrooms have long been used as functional foods around the world (Kalac, 2013), but only about 35 species have been commercially cultivated (Aida et al., 2009; Xu et al., 2011). Several types of the mushrooms have been reported to have therapeutic properties such as antidiabetic, antimicrobial, antioxidant, anticancer, lipid lowering and immune-modulating effects (Tan et al., 2015). Pleurotus species are very much effective in reducing harmful plasma lipids (Alam et al., 2007) and thus reduce the chance of atherosclerosis and other cardiovascular and artery- related disorders. These medicinal properties might be due to the presence of some important components in dietary mushroom.

Pleurotus spp. is one of most extensively studied white-rot fungi for its exceptional ligninolytic properties (Philippoussis et al., 2001; Olivieri et al., 2006; Li and Shah, 2016). This genus cleavages cellulose, hemicellulose and lignin from wood, whereas brown rot fungi only cleavage cellulose and hemicellulose (Machado et al., 2015). In basidiomycete fungi, extracellular laccases are constitutively produced in small amounts and the lignocellulolytic enzymes are affected by many typical fermentation factors, such as medium composition, pH, temperature, aeration rate, etc (Ahmed et al., 2013; Cogorni et al., 2014; Velioglu and Urek, 2015). Phenolic compounds are produced by fungi in adaptation to abiotic and biotic stress conditions such as infection and low temperature (Islam et al., 2016).

Bangladesh is a thickly populated country and we have to increase intensive use of land for increasing crop production also considering natural resources. In this case mushroom cultivation can be a huge opportunity for increasing crop production per unit area with the vertical use of land. As a vegetable, mushroom can play an important role to meet up the nutritional requirements of the population of our country. It is also a highly nutritious, delicious, medicinal and economically potential vegetable. The Greeks believed that mushrooms provided strength for warriors in battle. The Pharoaphs prized mushrooms as a delicacy and the Romans regarded mushrooms as the "Food of the Gods," which was served only on festive occasions. The Chinese treasured mushrooms as a health food, the "Elixir of life." The Mexican Indians used mushrooms as hallucinogens in religious ceremonies and in witchcraft as well as for therapeutic purposes

(Chang and Miles, 1988).

Pleurotus spp. are considered good source of superior quality protein, with well distributed essential amino acids (Patil et al., 2010). Oyster mushroom has high nutritional value as an important source of protein, carbohydrates, vitamins, calcium, and iron (Hilal et al., 2012). The nutritional advantages of mushrooms include a low content of calories and a high content of proteins, minerals and dietary fiber (Beluhan and Ranogajec, 2011). Oyster mushrooms are rich in Vitamin C, B complex, and mineral salts required by the human body (Randive, 2012).

The climatic conditions and seasonal diversity of Bangladesh is ideal for the cultivation of the oyster mushroom (Amin et al., 2007). Mushroom production in rural communities can alleviate poverty and improve the diversification of agricultural production (Chang and Mshigeni, 2001). Oyster mushroom has been widely cultivated in many different parts of the world. It has abilities to grow at a wide range of temperatures utilizing various lignocelluloses (Sa´nchez, 2010). Further, the oyster mushroom has many species which can be suitably cultivated in diverse agro-ecological situations (Shirur, 2011). Oyster mushroom (Pleurotus ostreatus) is a popular edible mushroom that is commercially cultivated worldwide (Zhang et al., 2012).

Oyster mushrooms are the easiest and least expensive commercial mushrooms to grow because they are well known for conversion of crop residues to food protein (Banik and Nandi, 2004). Oyster mushroom (Pleurotus ostreatus) is an edible mushroom having excellent fragrant and taste and its cultivation on crop residues is considered as potential source of income, an alternative food production, provision of employment, and for recycling of agricultural wastes.

Materials and Methods

The experiment was conducted at the Biochemistry laboratory and Mushroom Culture House (MCH) of the Department of Biochemistry, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh. Mother culture of oyster mushroom (Mushroom seed) was collected from National Mushroom Development and Extension Center, Savar, Dhaka, Bangladesh. The experiment was laid out in single factor Completely Randomized Design (CRD). The experiment included four treatments with five replications.

Treatment of the experiment

The experiment consists of four different fertilizer treatments. The experiment considered the following treatments:

T_1: Control (0 g NPK in 10 kg straw)
T_2: 2 g NPK in 10 kg straw
T_3: 4 g NPK in 10 kg straw
T_4: 6 g NPK in 10 kg straw
Here, N:P:K=2:1:1

Proximate analysis of the mushrooms

Determination of protein

The Protein contents of the fruiting bodies of the mushrooms were determined by the standard Micro-kjeldhal procedure. According to this method total nitrogen contents of the samples were estimated and protein contents were finding out by multiplying by 6.25 to the total nitrogen values. The total nitrogen was determined by the Kjeldahl methods, which depends upon the conversion of protein nitrogen into ammonium sulfate, by digestion ammonia liberated from the ammonium sulfate by making the solution alkaline were distilled into known volume of a standard acid, which was then back titrated.

Calculation

$$\text{percentage of nitrogen} = \frac{(A-B)\times 14\times 100}{W\times 1000}$$

Where A = ml of NaOH required in the titration of blank
B = ml of NaOH required in the titration of sample
N = Normality of the NaOH
W = Weight of the sample

The protein content in gram per 100 g of the dried sample

$$= \frac{\text{Precentage of nitrogen} \times 6.25 \times D}{100}$$

Where, D = Percentage of dried sample from the fresh sample

Total lipid estimation

Lipid was estimated as crude ether extraction of the dry materials. The dried sample (about 5.0 g) was weighed into a conical flask and plugged with fat free cotton. The flask was then placed in an electric shaker and extracted with anhydrous ether for about 16 hours. The ether extract was filtered into another weighed conical flask. The flask containing the original ether extract was washed 4 to 5 times with small quantities of ether and the washings were also transferred to the filter paper. The ether in the conical flask was then removed by evaporation, and the flask with the residual was dried in an oven at 80°C to 100°C, cooled in a dessicator and weighed. The result was expressed as follows:

Lipid contents (g) per 100 g of dried sample

$$= \frac{\text{Weight of ether extract X Percentage of dried sample}}{\text{Weight of the dried sample taken}}$$

Determination of total ash

One gram of the sample was weighed accurately into a crucible. The crucible was placed on a clay pipe triangle and heated first over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 5-6 hours at 600°C. It was then cooled in a desiccator and weighed. To ensure completion of ashing, the crucible was then heated in the muffle furnace for 1h, cooled and weighed. This was repeated till two consecutive weights were the same and the ash was almost white or grayish white in color. Then total ash was calculated as following equation (Raghuramulu et al., 2003):

$$\text{Ash content (g/100 g sample)} = \frac{\text{Weight of ash}}{\text{Weight of sample taken (g)}} \times 100$$

Total carbohydrate estimation

The content of the available carbohydrate was determined by the following equation:

Carbohydrate (g/100 g sample) = 100 - [(Moisture + Fat + Protein + Ash + Crude Fiber) g/100 g] (Raghuramulu et al., 2003).

Determination of crude fiber

Ten gram of moisture and fat-free sample was taken in a beaker and 200 ml of boiling 0.255 N H_2SO_4 was added. The mixture was boiled for 30 minutes keeping the volume constant by the addition of water at frequent intervals. The mixture was then filtered through a Moslin cloth and the residue washed with hot water till free from acid. The material was then transferred to the same beaker and 200 ml of boiling 0.313 N NaOH was added. After boiling for 30 minutes (keeping the volume constant as before) the mixture was filtered through a Moslin cloth and the residue was washed with hot water till free from alkali, followed by washing with some alcohol and ether. It was then transferred to a crucible, dried overnight at 80-100°C and weighed (We) in an electric balance (KEY: JY-2003; China). The crucible was heated in a muffle furnace (Nebertherm: Mod-L9/11/c6; Germany) at 600°C for 5-6 hours, cooled and weighed again (Wa). The difference in the weights (We-Wa) represents the weight of crude fiber (Raghuramuluet al., 2003).

Therefore,

Crude fiber (g/100 g sample) = [100-(moisture + fat)] x(We-Wa)/Wt. of sample

Estimation of Minerals

Equipments

For elementary composition analysis the equipment were used as electric balance, desiccators, atomic absorption spectrophotometer (AAS), spectrophotometer, porcelain crucible, beaker and flame photometer etc.

Determination of Ca, Mg, K, Fe, S, Zn, N and P

The sample was digested with nitric acid to release of Ca, Mg, K, Fe, S, Zn, Nand P. Ca, Mg, Fe, S and Zn were determined by atomic absorption spectrophotometer, K was determined by flame photometry, N was determined by flame photometry and P by spectrophotometer.

Calculations: For Ca, Mg, K, P

$$\text{mg per kg sample} = \frac{a \times 25000}{b \times c}$$

Where, a= mg/L Ca, Mg, K or P measured on atomic absorption spectrophotometer, flame photometer or spectrophotometer

b= ml diluted filtrate transferred into the 50 ml volumetric flask for determination of Ca, Mg, K or P

c = g sample weighed into the digestion tube

If an additional dilution is made before the transfer to the 50 ml volumetric flask, the result is multiplied with the dilution factor. But the above elements were in trace. So addition of dilution was not to be performed.

For Zn and Fe

$$\text{mg per kg sample} = \frac{d \times 100}{c}$$

Zn and Fe measured on atomic absorption spectrophotometer

c = g sample weighed into the digestion tube

Estimation of N

50 ml diluted filtrate was transferred into a 50 ml volumetric flask using a pipette to volume with water and mixed.30 ml water was added, mixed and then 10 ml ammonium molybdate-ascorbic acid solution was added to volume with water and mixed. After 15 minutes, the absorbance was measured on a spectrophotometer at 890 nm.

Determination of total sulphur

Organic matter is destructed and sulphur is oxidized to sulphate by digestion with a mixture of nitric and perchloric acid. The sulphate is determined by precipitation as barium sulphate using the following formula.

$$\% S = \frac{A \times 1374}{M \times W} \qquad \% SO_3 = \% S \times 2.50$$

Where,

A = weight of $BaSO_4$ g

M = amount of soln. transferred to beaker for precipitation of BaSO4 (ml)

W = weight of sample in g

Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significance of the difference among the treatment. All the data collected on different parameters were statistically analyzed by MSTAT-C. The mean values of all the characters were evaluated and analysis of variance was performing by the 'F' test. The significance of the difference among the treatments means was estimated by the least significant difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Proximate composition

Moisture

Statistically significant variation was recorded in terms of moisture content of oyster mushroom due to chemical nutrients (Table 1). The highest moisture content was found in T_1 (88.95%) treatment which was statistically identical with T_2 (87.33 %) treatment whereas, the lowest moisture content was recorded in T_3 (84.33%) treatment which was statistically identical with T_4 (85.42%) treatment. The findings of the present experiment corroborate with the Ragunathan et al. (1996) where they showed that the moisture content of the fruiting bodies ranged from 84.70 to 91.90%.

Dry matter

Chemical nutrients varied significantly in terms of dry matter content of oyster mushroom (Table 1). The highest dry matter content was found from T_3 (15.67 %) treatment which was statistically identical with T_4(14.58%) treatment and the lowest dry matter content was recorded in T_1 (11.05 %) treatment which was statistically identical with T_2(12.67 %) treatment. The result of the present study matches with the findings of previous one that reported by Kulsum et al.(2009), they revealed that the dry matter percentage of the fruiting body was ranged from 9.40 to 9.98.

Protein content

Protein content of oyster mushroom showed statistically significant due to chemical nutrients (Table 1). The highest protein content was recorded in T_3 (25.54%) treatment which was statistically identical with T_4 (25.49%) treatment. On the other hand, the lowest protein content was observed in T_1 (22.45%) treatment which was statistically identical with T_2 (23.07%) treatment. Zhang-Ruihong et al. (1998) reported the protein content of mushrooms produced was 27.2% on an average.

Lipid content

Statistically significant variation was recorded in terms of lipid content of oyster mushroom due to chemical nutrients (Table 1). The highest lipid content was observed from T_3 (6.23%) treatment and closely following by T_4 (5.97 %), T_2 (5.83 %) treatment whereas, the lowest lipid content was obtained in T_1 (5.47%). The result of the present study was found more or less similar with the findings of Alam et al. (2007a) who reported 4.30 to 4.41% lipids in oyster mushroom.

Ash

Chemical nutrients varied significantly in terms of ash content of oyster mushroom under the present trial (Table 1). The highest ash content was found in T_3 (8.76%) treatment, again the lowest ash content was recorded in T_1 (7.64%) treatment. The findings of the present study was supported by the study of Kulsum et al.(2009)who found that ash content was ranged from 6.58 to 8.41%. Alam et al. (2007b) reported 8.28 to 9.02% ash in Pleurotus spp. which was also higher than the findings of present study.

Carbohydrate

Statistically significant variation was recorded in terms of carbohydrate content of oyster mushroom due to chemical nutrients (Table 1). The highest carbohydrate content was recorded in T_1 (41.96%) treatment which was statistically identical with T_2 (38.98%) treatment whereas, the lowest was observed in T_3 (33.42 %) treatment which was closely followed with T_4 (35.94%) treatment. The findings of the present study were not supported by the study of Kulsum et al.(2009)who found that carbohydrate content was ranged from 32.85 to 56.38% which showed a high rate of variation. Ragunathan et al. (1996) recorded the carbohydrate content ranged from 40.6 to 46.3%. Chang et al. (1981) reported that the fruiting bodies of mushrooms contained 40.30-50.7% carbohydrates which were also than the findings of this study.

Crude fiber

Crude fiber content of oyster mushroom showed statistically significant variation due to chemical nutrients (Table 1). The highest crude fiber content was found in T_3 (25.85 %) treatment which was closely following by T_4 (24.26 %) and T_2 (24.17 %) treatment, while the lowest ash content was obtained in T_1 (22.48%) treatment. The findings of the present study corroborate with the study Alam et al. (2007a) reported 22.87g/100g to 23.29g/100g of fiber in Pleurotus spp. Manzi et

al. (2001) reported that on an average, a serving (100 g) of mushroom will supply 9 to 40% of the recommended of dietary fiber which was also differ from the present study.

Treatments	Moisture (%)	Dry matter (%)	Protein (%)	Lipid (%)	Ash (%)	Carbohydrate (%)	Crude fiber (%)
T_1	88.95 a	11.05 b	22.45 b	5.47 c	7.64 d	41.96 a	22.48 c
T_2	87.33 a	12.67 b	23.07 b	5.83 b	7.95 c	38.98 b	24.17 b
T_3	84.33 b	15.67 a	25.54 a	6.43 a	8.76 a	33.42 d	25.85 a
T_4	85.42 b	14.58 a	25.49 a	5.97 b	8.34 b	35.94 c	24.26 b
$LSD_{(0.05)}$	2.294	2.436	1.284	0.305	0.285	1.386	1.501
CV(%)	5.32	4.27	4.27	5.48	3.95	3.57	4.98

Table 1: Effect of chemical nutrients (NPK) on proximate nutrient composition of oyster mushroom

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_1: Control (0 g NPK in 10 kg straw)
T_2: 2 g NPK in 10 kg straw
T_3: 4 g NPK in 10 kg straw
T_4: 6 g NPK in 10 kg straw

Mineral content

Nitrogen (N)

Statistically significant variation was recorded in terms of N content of oyster mushroom due to chemical nutrients (Table 2). The highest N content was recorded in T_3 (4.09%) treatment which was closely followed by T_4 (3.92 %) and T_2 (3.83 %) treatment. On the other hand, while the lowest N content was observed in T_1 (3.47 %) treatment. Moni et al. (2004) reported that on dry matter basis, the percentage of nitrogen 18.46 to 27.78% which was much higher than the findings of this experiment.

Phosphorus (P)

Different chemical nutrients showed significant differences in terms of P content of oyster mushroom (Table 2). The highest P content was observed in T_3 (1.49 %) treatment which was statistically identical with T_4 (1.44 %) and T_2 (1.40 %)treatment, while the lowest P content was found in T_1 (1.33 %) treatment. Kulsum et al.(2009) also found that phosphorus content was ranged from 0.84 to 0.92% which was smaller than the findings of this experiment.

Potassium (K)

Significant variation was recorded in terms of K content of oyster mushroom due to chemical nutrients (Table 2). The highest K content was recorded in T_3 (2.69 %) treatment which was statistically identical with T_4 (2.60 %) treatment whereas, the lowest K content was observed in T_1 (2.34%) treatment which was closely followed by T_2 (2.51 %) treatment. The findings of the present study similar with the study of Chang et al. (1981) who reported that the fruiting bodies of Pleurotus contained 1.43 to 1.88 mg/g of K on dry weight basis. Sarker et al. (2007a) also found 1.3% potassium in oyster mushroom which was smaller than the findings of present study.

Calcium (Ca)

Different chemical nutrients varied significantly in terms of Ca content of oyster mushroom (Table 2). The highest Ca content was observed in T_3 (1.96%) treatment which was statistically identical with T_4 (1.95 %) and T_2 (1.92%) treatment and the lowest Ca content was recorded in T_1 (1.73%) treatment. Sarker et al. (2007b) reported maximum of 18400 ppm Ca was found in mushroom which was grown on wheat straw. Alam et al. (2007a) who found 22.15 to 33.7 mg/100 g calcium in different oyster mushroom varieties.

Magnesium (Mg)

Statistically significant variation was recorded in terms of Mg content of oyster mushroom due to chemical nutrients (Table 2). The highest Mg content was found in T_3 (0.79%) whereas, the lowest Mg content was recorded in T_1 (0.67%) treatment which was closely followed by T_2 (0.72 %) and T_4 (0.71%) treatment. Sarker (2004) also found 0.21% magnesium in oyster mushroom which was smaller than the findings of this experiment.

Iron (Fe)

Fe content of oyster mushroom showed statistically significant variation due to chemical nutrients (Table 2). The highest Fe content was recorded in T_3 (525.48 ppm) treatment which was closely followed by T_4 (510.81 ppm) treatment. On the other hand, the lowest Fe content was observed in T_1 (482.89 ppm) treatment. Sarker et al. (2007b) reported that content of Fe in the mushroom grown on different substrates varied from 92.09 ppm to 118.40 ppm. The result of the present study found iron higher than the value found by Alam et al. (2007a) who found that iron content of different oyster mushroom varieties ranged from 33.45 to 43.2 ppm.

Sulphur (S)

Statistically significant variation was recorded in terms of S content of oyster mushroom due to chemical nutrients (Table 2). The highest S content was found in T_4 (0.33%) treatment which was statistically identical with T_2 (0.32%), T_3 (0.32 %) treatment, whereas the lowest S content was recorded in T1 (0.28%) treatment. The findings of the present study were supported with the findings of Alam et al. (2007a) who recorded 0.238 to 0.321% of sulphur from their earlier study in oyster mushroom varieties.

Zinc (Zn)

Different chemical nutrients showed statistically significant differences in terms of Zn content of oyster mushroom (Table 2). The highest Zn content was observed in T_3 (15.54%) treatment which was statistically identical with T_2 (15.32 %) and T_4 (15.22 %) treatment whereas, the lowest Zn content in T1 (14.02%) treatment. The results of the present

study have the similarity with the study of Alam et al.(2007b) found from their earlier experiment that zinc content of different oyster mushroom ranged from 16 to 20.9%. Sarker et al. (2007a) found 30.92 ppm zinc in oyster mushroom.

Treatments	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	S (%)	Zn (%)
T_1	3.47 c	1.33 b	2.34 c	1.73 b	0.67 c	482.89 c	0.28 b	14.02 b
T_2	3.83 b	1.40 ab	2.51 b	1.92 a	0.71 b	498.86 b	0.32 a	15.32 a
T_3	4.17 a	1.49 a	2.69 a	1.96 a	0.79 a	525.48 a	0.32 a	15.54 a
T_4	3.92 b	1.44 a	2.60 a	1.95 a	0.72 b	510.81 b	0.33 a	15.22 a
$LSD_{(0.05)}$	2.294	2.436	1.284	0.305	0.285	1.386	1.501	0.759
CV(%)	5.32	4.27	4.27	5.48	3.95	3.57	4.98	3.79

Table 2: Effect of chemical nutrients (NPK) on the mineral contents of oyster mushroom

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_1: Control (0 g NPK in 10 kg straw)
T_2: 2 g NPK in 10 kg straw
T_3: 4 g NPK in 10 kg straw
T_4: 6 g NPK in 10 kg straw

Conclusion

The lowest moisture content (84.12%), carbohydrate content (34.83%) was found in T_3 [4 g NPK in 10 kg straw]. The highest dry matter content (15.67%), protein content (25.54%), lipid content (6.43%), ash content (8.76%), crude fiber (25.85%) was recorded in T_3. The highest amount of nitrogen content (4.17%), phosphorus content (1.49%), potassium (2.69%), calcium (1.96%), magnesium (0.79%), iron (525.48 ppm), sulphur (0.33%) and zinc (15.54%) was attained from T_3. So treatment T_3 performed significantly better on nutrient and mineral content of oyster mushroom (Pleurotus ostreatus).

Recommendations

In this experiment, mixed different chemical nutrients (NKP) performed better in respect of different nutrient composition and mineral content of oyster mushroom. Therefore, 4 g NPK in 10 kg straw can be recommended for farmer level oyster mushroom cultivation.

References

1.Ahmed, M., Abdullah, N., Ahmed, K.U., Bhuyan, M.H.M.B., 2013. Yield and nutritional composition of oyster mushroom strainsnewly introduced in Bangladesh. Pesq. Agropec. Bras. 2, 197–202.

2.Aida, F.M.N.A., Shuhaimi, M., Yazid, M., Maaruf, A.G., 2009. Mushroom as a potential source of prebiotics: a review. TrendsFood Sci. Technol. 20, 567–575.

3.Alam, N., Khan, A., Hossain, M.S., Amin S.M.R. and Khan, L.A., 2007. Nutritional Analysis of dietary Mushroom PleurotusfloridaEger and Pleurotussajorcaj (Fr.) Singer. Bangladesh J. Mushroom. 1(2): 1-7.

4.Alam, N., Islam, M.A., Roy, T.S., Hossain, M.S. and Khan, L.A.,2007b. Method for increasing biological efficiency of Oyster mushroom (Pleurotusflorida) in Madhya Pradesh. Adv. Plant Sci.14(5): 34-40.

5.Amin, S.M.R., Sarker, N.C., Khair, A. and Alam, N., 2007. Detection of Novel Supplements on Paddy Straw Substrates on Oyster Mushroom Cultivation. Bangladesh J. Mushroom. 1(2): 18-22.

6.Banik, S. and Nandi, R., 2004. Effect of supplementation of rice straw with biogas residual slurry manure on the yield, protein and mineral contents of oyster mushroom. Indust. Crops Prod.20(3): 311-319.

7.Beluhan, S., & Ranogajec, A., 2011. Chemical composition and non-volatile components of Croatian wild edible mushrooms. Food Chemistry, 124, 1076-1082. http://dx.doi.org/10.1016/j.foodchem.2010.07.081

8.Chang, S.T., Lau, O.W. and Cho, K.Y.,1981. The cultivation and nutritional value of Pleurotussajor caju. European J. App. Micro. Biotech.12: 58 62.

9.Chandha, K.L. and Sharma, S.R.,1995. Advances in Horticulture. Mushroom, Malhotra Publication house, New Delhi.13: 649.

10.Chang, S.T. and Miles, P.G., 1988. Edible Mushroom and their cultivation. CRC Press, Inc. Boca Raton, Florida U.S.A. pp. 27, 83, 88.

11.Chang, S.T. and Mshigeni, K.E., 2001. Mushroom and their human health: their growing significance as potent dietary supplements. The University of Namibia, Windhoek. pp. 1-7.

12.Chorvathoba, V., Bobek, P., Ginter, E. and Klavanova, J., 1993. Effect of the oyster fungus on glycemia and cholesterolemia in rats with insulin depended diabetes. Physol. Res. 42: 175-179.

13.Cogorni, P.F.B.O., Schulz, J.G., Alves, E.P., Gern, R.M.M., Furlan,S.A., Wisbeck, E., 2014. The production of Pleurotussajor-caju inpeach palm leaves (Bactrisgasipaes) and evaluation of its use toenrich wheat flour. Food Sci. Technol. Int. 34, 267–274.

14.Deepalakshmi K, Mirunalini S., 2014. Pleurotusostreatus: an oyster mushroom with nutritional and medicinal properties. J Biochem Tech 5(2): 718-26.

15.El-Enshasy HA and Hatti-Kaul R., 2013. Mushroom Immunomodulators:unique molecules with unlimited applications. Trends Biotechnol 31(12): 668-77.http://dx.doi.org/o.1016/j.tibtech.2013.09.003

16.Gomez, K.A. and Gomez, A.A., 1984. Statistical procedures for agricultural research. John Wiley and Sons, Inc. New York.

17.Hilal, A., Dundar, A., Yildiz, A., 2012. Effect of using differentlignocellulosic wastes for cultivation of Pleurotusostreatus (Jacq.)P. Kumm. on mushroom yield, chemical composition and nutritionalvalue. Afr. J. Biotechnol. 8 (4), 662–666.

18.Holman, R. I., 1976. Sigficance of essential fatty acids in human

nutrition, in Lipids, Vol. 1.Paoletti, R., Poscellati, G.andJasina, G., Eds, Raven press, New York. PP. 215.

19.Islam T, Yu XM, Xu BJ, 2016. Phenolic profiles, antioxidant capacities and metal chelating ability of edible mushrooms commonly consumed in China. LWT Food SciTechnol 72:423–431.

20.Kalac_, P., 2013. A review of chemical composition and nutritionalvalue of wild-growing and cultivated mushrooms. J. Sci. Food Agric. 93, 209–218.

21.Kulsum, U., Hoque, S. and Ahmed, K.U., 2009. Effect of different levels of cow dung with sawdust on yield and proximate composition of oyster mushroom (pleurotus ostreatus).Bangladesh J. Mushroom.3(2): 25-31.

22.Li, S., Shah, N.P., 2016. Characterization, antioxidative and bifidogeniceffects of polysaccharides from Pleurotuseryngii after heattreatments. Food Chem. 197, 240–249.

23.Machado, A.R.G., Teixeira, M.F.S., Kirsch, L.S., Campelo, M.C.L.,Oliveira, I.M.A., 2015. Nutritional value and proteases of Lentinuscitrinus produced by solid state fermentation of lignocellulosicwaste from tropical region. Saudi J. Biol. Sci. http://dx.doi.org/10.1016/j.sjbs.2015.07.002.

24.Manzi, P., Aguzzi, A. and Pizzoferrato, L., 2001. Nutritional value of mushroom widely consumed in Italy. Food Chem.73 (3): 321-325.

25.Moni, K. H., Ramabardan, R. and Eswaran, A., 2004. Studies on some physiological, cultural and post harvest aspects of Oyster mushroom Pleurotus ostreatus (Berk). Trop. Agril. Res.12: 360-374.

26.Olivieri, G., Marzocchella, A., Salatino, P., Giardina, P., Cennamo,G., Sannia, G., 2006. Olive mill wastewater remediation by means of Pleurotus ostreatus. Biochem. Eng. J. 31, 180–187.

27.Ozturk M, Tel-Cayan G, Muhammad A, Terzioglu P, EminDuru M. Mushrooms: A source of exciting bioactvie. Studies in Natural Products Chem 2015; 45(1): 363-456. http://dx.doi.org/10.1016/B978-0-444-63473-3.00010-1

28.Patil, S.S.; Ahmed, S.A.; Telang, S.M.; Baig, M.M.V., 2010. The nutritional value of Pleurotus ostreatus (Jacq. Fr) Kumm cultivated on different lignocellulosic agro wastes. Innovative Romanian Food Biotechnology, v.7, p.66 76.

29.Philippoussis, A., Zervakis, G., Diamantopoulou, P., 2001. Bioconversionof agricultural lignocellulosic wastes through the cultivationof the edible mushrooms Agrocybeaegerita, Volvariellavolvacea and Pleurotus spp. World J. Microbiol. Biotechnol. 17,191–200.

30.Randive, S.D., 2012. Cultivation and study of growth of oyster mushroom on different agricultural waste substrate and its nutrient analysis. Adv. App. Sci. Res.3: 1938 1949.

31.Raghuramulu, N., Madhavan, N.K. and Kalyanasundaram, S., 2003. A Manual of LaboratoryTechniques. National Institute of Nutrition. Indian Council of Medical Reasearch, Hyderabad-500007, India. pp. 56-58.

32.Ragunathan. R., Gurusamy,R., Palniswamy, M. and Swaminathan, K., 1996. Cultivation of Pleurotus spp. on various agro-residues. Food Chem. 55(2): 139-144.

33.Sa´ nchez, C., 2010. Cultivation of Pleurotusostreatus and other ediblemushrooms. Appl. Microbiol. Biotechnol. 85, 1321–1337.

34.Sarker, N.C., 2004. Oyster mushroom (Pleurotus ostreatus) Production Technology Suitable for Bangladesh and its Nutritional and Postharvest Behavior. Ph.D. Thesis. Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.

35.Sarker, N.C., Hossain, M.M.,Sultana, N., Mian, I.H., Karim, A.J.M.S. and Amin, S.M.R., 2007a. Performance of Different Substrates on the growth and Yield of Pleurotusostreatus(Jacquin ex Fr.) Kummer. Bangladesh J. Mushroom.1(2): 44-49.

36.Sarker, N.C., Hossain, M.M.,Sultana, N., Mian, I.H., Karim, A.J.M.S. and Amin, S.M.R., 2007b. Impect of different Substrates on Nutrient Content of Pleurotus ostreatus (Jacquin ex Fr.) Kummer. Bangladesh J. Mushroom.1(2): 35-38.

37.Sarmidi MR, El Enshasy HA. Biotechnology for wellness industry: Concepts and biofactories. Int J Biotechnol Well Ind 2012; 1(1): 3-29.

38.Shirur Mahantesh, 2011. Round the year cultivation of mushrooms. In Mushrooms cultivation, marketing and consumption by Manjit Singh, Bhuvnesh Vijay, Shwet Kamal and Wakchaure, G.C (Ed.). Directorate of Mushroom Research, Solan. pp. 229-232.

39.Soltani M, Kamyab H, El-Enshasy HA., 2013. Molecular weight (Mw) and Monosaccharide composition (MC): Two major factors affecting the therapeutic action of polysaccharidesextracted from Cordycepssinensis. J Pure ApplMicrobiol 7(3): 1601-13.

40.Tan YS, Baskaran A, Nallathamby N, Chua KH, Kuppusamy UR, Sabaratnam V, 2015. Influence of customized cooking methods on the phenolic contents and antioxidant activities of selected species of oyster mushrooms (Pleurotus spp.). J Food SciTechnol 52(5):3058–3064.

41.Velioglu, Z., Urek, R.O., 2015. Optimization of cultural conditions for biosurfactant production by Pleurotusdjamor in solid state fermentation. J. Biosci. Bioeng. 120, 526–531.

42.Xu, X., Yan, H., Chen, J., Zhang, X., 2011. Bioactive proteins frommushrooms. Biotechnol. Adv. 29, 667–674.

43.Zhang-Ruihong, H., Li-Xiu, J., Fadel, J.G. and Li-XJ.,1998. Oyster mushroom cultivation with rice and wheat straw. Biores. Tech. 82(3): 277-284.

44.Zhang, Z.J., Li, H.Z., Qiao, S.J., Zhang, X., Liu, P., Liu, X., 2012. Effect of salinity on seed germination, seedling growth, and physiological characteristics of Perillafrutescens. Plant Biosyst.146 (4), 246–251.