INTERNATIONAL JOURNAL OF PLANT PROTECTION
VOLUME 13 | ISSUE 2 | OCTOBER, 2020 | 180-186

● ISSN-0974-2670 | Visit us : *www.researchjournal.co.in*

IJPP

RESEARCH PAPER

DOI : 10.15740/HAS/IJPP/13.2/180-186

Effect of organic amendments on the nutritional value of oyster mushrooms (*Pleurotus* spp.)

■ Julie I. Elizabeth[1]* **and** T. Sheela Paul[2]

[1]Regional Agricultural Research Station Ambalavayal, Ambalavayal, **Wayanad (Kerala) India**
[2]Department of Plant Pathology, College of Horticulture, Vellanikkara, **Thrissur (Kerala) India**

ARITCLE INFO

Received : 28.07.2020
Revised : 09.09.2020
Accepted : 23.09.2020

KEY WORDS :
Nutritional value, Crude protein, Total free amino acid, Total carbohydrate, N, P and K

***Corresponding author:**
Email : julie.elizabeth@kau.in

ABSTRACT

Popularity of oyster mushroom is increasing because of its ease of cultivation, high yield potential as well as its unique nutritional value. Study with oyster mushrooms *viz*., *Pleurotus florida, P. sajorcaju, P. eous, P. tuber-regium and Hypsizygus ulmarius* revealed that the nutritional value of these mushrooms can be increased significantly when grown on paddy straw supplemented with organic amendments such as rice bran, neem cake, dry azolla, vermiwash and dry biogas slurry. In addition to increased yield, the organic supplements significantly increase thecrude protein, total free aminoacid, total carbohydrate and nutrients like N,P and K in oyster mushrooms. Nutrient content of the mushrooms varied with different concentrations of organic amendments used. In *P. florida, H. ulmarius* and *P.tuber-regium* paddy straw amended with dry azolla gave higher amount of crude protein content (35.4, 35.3 and 34.9, respectively). Paddy straw amended with dry azolla at 4 per cent, 6 per cent and 5 per cent, respectively recorded the maximum total free aminoacid in *P. florida* (0.6%), *P. sajor-caju* (0.43%) and *H. ulmarius* (0.56%). The major nutrient elements like N, P and K content also increased with addition of organic amendments.Thus, it is concluded from the study that supplementation of rice straw with rice bran, *Neem* cake, dry azolla, vermiwash and dry biogas slurry has strong impact in improving the crude protein, total free aminoacid, total carbohydrate and essential mineral nutrients such as N, P and Kcontent of oyster mushrooms.

How to view point the article : Elizabeth, Julie I. and Sheela Paul, T. (2020). Effect of organic amendments on the nutritional value of oyster mushrooms (*Pleurotus* spp.). *Internat. J. Plant Protec.*, **13**(2) : 180-186, **DOI : 10.15740/HAS/IJPP/13.2/180-186,** Copyright@ 2020: Hind Agri-Horticultural Society.

INTRODUCTION

Mushroom cultivation, a profitable and ecofriendly enterprise, involves the bioconversion of cellulose wastes into edible biomass. The growing increase in consumption of oyster mushroom is largely due to its taste, delicious flavour, medicinal and nutritional properties. Oyster mushroom is regarded as one of the commercially important edible mushrooms throughout the world. The most commonly cultivating species in India are *P. djamor, P. citrinopileatus, P. flabellatus, P. eous, P. sajor-caju, P. florida*etc. Various agricultural byproducts used as substrates for the cultivation of oyster mushroom. They grow on agricultural wastes rich in cellulose, hemicellulose and lignin. These residues are low in nitrogen content (0.5 to 0.8%), an essential element for cellular functions. At the time of fructification, most of the nitrogen utilized for mycelial growth, the depleted nitrogen in the substrate becomes inadequate and limits mushroom yield. *Pleurotus* species require carbon, nitrogen and inorganic compounds as their nutritional sources. The yield and quality of oyster mushroom depend on the chemical and nutritional content of substrates (Badu *et al.*, 2011). Cohen *et al.* (2002) reported that *Pleurotus* spp. have unique flavour and aromatic properties and it is considered to be rich in protein, fibre, carbohydrates, vitamins and minerals. They have a chemical composition which is attractive from the nutritional point of view. The essential amino acids of the human body are found in the oyster mushroom (Kaushlesh *et al.,* 2012). According to Tshinyanga (1996), supplements such as cottonseed meal and nitrogen influenced the chemical composition and nutritional value of cultivated mushrooms. Mushrooms grown on paddy straw supplemented with cotton seed powder increased protein and fat content of *P. sajor-caju* (Shashirekha *et al.*, 2002). Substrates used in mushrooms cultivation had effect on chemical, functional and sensorial characteristics of mushrooms (Oyetayo and Ariyo, 2013). Supplementation of paddy straw with residual biogas slurry increased protein and mineral content of *P. sajor-caju* (Banik and Nandi, 2004). According to Shashirekha *et al*. (2005) incorporation of cottonseed powder into paddy straw increased total protein, total free amino acids and lipid content of *P. florida*. Keeping these in view, a study was formulated to find out the effect of different organic amendments like rice bran, *Neem* cake, dry azolla, vermin wash and dry biogas slurry on the nutritional composition of oyster mushrooms.

MATERIAL AND METHODS

The investigation was conducted at College of Horticulture,Vellanikkara, Kerala during 2006 to 2009 to find out the effect of organic amendments such as rice bran, neem cake, dry azolla, vermiwash and dry biogas slurry on the nutritional value of oyster mushrooms *viz*., *Pleurotusflorida, P. sajor-caju, P. eous, P. tuber-regium* and *Hypsizygus ulmarius*. For the study paddy straw was used as substrate. Good quality paddy straw was chopped into bits of 4-5cm length and used for mushroom cultivation. The species of oyster mushrooms were obtained from Department of Plant Pathology, College of Horticulture, Vellanikkara, Thrissur, Kerala.

Chemical sterilization was followed for sterilizing the paddy straw (Sameera, 2007). The substrates were transferred to gunny bags and steeped in a solution made of carbendazim (75ppm), formaldehyde (500ppm) and calcium carbonate (0.2%) for 18h. The excess water drained off and spread on a clean floor for drying. The moisture content of the paddy straw was maintained at optimum level and was used for bed preparation. The standard compact polybag method described by Bhaskaran *et al.* (1978) was used for bed preparation. Poly bags of size 30 x 60cm with 150- 200 guage thickness were used. About 30 holes of 0.5mm size were made on each polythene bag and the bottom was tied with a twine. Organic amendments at three different concentrations were used for the experiment *viz*., T_1 (4% rice bran), T_2 (5% rice bran),T_3 (6% rice bran), T_4 (1% *Neem* cake), T_5 (3% *Neem* cake), T_6 (5% *Neem* cake), T_7 (4% dry azolla), T_8 (5% dry azolla), T_9 (6% dry azolla), T_{10} (5% vermiwash), T_{11} (10% vermiwash), T_{12} (15% vermiwash), T_{13} (paddy straw and dry biogas slurry @ 1:0.25ratio), T_{14} (paddy straw and dry biogas slurry @ 1:0.5 ratio), T_{15} (paddy straw and dry biogas slurry @ 1:1 ratio) and T_{16} (control- paddy straw without amendments). Rice bran, *Neem* cake and dry biogas slurry were sterilized in an autoclave at a pressure of 1.05 per cm^2 for 15 minutes. Azolla was dried to optimum moisture level and sterilized by steaming for 20 minutes in a pressure cooker. Vermiwash was also sterilized by steaming. The sterilized paddy straw was thoroughly mixed with these organic amendments and used for the preparation of beds whereas, vermiwash was sprayed on the sterilized paddy straw using a hand sprayer. The bags were filled upto 5cm height with sterilized substrate and pressed with hand for making it even. Then 20-25g spawn was sprinkled over the filled straw along the peripheral region. A second layer of sterilized straw was filled and spawned as above. This process repeated four times. Finally, the bag was tied tightly with a twine. For filling one mushroom bed of 500g weight 125g spawn was used. The inoculated bags were incubated in a dark room for spawn run. The room temperature and relative humidity were maintained at 25-28^{0}C and 80-90 per cent, respectively by spraying water inside the room. After spawn run, the beds were transferred to cropping room where the temperature and relative humidity were maintained at 25-28^0 C and 80- 90 per cent, respectively.

Nutritional value of sporophores produced on paddy straw amended with rice bran, *Neem* cake, dry azolla, vermiwash and dry biogas slurry was evaluated by estimating crude protein, total carbohydrate, total free amino acid and minerals *viz*., N, P and K. The crude protein content (Nx6.25) of samples was estimated by the macro-Kjeldahl method. The total carbohydrate content in the sample was measured by anthrone method (Hedge and Hofreiter, 1962). The total free amino acid content was determined by the method described by Sadasivam and Manickan (1992). Harvested mushrooms were dried in a hot air oven at 60^{0}C and ground into powder samples for the analysis of mineral contents. The nitrogen and phosphorus content were determined by Microkjeldhals estimation and Vanado molybdate yellow colour method, respectively. The potassium content was analysed by direct reading using flame photometer. Experiment was laid out in Completely Randomized Design with four replications. Analysis of variance was performed on the data collected in the experiments using statistical package of MSTAT (Freed, 1986). Multiple comparisons of the means were done using DMRT.

RESULTS AND DISCUSSION

The result of crude protein content of oyster mushrooms is presented in Table 1. In *P. florida* and *H. ulmarius*, maximum crude protein content of 35.4 and 35.3 per cent, respectively were obtained from paddy straw amended with 6 per cent dry azolla. In *P. sajor-caju*, crude protein content was maximum (29.4%) in paddy straw amended with dry biogas slurry at 1:0.25 ratio (T_{13}) and in *P. eous* paddy straw amended with 6 per cent rice bran recorded maximum crude protein content of 34.3 per cent. The lowest concentration of dry azollawas found superior giving maximum crude protein content (34.9%) in *P. tuber-regium*. Banik and Nandi (2004) reported increased crude protein content of *P. sajor-caju* grown on paddy straw amended with biogas slurry. The increase in crude protein content might be because of the increased nitrogen content of substrates by the addition of organic amendments. Shashirekha *et al*. (2005) observed an increase in crude protein content of *P. florida* grown on rice straw amended with cotton seed powder. From the cited data, it is evident that supplementation of organic amendments improved the crude protein content in mushroom in comparison to straw alone when used as substrate. So,

Table 1 : Effect of organic amendments on the crude protein content of oyster mushrooms

Treatments	Crude protein content (%)				
	P. florida	*P. sajor- caju*	*P. eous*	*P. tuber-regium*	*H. ulmarius*
T_1	32.4^{Bcd}	24.1^{Dcd}	26.95^{Cde}	23.8^{Df}	34.7^{Aab}
T_2	29.1^{Bef}	27.5^{BCab}	28.7^{Bcd}	26.8^{Cde}	35.0^{Aab}
T_3	30.5^{Be}	28.7^{Ca}	34.3^{Aa}	33.6^{Aa}	30.5^{Bd}
T_4	29.8^{Bef}	23.5^{Dd}	28.5^{BCcd}	27.1^{Ccde}	32.8^{Ac}
T_5	30.3^{Ae}	24.6^{Ccd}	30.1^{Abc}	27.5^{Dcde}	31.5^{Acd}
T_6	34.1^{Aabc}	28.2^{Ca}	30.6^{Bb}	33.8^{Aa}	27.3^{Ce}
T_7	30.8^{Bde}	27.5^{Cab}	22.6^{Dg}	34.9^{Aa}	30.1^{Bd}
T_8	29.9^{ABef}	27.6^{Ca}	28.2^{BCd}	30.6^{Ab}	30.7^{Ad}
T_9	35.4^{Aa}	27.5^{Cab}	30.95^{Bb}	27.5^{Ccde}	35.3^{Aa}
T_{10}	28.2^{Af}	23.6^{Cd}	25.2^{BCef}	25.9^{Be}	25.6^{Bf}
T_{11}	33.1^{Abc}	23.95^{Ccd}	25.5^{Cef}	28.2^{Bcd}	25.0^{Cfg}
T_{12}	29.9^{Aef}	25.4^{Bcd}	22.4^{Cg}	28.9^{Ac}	30.3^{Ad}
T_{13}	29.6^{Aabc}	29.4^{Aa}	28.7^{Acd}	22.6^{Bf}	30.2^{Ad}
T_{14}	33.95^{Aab}	28.0^{Ba}	24.2^{Cfg}	26.95^{Bcde}	32.7^{Ac}
T_{15}	34.6^{Bg}	28.9^{Ba}	27.5^{Bd}	34.3^{Aa}	33.3^{Abc}
T_{16}	23.3^{A}	25.7^{Abc}	25.6^{Aef}	23.3^{Bf}	23.8^{Bg}
	30.9	26.5^{D}	27.5^{C}	28.5^{B}	30.5^{A}

from overall evaluation, it is evident that supplementation of organic amendments were effective in improving nutritional quality of oyster mushroom in terms of protein content.

Addition of organic amendments expressed positive effect on the total carbohydrate content of oyster mushrooms (Table 2). Vermiwash at 15 per cent (T_{12}) concentration gave the highest per cent of total carbohydrate in *P. florida* (55.3%). In *H. ulmarius* all concentrations of dry azolla and vermi wash gave significantly higher quantity of total carbohydrate content whereas, in *P. eous, P. sajor-caju* and *P. tuber-regium*, the highest content of the same was obtained from treatments with dry biogas slurry at 1:0.25 and 1:1 ratio, respectively. The improved chemical composition of substrates after supplementation might have resulted in increased total carbohydrate content. Addition of organic amendments increased the secretion of lignolytic enzymes of fungal species favouring the active biodegradation of rice straw substrate. Shashirekha *et al*. (2002) found that the addition of oil seed cakes increased the secretion of lignolytic enzymes aiding the breakdown of lignin to create easier accessibility and degradation of other carbohydrates. The degraded carbohydrates served as the energy source for the construction of fruiting bodies and as the structural components of fruiting bodies. Shashirekha *et al*. (2005) also reported increased total carbohydrate content of *P. florida* grown on rice straw amended with cotton seed powder. Saw dust supplemented with different levels of wheat bran, rice bran or maize powder improved the yield and quality of *Lentinulaedodes* (Moonmoon *et al*., 2011).

Results presented in Table 3 showed that the total free aminoacid content varied with mushroom species and different concentrations of organic amendments. Comparing with control, various concentrations of dry azolla had significant effect in increasing the total free aminoacid content of *P. florida* (0.6%), *P. sajor-caju* (0.43%) and *H. ulmarius* (0.56%) whereas for *P. tuber-regium*, paddy straw amended with neem cake (T_6) gave significantly higher quantity (0.54%). Paddy straw supplemented with 6 per cent rice bran (T_3) gave significantly highest quantity of total free amino acid in *P. eous* (0.52%). The increase in total free aminoacid content might be due to the increased protein content of the substrates due to supplementation. Shashirekha *et al*. (2005) obtained an increased total free aminoacid content of *P.florida* grown on paddy straw supplemented with cotton seed powder. According to them, contribution of several aminoacids from cotton seed powder enhanced the activities of protease and transaminase which was necessary for the conversion of substrate proteins.

Results presented in Table 4 demonstrate the effect

Table 2 : Effect of organic amendments on the total carbohydrate content of oyster mushrooms

Treatments	Total carbohydrate content (%)				
	P. florida	*P. sajor- caju*	*P. eous*	*P. tuber-regium*	*H. ulmarius*
T_1	52.2^{Aa}	49.8^{Aabc}	25.2^{Chi}	41.1^{Bcdef}	39.2^{Bb}
T_2	34.6^{Ccd}	52.4^{Aab}	43.8^{Bbcd}	40.3^{BCcdef}	39.6^{BCb}
T_3	40.2^{Bbc}	51.1^{Aabc}	40.5^{Bde}	40.8^{Bcdef}	41.4^{Bb}
T_4	36.1^{Bbcd}	35.1^{Be}	26.95^{Bghi}	33.4^{BCf}	43.8^{Ab}
T_5	31.4^{Bd}	53.5^{Aab}	33.1^{Bfg}	33.4^{Bf}	37.1^{Bb}
T_6	33.3^{Ccd}	51.5^{Aab}	35.9^{BCef}	34.4^{BCdef}	40.7^{Bb}
T_7	33.9^{Bcd}	34.2^{Be}	54.3^{Aa}	33.8^{Bef}	51.7^{Aa}
T_8	42.5^{Bcb}	39.4^{Cde}	48.2^{ABabc}	41.7^{BCcde}	54.3^{Aa}
T_9	42.7^{Bb}	51.0^{Aabc}	28.7^{Cgh}	38.5^{Bcdef}	56.6^{Aa}
T_{10}	37.3^{Cbcd}	46.2^{Bbcd}	21.1^{Di}	40.4^{BCcdef}	53.9^{Aa}
T_{11}	50.9^{Ba}	36.2^{Ce}	49.3^{Bab}	42.2^{Ccd}	57.7^{Aa}
T_{12}	55.3^{Aba}	49.2^{BCabc}	51.1^{BCa}	45.1^{Cbc}	58.5^{Aa}
T_{13}	37.5^{Bbcd}	54.5^{Aa}	38.6^{Bdef}	51.4^{Aab}	40.1^{Bb}
T_{14}	23.2^{Ce}	43.6^{Acd}	41.4^{ABcde}	35.5^{Bdef}	40.8^{ABb}
T_{15}	34.9^{Ccd}	52.4^{Aab}	54.5^{Aa}	54.0^{Aa}	43.4^{Bb}
T_{16}	24.6^{Be}	39.7^{Ade}	24.7^{Bhi}	20.95^{Bg}	23.1^{Bc}
Mean	38.1^{B}	46.2^{A}	38.6^{B}	39.2^{B}	45.1^{A}

of paddy straw supplementation on the N content of oyster mushrooms. Studies on the effect of organic amendments on the nutrient element composition of oyster mushrooms revealed that the N content varied with mushroom species and different concentrations of organic amendments. The maximum N content of *P. florida* (5.7%) was obtained from T_9 (6% dry azolla) and T_{14} (paddy straw and dry biogas slurry @ 1:0.5 ratio)

Table 3 : Effect of organic amendments on the total free aminoacid content of oyster mushrooms

Treatments	Total free aminoacid content (%)				
	P. florida	*P. sajor- caju*	*P. eous*	*P. tuber-regium*	*H. ulmarius*
T_1	0.18^{Cde}	0.28^{Bc}	0.27^{Bdef}	0.33^{ABcdef}	0.39^{Ac}
T_2	0.19^{Bde}	0.23^{Bcde}	0.19^{Bgh}	0.35^{Acd}	0.35^{Acde}
T_3	0.23^{CDcd}	0.22^{Dcdef}	0.52^{Aa}	0.29^{Cdef}	0.38^{Bc}
T_4	0.19^{Cde}	0.20^{Cdef}	0.36^{Bbc}	0.45^{Ab}	0.37^{Bcd}
T_5	0.28^{Cc}	0.21^{Dcdef}	0.24^{CDefg}	0.49^{Aab}	0.38^{Bc}
T_6	0.27^{Cc}	0.26^{Ccd}	0.21^{Cfgh}	0.54^{Aa}	0.45^{Bb}
T_7	0.60^{Aa}	0.36^{Cb}	0.16^{Dh}	0.19^{Di}	0.48^{Bb}
T_8	0.51^{Ab}	0.27^{Bcd}	0.28^{Bcdef}	0.20^{Chi}	0.56^{Aa}
T_9	0.48^{Ab}	0.43^{Ba}	0.18^{Dgh}	0.22^{Dghi}	0.34^{Cde}
T_{10}	0.18^{Cde}	0.22^{Bcdef}	0.29^{ABcde}	0.37^{Ac}	0.25^{Bf}
T_{11}	0.19^{Cde}	0.23^{BCcde}	0.29^{Abcde}	0.32^{Acdef}	0.30^{Adef}
T_{12}	0.19^{Bde}	0.21^{Bcdef}	0.36^{Abcd}	0.34^{Acde}	0.30^{Adef}
T_{13}	0.13^{Def}	0.18^{CDef}	0.21^{Befgh}	0.30^{Acdef}	0.27^{ABf}
T_{14}	0.14^{Cef}	0.17^{Cef}	0.37^{Ab}	0.27^{Befg}	0.26^{Bf}
T_{15}	0.14^{Bef}	0.17^{Bef}	0.22^{Aefgh}	0.27^{Aefg}	0.29^{Bf}
T_{16}	0.10^{Cf}	0.15^{Cf}	0.22^{Befgh}	0.26^{Bfgh}	0.36^{Acde}
Mean	0.25^{D}	0.24^{D}	0.27^{C}	0.32^{B}	0.36^{A}

Table 4 : Effect of organic amendments on N content of oyster mushrooms

Treatments	N content (%)				
	P. florida	*P. sajor- caju*	*P. eous*	*P. tuber-regium*	*H. ulmarius*
T_1	5.2^{Bb}	3.9^{Dbc}	4.4^{Cde}	3.9^{Dfg}	5.6^{Aab}
T_2	4.7^{Bcd}	4.4^{CDa}	4.6^{BCcd}	4.3^{Dde}	5.6^{Aab}
T_3	4.9^{Bc}	4.6^{Ca}	5.5^{Aa}	5.4^{Aa}	4.9^{BCe}
T_4	4.8^{Bcd}	3.8^{Dc}	4.5^{BCcd}	4.4^{Ccde}	5.3^{Acd}
T_5	4.8^{Acd}	3.9^{Cbc}	4.8^{Abc}	4.4^{Bcde}	5.0^{Ade}
T_6	5.5^{Aab}	4.5^{Ca}	4.9^{Bb}	5.4^{Aa}	4.4^{Cf}
T_7	4.9^{Bc}	4.5^{Ca}	3.6^{Dg}	5.6^{Aa}	4.8^{Be}
T_8	4.8^{Acd}	4.4^{Ca}	4.6^{BCcd}	4.9^{Ab}	4.9^{Ae}
T_9	5.7^{Aa}	4.4^{Ca}	4.9^{Bb}	4.4^{Ccde}	5.7^{Aa}
T_{10}	4.5^{Ad}	3.9^{Bbc}	4.0^{Bf}	4.1^{Bef}	4.1^{Bg}
T_{11}	5.3^{Ab}	3.9^{Cbc}	4.1^{Cef}	4.5^{Bcd}	3.9^{Cg}
T_{12}	4.8^{Acd}	4.1^{Cbc}	3.6^{Dg}	4.6^{Bbc}	4.9^{Ae}
T_{13}	4.8^{Acd}	4.7^{Aa}	4.6^{Acd}	3.6^{Bg}	4.8^{Ae}
T_{14}	5.7^{Aa}	4.5^{Ca}	3.9^{Dfg}	4.3^{Ccde}	5.3^{Bcd}
T_{15}	5.6^{Aa}	4.6^{Ca}	4.4^{Cd}	5.5^{Aba}	5.3^{Bbc}
T_{16}	3.8^{Be}	4.1^{Ab}	4.1^{Af}	3.7^{Bg}	3.9^{ABg}
Mean	4.96^{A}	4.2^{E}	4.4^{D}	4.5^{C}	4.9^{B}

while in *P. sajor-caju*, organic amendmentssuch as rice bran (6%), *Neem* cake (5%) and all the concentrations of dry azolla and dry biogas slurry gave significantly higher quantity of N content. Paddy straw amended with 6 per cent rice bran gave the highest amount of N in *P. eous* (5.5%) while in *P. tuber-regium,* the highest N content (5.6%) was recorded from T_7 (4 % dry azolla). The treatment T_9 (6 % dry azolla) gave highest N content

Table 5 : Effect of organic amendments on P content of oyster mushrooms

Treatments	P content (%)				
	P. florida	*P. sajor- caju*	*P. eous*	*P. tuber-regium*	*H. ulmarius*
T_1	0.91^{Ab}	0.62^{Bd}	0.30^{Eh}	0.52^{Cb}	0.48^{Dg}
T_2	0.92^{Ab}	0.73^{Cb}	0.77^{Bbc}	0.56^{Da}	0.49^{Eg}
T_3	0.33^{Df}	0.63^{Bd}	0.86^{Aa}	0.31^{Ed}	0.49^{Cg}
T_4	0.55^{Dd}	0.63^{Cd}	0.79^{Bb}	0.25^{Eh}	0.85^{Ac}
T_5	0.88^{Ac}	0.57^{Ce}	0.65^{Be}	0.28^{Def}	0.88^{Ab}
T_6	0.88^{Bc}	0.69^{Dc}	0.76^{Cc}	0.27^{Efg}	0.91^{Aa}
T_7	0.31^{Df}	0.75^{Aa}	0.42^{Bf}	0.32^{Dd}	0.36^{Ch}
T_8	0.88^{Ac}	0.58^{De}	0.69^{Cd}	0.39^{Ec}	0.80^{Bd}
T_9	0.92^{Ab}	0.50^{Df}	0.38^{Eg}	0.56^{Ca}	0.80^{Bd}
T_{10}	0.97^{Aa}	0.58^{Ce}	0.26^{Eijk}	0.31^{Dd}	0.65^{Be}
T_{11}	0.96^{Aa}	0.61^{Bd}	0.24^{Ek}	0.30^{Dde}	0.57^{Cf}
T_{12}	0.56^{Cd}	0.69^{Bc}	0.28^{Ei}	0.30^{Dde}	0.81^{Ad}
T_{13}	0.42^{Be}	0.26^{Ch}	0.27^{Cij}	0.27^{Cfg}	0.49^{Ag}
T_{14}	0.43^{Be}	0.46^{Ag}	0.28^{Di}	0.32^{Cd}	0.31^{Ci}
T_{15}	0.56^{Bd}	0.69^{Ac}	0.26^{Dijk}	0.26^{Dgh}	0.32^{Ci}
T_{16}	0.32^{Bg}	0.69^{Ac}	0.25^{Cjk}	0.18^{Di}	0.22^{Cj}
Mean	0.66^{A}	0.60^{B}	0.47^{E}	0.34^{E}	0.59^{C}

Table 6: Effect of organic amendments on K content of oyster mushrooms

Treatments	K content (%)				
	P. florida	*P. sajor- caju*	*P. eous*	*P. tuber-regium*	*H. ulmarius*
T_1	4.6^{Ab}	3.6^{Bg}	3.3^{Cb}	0.92^{Egh}	1.5^{Dg}
T_2	4.6^{Ab}	4.5^{Ba}	3.1^{Cc}	1.8^{Db}	1.7^{Ef}
T_3	4.7^{Aab}	2.7^{Cj}	3.1^{Bc}	1.4^{Dd}	3.1^{Bcd}
T_4	4.6^{Ab}	4.1^{Bc}	2.9^{Cd}	1.6^{Dc}	2.9^{Ce}
T_5	4.6^{Ab}	4.0^{Bd}	2.9^{Cd}	1.3^{De}	2.9^{Ce}
T_6	4.6^{Ab}	4.2^{Bb}	2.9^{Cd}	1.3^{Ee}	3.6^{Cb}
T_7	4.4^{Ad}	3.7^{Bf}	2.8^{De}	1.3^{Ee}	2.9^{Ce}
T_8	4.6^{Ab}	2.6^{Dk}	2.9^{Cd}	1.2^{Ef}	3.1^{Bc}
T_9	4.7^{Aa}	2.8^{Di}	3.4^{Ca}	1.9^{Ea}	4.6^{Ba}
T_{10}	4.5^{Ac}	2.5^{Dl}	2.7^{Cf}	1.2^{Ef}	3.0^{Bd}
T_{11}	4.6^{Ab}	3.9^{Be}	2.7^{Df}	1.4^{Ed}	3.1^{Cc}
T_{12}	4.5^{Ac}	3.9^{Be}	2.1^{Dh}	1.3^{Eef}	3.1^{Cc}
T_{13}	2.9^{Bf}	3.4^{Ah}	2.6^{Cg}	1.0^{Dg}	2.9^{Be}
T_{14}	3.0^{Ac}	2.8^{Ci}	2.7^{Df}	1.4^{Ed}	2.9^{Be}
T_{15}	2.9^{Af}	2.5^{Cl}	2.7^{Bf}	1.4^{Dd}	2.9^{Ae}
T_{16}	2.2^{Cg}	2.6^{Bk}	2.6^{Bg}	0.9^{Dh}	2.9^{Ac}
Mean	4.1^{A}	3.4^{B}	2.8^{D}	1.3^{E}	2.9^{C}

(5.7%) in *H. ulmarius* whereas the lowest content (3.9 %) was obtained from T_{11} (10% vermiwash) and T_{16} (control).

In *P. florida, P. tuber-regium* and *H. ulmarius* all treatments with organic amendments showed positive results with increased P content (Table 5). Paddy straw amended with 5 per cent and 10 per cent vermiwash (T_{10} and T_{11}) gave the highest P content in *P. florida* (0.97 and 0.96 %, respectively) whereas in *P. tuber-regium* the maximum P content (0.56%) was obtained from T_2 (5% rice bran) and T_9 (6 per cent dry azolla). The P content of *H. ulmarius* was significantly higher in T_6 (5 % *Neem* cake) with 0.91 per cent of phosphorus. Paddy straw amended with 4 per cent dry azolla (T_7) gave maximum content of P in *P. sajor-caju* (0.75%) whereas in *P. eous* the highest quantity (0.86%) was recorded from paddy straw amended with 6 per cent rice bran (T_3).

The study indicated that the K content of oyster mushrooms significantly varied with treatments and species (Table 6). K content of *P. florida, H. ulmarius, P. eous* and *P. tuber-regium* were significantly higher in T_9 (6 % dry azolla) with 4.7, 4.6, 3.4 and 1.9 per cent, respectively while in *P. sajor-caju*, the maximum K content (4.5%) was obtained fromT_2 (5% rice bran). This increase in major nutrients can be attributed to the modified chemical composition of paddy straw due to the addition of organic amendments, which favoured enzyme activity of mushrooms so as to degrade and utilize the major elements present in the substrate. Difference in mineral content of mushroom not only depended on mushroom species but also depended on organic used. That was due to mineral concentration of organic amendments. Similar results were obtained during the cultivation of *P. sajor-caju* on paddy straw amended with cow dung biomanure (Banik and Nandi, 2004). They found that the quantity of elements like P, Na, K, Ca, Fe, Zn and Cu increased in mushrooms grown on paddy straw amended with cow dung biomanure.

REFERENCES

Badu, M., Twumasi, S.K. and Boadi, N.O. (2011). Effect of lignocellulosic in wood used as substrate on the quality and yield of mushrooms. *Food Nutr. Sci*., **2** : 780-784.

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. *AZ.,* **20**: 311-319.

Bhaskaran, T.L., Sivaprakasam, K. and Kandaswamy, T.K. (1978). Compact bag method- A new method of increasing the yield of *Pleurotussajor-caju.Indian. J. Mush*., **4**: 10.

Cohen, R., Persky, L. and Land Hadar, Y.(2002). Biotechnological applications and potential of wood-degrading mushrooms of the genus *Pleurotus. Appl. Microbiol. Biotech*., **58**: 582-594.

Freed, R. (1986). *MSTAT Version 12*. Department of Crop and Soil Sciences. Michigan State University, 168pp.

Hedge, J.E. and Hofreiter, B.T. (1962). *Carbohydrate chemistry 17*, Whistler, R.L. and Bemiller, J.N. (eds.), Academic Press, New York, U.S.A., pp. 122-134.

Kaushlesh, K.Y., Neelima, G., Shukla, P.K., Kumar, S. and Preeti, Y. (2012). Preliminary studies on utilization of fruit waste composts for production of Oyster mushroom, *Pleurotus florida* (Mont.) Singer. *Mushroom Res.,* **21**: 75-78.

Moonmoon, M., Shelly, N.J., Khan, M.A., Uddin, M.N., Hossain, K., Tania, M. and Ahmed, S. (2011). Effects of different levels of wheat bran, rice bran and maize powder supplementation with saw dust on the production of shiitake mushroom [*Lentinusedodes* (Berk.) Singer]. *Saudi. J. Biol. Sci*., **18** (4) : 323–328.

Oyetayo, V.O. and Ariyo, O.O. (2013). Micro and macronutrient properties of *Pleurotusostreatus* (Jacq:Fries) cultivated on different wood substrates. *Jordan J. Biol. Sci*., **6**: 223-226.

Sadasivam, S. and Manickan, A. (1992). *Biochemical methods*.2nd Ed. New Age International Private Ltd. Publishers, New Delhi, India, 256pp.

Sameera, P. (2007). Diseases of milky mushroom (*Calocybeindica* P and C) and their management. M.Sc. (Ag.) Thesis, Kerala Agricultural University, Thrissur (Kerala) India, 118pp.

Shashirekha, M.N., Rajarathnam, S. and Bano, Z. (2002). Enhancement of bioconversion efficiency and chemistry of the mushroom *Pleurotussajor-caju* (Berk and Br.) Sacc.produced on spent rice straw substrate supplemented with oilseed cakes. *Fd. Chem*., **92**: 255-259.

Shashirekha, M.N., Rajarathnam, S. and Bano, Z. (2005). Effects of supplementing rice straw growth substrate with cotton seeds on the analytical characteristics of the mushroom, *Pleurotusflorida* (Block and Tsao). *Fd. Chem*., **92**: 255-259.