

INFLUENCE OF SOME AGRICULTURAL WASTES ON GROWTH, YIELD AND NUTRITIONAL VALUES OF WINTER MUSHROOM (*Flammulina velutipes* (Curtis) Singer)

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ABSTRACT

The present experiments were carried out during two successive seasons of 2007-2008 and 2008-2009 at the Mushroom Research Lab., Faculty of Agriculture, Cairo University. A mushroom strain of *Flammulina velutipes* (Curtis) Singer used in this study was provided by Fujian Agricultural University, China. This study aimed to achieve the following goals:

- 1- Using some agricultural wastes; *i. e.*, rice straw, wheat straw, Faba bean stalks and maize cobs as well as soft sawdust for the cultivation of a strain of *Flammulina velutipes*.
- 2- Determine the effect of these wastes on growth parameters and yield.
- 3- Evaluate the produced mushroom fruit bodies for their nutritional value.

Maize cob wastes caused the highest values of total yield first and second flush weight as well as biological efficiency and number of days from spawning till first flush. Meanwhile, rice straw resulted in the lowest first flush percentage weight of clusters and branches. Weight of clusters was the highest when grown in maize cobs. Rice straw caused the lowest values of number and weight of clusters and branches. *Flammulina velutipes* grown on Faba bean stalks recorded the highest values of crude protein and fibers. Meanwhile, maize cobs resulted in the highest values of total carbohydrates.

It was observed that there were changes in the chemical components of the substrates after cultivation as compared to those before cultivation. Crude protein and ash increased after cultivation. Meanwhile, fibers, fats, and total carbohydrates decreased after the substrate cultivation.

Key words: *cultivation ,Flammulina velutipes, yield .*

1 .INTRODUCTION

Mushrooms have been treated as a special kind of food, since earliest times. They also have been considered as the oldest microbial food (Kurtzman, 1974). Ancient Egyptians, Chinese and Japanese were probably the first people who professionally cultivated mushrooms (Vangriensven, 1988). Also, Singh (2000) mentioned that, since, a major part of lignocellulosic wastes are burned resulting in multi effect hazards including oxygen deficient in the environment, respiratory diseases and poor visibility at night, cultivation of mushroom on the lignocellulosic wastes is an effective methodology for production of nutritional food and better lignocellulosic waste management. Worldwide production of cultivated mushrooms has been increased at an accelerated rate because they are delicious, nutritious, and have health stimulating properties (Yamanaka, 1997). Nanagulyan (2000) reported that, proposed waste-free technology of growing *Flammulina velutipes* allows to get a

valuable food product as well as some additional feeding materials for livestock. Agricultural and industrial wastes are available in large quantities all over the world, and have a different chemical composition that was studied by many authors in this connection . These wastes are usually suitable for mushroom cultivation as a single or could be adjusted to be suitable by mixing more than one of them or even by addition of some supplements (Hassan, 2002). Venkatroman *et al.* (1989). reported that, rice straw was found to be a better substrate for the bioconversion by *F. velutipes* than other straw. Royse (1995) stated that sawdust mixed with rice bran could be used as a favorable substrate for *F. velutipes* cultivation. Also, Zhanxi and Zhanhua (2001) mentioned that *F. velutipes* utilizes various kinds of materials such as sawdust, agricultural byproducts(cereal straw, cotton seed residue). Moreover, Hong *et al.* (2001) cultivated some strains of *F. velutipes* on media consisting of maize straw.Hassan(2002) observed that the mycelium growth rate differed on the rice

straw, wheat straw, bean stalks, corn cobs and sawdust. The substrate affected the yield and biological efficiency of *F. velutipes* (Lu *et al.* 1989, Xiong and Jiang, 1999, Zhanxi and Zhanhua, 2001, Pawalk *et al.*, 2001). Variations in the chemical composition of mushroom were affected by substrates (Madbouly, 1987, Madbouly *et al.*, 1993 and Khaled, 1997).

1.1. Moisture content: Crisan and Sands (1978) found that the moisture content of fresh *F. velutipes* was 92%. Sheng *et al.*, (1997) reported that, the moisture content of 11 strains of *F. velutipes* cultivated in different media (rice straw, wood dust, corn cob and cotton seed husk) ranged from 82- 89%.

1.2. Total protein content: Crisan and Sands (1978) found that the protein content of *F. velutipes* was 25.11% on dry weight basis. Tonomura, (2001) stated that *F. velutipes* contained 31.2% protein (on dry basis). Stamets and Chilton (1983) recorded that the protein content for *F. velutipes* fruit bodies grown on different media was 24.5% on the average (dry weight basis). Sheng *et al.* (1997) showed that, the protein content was found to be ranged from 8.39% - 11.8% (on dry weight basis) according to the cultivation media. The highest protein content was recorded in the fruit bodies grown on rice straw, while the lowest amount was found in those grown on cotton seed husk. Yang *et al.* (2001) found that *F. velutipes* contained 20 and 26.7% crude protein (on the dry basis).

1.3. Crude fiber: Mushrooms contain relatively large amount of crude fiber. Fibers are considered a part of a healthy diet (Oei, 1991) Crisan and Sands (1978) mentioned that, *F. velutipes* fruitbodies contained 3.7% crude fiber. Whereas Yang *et al.* (2001) found that crude fiber of *F. velutipes* was 15 and 16.98% on dry basis for white and yellow strain, respectively.

1.4. Ash and minerals: Crisan and Sands (1978) mentioned that, *F. velutipes* fruit bodies contained 7.4% ash (on the dry weight basis) while, a higher amount of ash content being 10.2% was recorded by Yuexin (1999) for *F. velutipes* mushroom. As for minerals in the fruit bodies of *F. velutipes* mushroom, Crisan and Sands (1978) mentioned that, Calcium, phosphorous, iron, sodium and potassium were presented in this mushroom at 12, 171, 4, 19 and 380 mg/100g dry matter, respectively.

In Egypt, enormous quantities of agricultural by-products are produced annually. Rice straw, wheat straw, maize stalks, and other cereal straws, besides sugar cane bagasse are the most local agricultural wastes. The total quantity of the aforementioned agricultural wastes produced in Egypt 2002 reached about 17 million tons. (Agricultural Statistics Report, 2003, Ministry of Agriculture, Egypt).

F. velutipes mushrooms have been newly obtained from China for their cultivation on local cheap organic wastes. So, the present study aimed to achieve the following goals:

- 1- Using some agricultural wastes; *i.e.*, rice straw, wheat straw, faba bean stalks and cob maize as well as soft sawdust as industrial waste for cultivation of mushroom strain.
- 2- Determine the effect of agricultural wastes on the growth parameters and yield of the tested mushrooms.
- 3- Evaluate the produced mushrooms for its nutritional value.

2. MATERIALS AND METHODS

Mushroom strain of *Flammulina velutipes* (FC01) was obtained by Fujian Agricultural University, China. The present work was carried out in the Vegetable Crops Department, Mushroom Researches Lab. Faculty of Agriculture, Cairo University, during the two successive seasons 2007- 2008 and 2008- 2009 in 15th November in both seasons.

2.1. Substrates

Various agricultural wastes were obtained from the Experimental Farm of the Faculty of Agriculture, Cairo University, as follows:

- | | |
|---------------------|----------------|
| 1- Rice straw | 2- Sawdust |
| 3- Faba bean stalks | 4- Wheat straw |
| 5- Maize cobs | |

2.2. Substrates container

Plastic bags were also used 25×30 cm. Each contained 1kg of wet substrate.

2.3. Preparation of growing substrate

Various agricultural wastes were chopped, water was added until its moisture ranged between 60-70%. Wheat bran and limestone were added (5% for each), sterilized for 45 minutes under 1.5 pressure atmosphere at 121 °C in the autoclave and cooled to room temperature. (Leong, 1980).

2.4. Substrate inoculation

Upon cooling to room temperature 2%(w/w) spawn was mixed with the substrate in the containers, each container holds 1kg of substrates. The containers were transferred to dark incubation room and left for 30 days. At the end of the incubation period, the bags were opened, the

substrates were covered by dense mycelium growth.

2.5. Induction of fruiting bodies

After completion of the spawn run, the environmental changes to be suitable for inducing fruiting body. The bags were exposed to light by cutting away the top of the bags. The relative humidity was raised to 80-90%.

2.6. Harvesting

The mushroom fruiting bodies were harvested up on reaching maturity, at which the fruiting bodies start to "curl up". At this stage, the fruiting bodies were picked up in flushes. Data were recorded on the following characters:

- 1- Number of days from spawning to the first flush.
- 2-Weights of fruiting bodies of first flush in (g).
- 3- Total yield weight of all fruiting bodies picked during the whole period of growth in (g).
- 4- Percentage of the first flush to total yield was calculated according to the following equation:

Yield of the first flush

$$\frac{\text{Yield of the first flush}}{\text{Total yield}} \times 100$$

- 5- Biological efficiency (BE): was estimated according to the following equation:

$$\frac{\text{Fresh weight of total yield}}{\text{Weight of dry substrates}} \times 100$$

2.7. Quality of fruiting bodies: The morphological characters

The following measurements were recorded on fruiting bodies of the first flush:

- 1- Average weight of fresh cluster of fruiting bodies in (g).
- 2- Number of branches in the cluster.
- 3- Fresh weight of branches of the cluster in (g).
- 4- Length (cm) and thickness (mm) of the stipes of the branches.
- 5- Diameter (cm) of capes.

2.8. Chemical characters

Samples were taken from full cap and stipes of the fruiting bodies, Mixed together and analyzed. The following measurements were taken:

2.8.1. Moisture

The moisture content was determined by keeping the sample in an oven at 105 °C till constant weight, according to (A. O. A.C. 1980).

2.8.2. Ash

The ash was determined according to (A. O. A. C 1980) by heating the sample in a muffle at 550 °C to constant weight.

2.8.3. Crude protein

Crude protein of mushroom was calculated from total nitrogen content as determined by the micro-kjeldahi method (A. O. A. C 1980), using the conversion factor (N ×6.25).

2.8.4. Crude fiber

Crude fiber content of mushrooms was determined according to the method of Chang and Quimio (1982).

2.8.5. Crude fat

Crude fat of mushroom was determined by Soxhlet procedure similar to the basic method described in A.O.A.C (1980) and modified by Chang and Quimio (1982).

2.8.6. Total carbohydrates

Total carbohydrates were calculated as follows.

Total carbohydrates= 100-(Moisture+ Ash+ Crude protein+ Crude fiber+ Crude fat) according to A.O.A.C. method (1980).

2.8.7. Chemical composition of substrates

Samples of the substrates were taken before spawning and after harvesting to determine moisture, crude protein, ash, crude fat, crude fiber and total carbohydrates.

2.8.8. Experimental design

Randomized complete block design with 3 replicates was adopted.

All data were statistically analyzed according to Gomez and Gomez(1984).

3. RESULTS AND DISCUSSION

The data presented in Table (1) indicate the effect of different substrates on the weight of total yield, first flush, second flush, number of days until first flush and the biological efficiency in both seasons. Data showed significant differences between substrates on the total yield, first flush, second flush and biological efficiency on both seasons. The best results on the previous characters were obtained by applying maize cobs followed by faba beans stalks and wheat straw then sawdust. Meanwhile rice straw caused the lowest values. As regarding to the first flush percentage, data showed significant differences between the substrates used to cultivate *Flammulina velutipes* in both seasons. Using rice straw resulted in the highest values followed by faba bean stalks or wheat straw then sawdust. On the other hand, the lowest values were obtained by applying maize cobs. Results of the present work are in agreement with those obtained by Stamets and Chiltion (1983), Lu *et al.* (1989), Xiong and Jiang (1999), Oei (1991) and Tonomura (2001). They found that the yield of *F. velutipes* was equivalent to 20-37% of the initial wet weight of the substrate . Ghada (2004) found that the yield of the first flush represented 51-72% of the total

yield of *F. velutipes*. as reported by Flegg (1997) and Hassan (2002). Also, Xiong and Jiang (1999) found that the total yield of *F. velutipes* ranged from 193-213g when grown on different substrates. Tange *et al.*(2001) reported that rice straw substrate gave the lowest yield.. Zhang *et al.* (2001) obtained a BE of 112% when cultivated *F. velutipes* on cotton seed hulls. Meanwhile, Stamets (1993) recorded higher BE of 150% for *F. velutipes*.

Zou *et al.* (2005) found that all growth promoting agents markedly accelerated hyphal growth of the fungus and increased its yield. An optimum combination was identified, which shortened vegetative growth period by 4-6 days and increased the biological efficiency by 55.08%. Sharma *et al.* (2006). indicated that the addition of wheat bran to the sawdust medium enhanced the activity levels of endo-glucanase, exo-glucanase, xylanase and laccase, whereas the addition of cotton seed cake and deoiled soybean resulted in decrease activity of these enzymes. Wheat bran and deoiled soybean, at the proportion of 10% were the best supplements for mycelial growth of *F. velutipes*. The addition of wheat bran to the medium caused an increased biological efficiency and quicker spawn running than in the control medium, whereas poor spawn running and no fruiting-body formation were recorded in the medium enriched with cottonseed cake, soybean meal, or deoiled soybean and found that the incorporation of 10% wheat bran into sawdust resulted in the most rapid spawn run and the highest biological efficiency (37.5%).

3.1. Days from spawning until first flush

The effect of substrates on the number of days from spawning till the first flush (Table 1) was not significant in the first season. In the second season, there were significant differences between the substrates applied to cultivate *Flammulina*. Sawdust caused the lowest number of days from spawning till the first flush. *Flammulina* cultivated on maize cobs recorded the highest number of days. The above mentioned results could be attributed to, that maize cobs are richer in nutrients than sawdust, which encourage mycelium growth. Bahl (1994) reported that grain spawn is easier to plant than other materials and the mycelium growth was faster when using grain. On the other hand, saw dust contains many complex compounds such as lignin and resins which altered the growth of mushroom mycelium. The present results are coinciding with those reported by Tonomura (2001). Also, Stamets and Chilton (1983) recorded that the media consisted of 4 parts of sawdust plus one part of bran gave good results. The same authors' (1983)

and Oei (1991), stated that at spawn running temperature of 22-26 °C and relative humidity of over 90%, the incubation times of *F. velutipes* ranged from 20 to 30 days. Regarding the fruiting bodies development time, these results coincide with those reported by Stamets (1993), who found that fruiting body development for *F. velutipes* took 5-8 days. Tonomura (2001) found that incubated *F. velutipes* bags fruited after 12-14 days. From the present data, it could be concluded that, the type of media had an obvious effect on incubation period of *F. velutipes* and a slight effect on pin heads appearance and fruit bodies developmental time.

3.2. Quality of first flush

3.2.1. Cluster number of first flush

Data represented in Table (2) indicate that the effects of different substrates on cluster number of first flush were significant in both seasons. The highest numbers of clusters were obtained with the application of wheat straw or faba bean stalks followed by maize cobs then sawdust, meanwhile rice straw resulted in the lowest values.

3.2.2. Weight of clusters, number and weight of branches

In both seasons, significant differences were detected in the weight of clusters and the weight of branches (Table 2).

3.2.3. Cultivation of *Flammulina velutipes*

In maize cobs caused the highest values of weight of branches followed by sawdust or faba bean stalks, then wheat straw. Meanwhile rice straw resulted in the lowest values. Sawdust caused the highest values of the number of branches while rice straw caused the lowest values.

3.3. Stem length

Data in Table (3) indicate that there were significant differences between substrates on stem length in both seasons. *Flammulina* mushroom cultivated in maize cob substrates had the tallest stems followed by wheat straw and rice straw without significance between them, then faba bean stalks. Stem length recorded the lowest values when grown in sawdust substrates.

3.4. Stem thickness

The effect of different substrates on stem thickness in the first season was not significant, while it was significant in the second season. Stem thickness gave the lowest values when cultivated in maize cobs substrate.

F. velutipes mushroom had round small white cap, central over long stem and grown in clusters. Also, the data prove that fruit bodies of *F. velutipes* had pleasant odor. The gills were white, while stems were white and the lower part of the stems turned yellow to brown by age. The cap

Table (1): Effects of substrates on the total yield (g), first flush (g), % first flush, second flush (g), BE % and N. days from spawning till first flush of *F. velutipes*.

First season (2007-2008)						
Substrates	T. Yield	First flush	First flush. %	Second flush	BE%	N. days from spawning till first flush
Rice straw	33.70	31.34	92.90	2.36	12.52	60.70
Wheat straw	100.00	78.74	78.80	21.34	31.15	60.30
Maize cob	208.10	135.10	65.00	73.00	62.87	60.30
F. bean stalks	108.30	85.90	79.40	22.47	30.92	59.70
Sawdust	78.40	57.81	73.90	20.57	30.41	59.30
LSD 5%	11.13	13.44	10.67	15.23	3.18	N.S.
Second season (2008-2009)						
Substrates	T. yield	First flush	First flush. %	Second flush	BE %	N. days from spawning till first flush
Rice straw	31.90	29.10	91.80	2.80	12.36	60.30
Wheat straw	105.10	83.26	79.29	21.84	33.28	59.60
Maize cob	212.60	149.10	70.10	63.26	64.63	61.00
F. bean stalks	119.50	94.14	80.50	23.35	35.36	60.70
Sawdust	80.30	60.88	75.60	19.42	30.02	59.00
LSD 5%	8.25	11.83	6.69	10.05	4.22	0.81

Table (2): Effects of substrates on the number of clusters, weight of clusters (g), number of branches and weight of branches (g) of *F. velutipes*.

First season (2007-2008)				
Substrates	N. clusters	W. clusters	N. branches	W. branches
Rice straw	2.81	11.14	7.60	1.46
Wheat straw	5.22	15.09	8.53	1.78
Maize cob	3.93	34.54	16.59	2.08
F. bean stalks	4.85	17.70	10.48	1.70
Sawdust	3.10	19.49	10.51	1.85
LSD 5%	0.63	4.76	1.52	0.31
Second season (2008-2009)				
Substrates	N. clusters	W. clusters	N. branches	W. branches
Rice straw	2.58	11.30	7.58	1.50
Wheat straw	5.44	15.35	8.60	1.80
Maize cob	3.80	38.75	10.45	2.20
F. bean stalks	5.20	18.49	10.75	1.80
Sawdust	2.90	20.31	17.64	1.94
LSD 5%	0.52	3.42	1.07	0.40

Table (3): Effects of substrates on stem length (cm), cap diameter (cm), stem thickness (cm) of *F. velutipes*.

First season (2007-2008)			
Substrates	Stem length (cm)	Cap diameter (cm)	Stem thickness (cm)
Rice straw	11.00	2.09	0.32
Wheat straw	11.20	2.20	0.30
Maize cob	12.00	2.19	0.26
F. bean stalks	10.80	1.95	0.30
Sawdust	9.40	1.73	0.32
LSD 5%	1.08	N. S.	N. S.
Second season (2008-2009)			
Substrates	Stem length (cm)	Cap diameter (cm)	Stem thickness (cm)
Rice straw	11.10	2.01	0.31
Wheat straw	11.10	2.27	0.31
Maize cobs	11.80	2.18	0.25
F. bean stalks	1.70	1.97	0.29
Sawdust	9.10	1.96	0.30
LSD 5%	0.58	N. S.	0.03

diameter ranged from 1.7 to 2.3 cm. This result is within the range of the results obtained by Stamets (1993), 1-5 cm, Zhanxi and Zhanhua (2001), 0.8-1.5 cm and Tonomura (2001), 2-3 cm. Moreover, the results in the same Table (3) reveal that branches of fruit body weight ranged from 1.5 to 2.2(g). Also, stem length ranged between 10.5 and 19 cm and 0.2-0.5 cm for stem diameter. These results are within the range of the results obtained by Stamets and Chilton (1983); Oei (1991) and Zhanxi and Zhanhua (2001).

3.5. Chemical component and nutritive value

Fruit bodies of *F. velutipes* grown on different media were chemically analyzed for their content of moisture, crude protein, crude fiber, ash and total carbohydrates. Moisture content of mushroom fruit bodies represents the major component in their chemical composition. The chemical component and nutritive value were affected by different substrates, (Table 4).

3.5.1. Moisture percentage

There were significant differences in moisture (%) between mushrooms cultivated in different substrates. Sawdust substrate caused the highest content of moisture percentage, while faba bean stalks resulted in the lowest values in both seasons. The present results are in good agreement with the range of the data obtained by Crisan and Sands (1978), and Yuexin (1999). They found that *F. velutipes* fruit bodies contained (88.7-92%) moisture. Sheng *et al.* (1997) stated that moisture content was recorded (82-89%) when *F. velutipes* were cultivated on rice straw, sawdust, corn cobs and cotton seed husk.

3.5.2. Crude protein percentage

Flammulina mushroom grown on faba bean stalks recorded the highest crude protein percentage followed by wheat straw, white maize cobs followed by sawdust substrates resulted in the lowest values in both seasons. Many authors, found that the protein content of *F. velutipes* was 20.11-33.20% (Crisan and Sands, 1978, Fujihara *et al.*, 1995 and Zhanxi and Zhanhua, 2001).

3.5.3. Fiber percentage

cultivated in sawdust or faba bean stalks substrates had the highest fiber percentage content in the first and the second seasons, respectively. On the other hand, *Flammulina velutipes* grown in wheat straw recorded the lowest values in both seasons. Also, Crisan and Sands (1978) recorded that *F. velutipes* fruit bodies contained 3.7% crude fiber. Similarly, Tonomura (2001) stated that the crude fiber content of *F. velutipes* was 3.3% on dry weight basis while Kurusawa *et al.* (1982) recorded 12.2% crude fiber on dry weight basis.

3.5.4. Ash percentage

There were significant differences between ash percentage content of *Flammulina* mushrooms grown in different substrates (Table 4).

The highest values of ash percentage were obtained from mushrooms cultivated on sawdust followed by rice straw, while it recorded the lowest values when grown in maize cobs substrate in both seasons. Crisan and Sands (1978) mentioned that, *F. velutipes* fruit bodies contained 7.4% ash (on dry weight basis). Also, Tonomura (2001) stated that the ash content was 7.6% on dry weight basis. While, 10.2% was recorded by Yuexin (1999).

3.5.5. Crude fat percentage

Crude fat content of *Flammulina velutipes* was affected significantly by different substrates in the first season, while there was no significance in the second. The highest values were recorded by faba bean stalks followed by rice straw, while the lowest ones caused by maize cobs substrates. Crisan and Sands (1978) mentioned that, lipid contents of *F. velutipes* fruit bodies were 1.9% (on dry weight basis). Tonomura (2001) recorded 5.8% fat (on dry weight basis). Meanwhile, Koyama *et al.* (1984) found that the lipids content of *F. velutipes* was 6.9% on the dry matter. Meanwhile, Sheng *et al.* (1997) found that the lipids content ranged between 1.79-2.977%. On the other hand, higher lipid contents for *F. velutipes* were recorded by Yang *et al.* (2001) who found that the crude fat was 8.89 and 9.23% on the dry basis for white and yellow *F. velutipes* in succession.

3.5.6. Total carbohydrate percentage

Data presented in Table (4) show significant differences between the effect of substrates on total carbohydrates percentage of *Flammulina velutipes* in both seasons. Mushrooms grown on maize cobs contained the highest values of total carbohydrates. Crisan and Sands (1978) mentioned that the fruit bodies of *F. velutipes* contained 73.1% total carbohydrates.

Moreover, Sheng *et al.* (1997) found that the total carbohydrate content ranged from 43.33-61.21% according to mushroom strain and cultivation medium. Meanwhile, Yuexin (1999) demonstrated that the total carbohydrates content of *F. velutipes* fruit bodies (on dry weight basis) was 61.22%.

3.5.7. Chemical component of substrates after and before cultivation:

From the present data it was observed that there were changes in the chemical components of substrates after cultivation compared to substrates before cultivation. As shown in Tables (5 and 6) data indicate that there were significant differences between different substrates before

and after cultivation in both seasons. except in crude fat percentage in the second season which (1993), Aly (1994), Mohammady (1996), Khaled (1997) and Hassan (2002) who found that nitrogen

Table (4): Effects of substrates on the chemical components: protein, ash, fiber and total carbohydrates of *F. velutipes*

First season (2007-2008)						
Component% Substrates	Moisture	Protein	Fibers	Ash	Fats	T. carbohydrates
Rice straw	87.00	21.60	9.40	7.50	2.93	58.57
Wheat straw	88.40	23.40	7.00	7.20	2.18	60.27
Maize cob	85.80	19.10	8.40	6.80	1.88	63.87
F. beans stalks	84.50	24.30	12.50	7.36	3.00	52.84
Sawdust	89.20	21.40	12.60	8.00	2.10	55.90
LSD 5%	2.11	2.38	0.79	0.56	0.21	6.53
Second season (2008-2009)						
Component% Substrates	Moisture	Protein	Fibers	Ash	Fats	T. carbohydrates
Rice straw	88.10	22.10	9.00	7.30	2.79	58.81
Wheat straw	86.30	23.60	7.20	7.20	2.00	60.27
Maize cob	87.20	19.30	8.10	6.50	1.71	64.39
F. beans stalks	85.00	24.00	12.70	7.10	3.12	53.08
Sawdust	88.90	21.90	12.30	7.90	2.00	55.90
LSD 5%	1.91	0.87	0.52	0.86	N. S.	2.34

showed no significant difference. Maize cobs contained the highest values of moisture and total carbohydrate percentage in the substrates before cultivation. These results of moisture content are in agreement with those reported by Stamets and Chilton (1983), Stamets (1993) and Khaled (1997) who found that the moisture content of some agricultural and industrial wastes included rice straw, wheat straw, bean peels, sawdust and corn stalks ranged from 7.5 to 17.2 %. On the other hand, the presented results are higher than those found by Hassan (2002), who stated that rice, wheat, soybean straws and sawdust contained 6.99-9.58% moisture. Concerning the total carbohydrate, the data in the present study are in agreement with the values obtained by Heltay and Zavodi (1960), Gramss (1979) and Hassan (2002). They found that, the total carbohydrate of some wastes ranged from 48.8 to 55.88%. While after cultivation sawdust and rice straw substrates had the highest values of moisture percentage in the first and the second seasons, respectively. On the other hand, maize cobs and rice straw substrates contained the highest values of the total carbohydrate percentage in the first and second seasons, respectively. Faba bean stalks contained the highest values of crude protein in both cases after and before cultivation. These results are in accordance or nearly similar to those obtained by Kaul *et al.* (1981), Mehta *et al.* (1990), Stamets

content of faba bean stalks ranged from 0.9-1.14%. After and before cultivation sawdust had the highest values of fibers while wheat straw had the highest values of ash and fats. Concerning ash, the present results of ash content of sawdust are in accordance with that obtained by Mohammady (1996)3.02%. Before cultivation sawdust had the lowest values of moisture, crude protein, ash, crude fats and total carbohydrates percentage. While wheat straw contained the lowest values of fibers in both seasons. On the other hand, after cultivation sawdust substrates had the lowest values of crude protein, ash, fats and total carbohydrates in both seasons. Meanwhile, faba bean stalk substrate had the lowest moisture percentage in both seasons. Rice straw had the lowest values of fiber percentage after cultivation, in both seasons.

From the aforementioned results in the present study it could be concluded that:

- 1- Cultivation of *F. velutipes* mushrooms that are newly introduced to Egypt from China under the local environmental conditions on cheap lignocellulosic wastes is a very important achievement. Since, *F. velutipes* mushroom is highly prized for its nutritive and medical benefits.
- 2- In wastes, crude protein and ash increased. While fibers, fats and total carbohydrates percentage decreased after cultivation.

Table (5): Chemical component of substrates before cultivation.

First season (2007-2008)						
Component% Substrates	Moisture	Protein	Fibers	Ash	Fats	T. carbohydrates
Rice straw	8.50	4.60	30.80	14.10	2.10	48.40
Wheat straw	7.50	4.90	28.50	17.30	2.60	46.70
Maize cob	11.20	4.40	33.10	10.60	1.50	50.40
F. bean stalks	9.40	8.80	39.00	11.10	1.40	39.70
Sawdust	5.80	2.50	62.20	7.50	0.90	26.90
LSD 5%	0.51	0.74	7.91	4.40	0.45	1.66
Second season (2008-2009)						
Component% Substrates	Moisture	Protein	Fibers	Ash	Fats	T. carbohydrates
Rice straw	8.30	4.10	34.10	13.90	2.10	45.80
Wheat straw	7.10	4.80	30.90	16.80	2.40	45.10
Maize cob	11.30	4.20	34.40	11.30	1.60	48.50
F. bean stalks	9.20	8.10	38.80	10.70	1.40	41.00
Sawdust	5.30	2.20	58.00	6.80	1.10	31.90
LSD 5%	0.87	0.55	6.35	1.31	0.35	6.41

Table(6): Chemical component of substrates after cultivation *F. velutipes*.

First season (2007-2008)						
Component% Substrates	Moisture	Protein	Fibers	Ash	Fats	T. carbohydrates
Rice straw	73.10	9.40	25.70	32.50	1.30	31.10
Wheat straw	67.90	10.60	33.60	37.10	1.30	27.40
Maize cob	66.90	7.20	28.50	30.50	0.80	33.00
F. bean stalks	65.00	12.10	33.50	30.50	1.00	22.50
Sawdust	74.20	5.90	49.80	27.50	0.50	16.30
LSD 5%	1.58	0.38	5.44	2.43	0.23	3.02
Second season (2008-2009)						
Component% Substrates	Moisture	Protein	Fibers	Ash	Fats	T. carbohydrates
Rice straw	74.20	9.20	23.10	31.10	1.20	35.40
Wheat straw	68.40	10.10	35.20	35.20	1.40	28.10
Maize cob	67.10	7.00	27.80	30.90	0.80	33.50
F. bean stalks	66.20	11.90	34.30	32.10	1.00	20.70
Sawdust	73.10	5.20	47.60	26.90	0.60	19.80
LSD 5%	2.22	0.99	2.59	3.55	N. S.	2.48

4. REFERENCES

- A. O. A. C. (1980). Official Methods of Analysis of the Association of Analytical Chemists, 14th ed, Washington, D.C., U.S.A.
- Aly A.Z.M. (1994). Biochemical Studies on the Utilization of Agricultural Wastes for Growing Some Mushroom Species. Ph.D. Thesis, Fac. of Agric., Cairo Univ. 233pp.
- Bahl N. (1994). "Handbook on Mushrooms" 3rd ed. Published by Oxford & IBH Publishing Co. PVT. LTD, New Delhi, India.
- Chang S. T. and Quimio T.H. (1982). Tropical Mushrooms. Biological Nature and culture Method. The Chinese Univ. Press. Hong Kong.
- Crisan E. and Sands A. (1978). Nutritional value in "Biology and Cultivation of Edible Mushrooms" Editors: S.T. Change and W. A. Hayes. p. 137-187. Publishing by Academic Press Inc. U.S.A.
- Flegg P. (1997). Micro-organisms in the substrate. The Mushroom Journal, 566: 24-25.
- Fujihara S., Kasuga M., Aoyagi Y. and Sugahara T. (1995). Nitrogen to protein conversion factors for some common edible mushroom. Journal of Food Science, 60(5) 1045-1047.
- Ghada M. M. (2004). Production and Processing of *Flammulina velutipes* and *Lentinus edodes*. Ph. D. Thesis, Fac. of Agric., Cairo Univ. 240pp.

- Gomez K. A and Gomez A. A (1984). Statistical Records for Agric. Res. 2nd. Ed. John Wiley&Sons. Bup. p. 139-153.
- Gramss G. (1979). Some differences in response to competitive microorganisms deciding on growing success and yield destroying edible fungi. *Mushroom Science*, 10 (1): 265-285.
- Hassan F. R. H (2002). Studies on Bioconversion of Some Agricultural Wastes Using *Pleurotus* and *Agaricus* mushrooms. Ph. D. Thesis, Fac. of Agric, Cairo Univ., Egypt. 189 pp.
- Heltay I. and Zavodi I. (1960). Rice straw compost. *Mushroom Sci.*, 4:393-399.
- Hong J., Wang, H., Hui Z. O., Hong H., Wei J. and Zhang W. (2001). Preliminary researches on *Flammulina velutipes*, and *Ganoderma lucidum* cultivation using maize straw. *Edible Fungi of China*, 20 (6): 11-12.
- Kaul T., Khurana M. and Kchroo J. (1981). Chemical composition of cereal straw of the Kashmir Valley. *Mushroom Sci.*, 11 (2): 19-25.
- Khaled A. M. (1997). Studies on the Production and Evaluation of Oyster Mushroom. Ph. D. Thesis. Fac. of Agric. Cairo. Univ. 212p.
- Koyama N., Aoyagi Y. and Sughara T. (1984). Fatty acids composition and ergosterol contents of edible mushrooms. *J. Jap. Soc. Food Sci. Technol.* 31:732-738.
- Kurtzman R.H.(1974). The metabolism of fatty substances by the oyster mushroom. Proc. of the 9th International Scientific Congress on the Cultivation of Edible Fungi .Tokyo; 557-565.
- Kurusawa S., Sugahara T. and Hayashi J. (1982). Studies on dietary fiber on mushrooms and edible wild plants., *Nutr. Rep. Inc.*, 26: 167-173.
- Leong P. C. (1980). Utilization of cotton waste substrate with treatment for the cultivation of Oyster mushroom. (*Pleurotus*). In Singapore. *Journal of Primary Industries* 8 (1): 21-27. (c. a. Hort. Abst. 51, 8, 6295, 1981).
- Lu Q. G., Gui Y. M. and Tong X. L. (1989). Mycelium growth and mushroom yield of *Flammulina velutipes* on different culture media. *Jiangsu Agricultural Sciences.*, (3): 26-27.
- Madbouly F. H. (1987). Some Studies on Cultivation and Preservation of Mushrooms. Ph. D. Thesis, Fac. of Agric., Cairo Univ. 205pp.
- Madbouly F. H., Farrag A. M. and Khoreba A. H. (1993). Chemical constituents of mushroom (*Pleurotus* spp.) as affected by substrate, strains and their interaction. Fifth Arab Conf. of Food Sci. & Tec. 583-601 .
- Mehta V., Gupata J. K. and Kaushal S. C. (1990). Cultivation of *Pleurotus* mushroom on rice straw and biogas. Production from spent straw. *World Journal of Microbiology and Biotechnology*, (6): 36-370.
- Mohammady T. F. (1996). Utilization of Organic Wastes for Cultivation and Production of Mushroom. Ph. D. Thesis, Faculty of Agriculture, Ain Shams Univ. 245pp.
- Nanagulyan S. G. (2000). Applied researches on edible mushrooms in the republic of Armenia Proceeding the 15th International Congress on Science and Cultivation of Edible Fungi, Edited by L. J. L. D- Van Griensven, 15-19 May, Maastricht/ Netherlands, Volume II: p. 783-787.
- Oei P. (1991). "Manual on Mushroom Cultivation" First Published by Tool Publication. Amsterdam, The Netherland. , Volume II: pp. 511-604.
- Pawalk R., Siwulski M., Kosson R., Szwe J. J. and Gorecka K. (2001). The effect of different cultivation media on the yield of *Flammulina velutipes* (Curtis: Fries) singer. Biological and agrotechnical aspects of vegetable crops management. Proceedings of National Polish Vegetable Crops Conference, Skierniewic, Poland, 21-22 June 2001. *Vegetable Crops Research Bulletin*. 2001, 54 (2): 93-96.
- Royse D. J. (1995). Specially mushrooms cultivation on synthetic substrate in the USA and Japan. *Mushroom News*, May, 4-19.
- Sharma V.P.S.R and Satish K. (2006). On the productivity of *Flammulina velutipes*. *India, Mushroom Research*. (2006). 15:2, 129-134.
- Sheng J. W., Jia S. M., Wu J. J. and Jia J. H. (1997). Nutritional composition of *Flammulina velutipes*. *Edible-fungi-of China.*; 16 (5): 36-38.
- Singh M. P. (2000). Biodegradation of lignocellulosic wastes through cultivation of *Pleurotus Sajor-caju*. Proceeding the 15th International Congress on Science and Cultivation of the Edible Fungi, Editions by L. J. L-D. Van Griensven, 15-19 May, Masstricht/ Netherland, Volume II p. 517-521.
- Stamets P. (1993). "Growing Gourmet and Medicinal Mushrooms" Published by, Ten Speed Press, Berkeley, CA 94707.
- Stamets P. and Chilton J. S. (1983). "The Mushroom Cultivar": A Practical Guide to

- Growing Mushrooms at Home. Agaricon Press, Olympia, Washington.
- Tange Z. N., Bian G. Q., Zhang M., Yang H. B and Yu J. H. (2001). Studies on cultivating *Flammulina velutipes* (Fr) Sing with paspalue Notatum flugge Edible Fungi of China 20 (4): 10-12.
- Tonomura (2001). *Flammulina velutipes* in "The Biology and Cultivation of Edible Mushrooms" Editors.: S. T. Change and W. A. Hayes. 410-420 pp. Publisheing by Academic Press. Inc. U. S. A.
- Vangriensven. L. J. L. D. (1988). The Cultivation of Mushrooms, 1st (ed). published in co-operation with and sponsored by Darlington Mushroom Laboratories LTD, Rustington, Sussex, England.
- Venkatroman K., Kisha S. and Gupta B. N. (1989). Changes in composition of straw on treatment with *Callybia Velutipes* and *Coprinus fietoriumsm*. Indian Journal of Animal Nutrition, 6 (4): 307- 316.
- Xiong H. and Jiang X. J. (1999). Studies on culture of *Flammulina velutipes* with quail ordure. Research of Agricultural Modernization. 20, (2): 125-127.
- Yamanaka K. (1997). Production of cultivated edible mushrooms. Food Reviews International, 13(3): 327-333.
- Yang X. B., Xiong W. P. and Chamba C. (2001). Comparative trials on six *Flammulina velutipes* strains introduced to Tibet. Edible Fungi of China. 20 (2): 11-12.
- Yuexin L. (1999). Instant notes in edible fungi. International training class Jun-Cao Technology Institute, Fujian Agricultural Univ. China.
- Zhang D. J., Jun W.Q., Dang, J.Z., Ge G. and Wu Q .J.(2001). Studies on row material culture and physiology of white *Flammulina velutipes*. Chinese Research of Agricultural modernization .22(5):230-241.
- Zhanxi L. and Zhanhua L. (2001). The Textbook for International Training Class, Jun-Cao, Fujian Agricultural Univ. China.
- Zou X.Y., Zhao H. B., Qiao D. and Li S. M. (2005). Optimization of the combinations of growth-promoting agents for *Flammulina velutipes*. China; Plant Protection, 31(5):3 48-352. 3 ref.

تأثير بعض المخلفات الزراعية على نمو وانتاج والقيمة الغذائية *Flammulina velutipes* (Curtis) Singer لعيش الغراب

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ملخص

تم دراسة تأثير بعض المخلفات الزراعية على نمو وانتاج والقيمة الغذائية لعيش الغراب *Flammulina velutipes* حيث اجريت التجربة فى موسمين 2007/2008 و2008/2009 فى كلية الزراعة - جامعة القاهرة واستخدمت بيئات قش الارز وتبن القمح و مخلفات الفول البلدى وقوالح الذرة ونشارة الخشب كبيئات لنمو *F. velutipes* وكانت اهم النتائج المتحصل عليها هى:-

اعطت بيئة قوالح الذرة اعلى قيمة فى الانتاجية والكفاءة الانتاجية ووزن المجاميع وعدد الايام من التلقيح حتى القطفة الاولى وكذلك اعطت اعلى نسبة مئوية للكربوهيدرات الكلية فى كلا الموسمين. اما بيئة قش الارز فقد اعطت اقل قيمة فى انتاج النسبة المئوية للقطفة الاولى ووزن المجاميع وعدد الافرع للقطفة الاولى.

اعطت بيئة مخلفات الفول البلدى اعلى قيمة من البروتين الخام والالياف بينما اعطت قوالح الذرة اعلى قيمة فى للكربوهيدرات الكلية.

لوحظ حدوث تغير فى التحليل الكيمايى للبيئة بعد الزراعة بالمقارنة بقبل الزراعة حيث وجد ان الالياف والدهون والكربوهيدرات الكلية تقل بعد الزراعة بينما تزداد نسبة البروتين والرماد.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (61) العدد الثالث (يوليو 2010): 299- 308.