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Cultivation of the Monkey Head Mushroom (*Hericium erinaceus*) in Egypt

Hassan, F.R.H.

Food Tec. Res. Inst., Agric. Res. Center, Giza, Egypt.

Abstract: *Hericium erinaceus* a Chinese edible and medicinal mushroom(newly introduced to Egypt from China) was grown under local conditions in Egypt using the available lignocellulosic wastes as growing media. Incubation time, yield, biological efficiency (BE%) were determined through three consecutive growing seasons. Also, chemical composition of fruit bodies were estimated. The incubation time for the tested growing media ranged from 37 to 46 days.The highest yield of *H. erinaceus* (184 g /1 kg media)and BE 50.3 %were obtained when grown on sawdust. Also, using a mixture of sawdust with wheat straw as growing medium gave a good yield (165g/ 1kg medium) and BE of 46.5%. *H. erinaceus* mushroom grown on different media in Egypt contained 24.07 – 26.8 % crude protein. Cultivation of *H. erinaceus* in Egypt is a very important achievement, since this mushroom type is highly prized for their nutritive and medicinal benefits.

Keywords: Monkey head, *Hericium,erinaceus*, cultivation, mushroom, yield, media

INTRODUCTION

Mushrooms provide a highly nutritious source of food and, more recently, attention has focused on second area of exploitation following the discovery that, many of these mushrooms produce arange of metabolites of intense interest to the nutriceutical and pharmaceutical (e.g. anti-tumor, immunomodulation agents and hypocholesterolaemic agents) and food (e.g. flavor compounds) industries. Most mushroom species, if not all, contain biologically active polysaccharides. The data demonstrated there are 660 species from182 genera of mushrooms containing antitumor or immunostimulating polysaccharides.Fruiting bodies, submerged cultivated mycelial biomass and liquid cultivated broth are sources of the bioactive compounds [1].

Mizuno, [2], reported that, polysaccharides (HEPS) in the fruiting bodies of *H. erinaceus* may have beneficial effects against stomach, esophageal and skin cancers. *H. erinaceus* (its fruiting body, mycelium, and products in the medium) also contains some lower MW pharmaceutical constituents, such as the novel phenols (hercenones A and B) and Y-A-2 which may have chemotherapeutic effects on cancer.. Keun *et al*[3] studied the hypolipidaemic effect of an exo-biopolymer produced from a submerged mycelial culture of *Hericium erinaceus* in dietary-induced hyperlipidaemic rats. The oral administration of exo-biopolymer, at the dose of 200 mg/kg body weight, substantially reduced the plasma total cholesterol (32.9%), low density lipoprotein cholesterol (45.4%), triglyceride (34.3%), phospholipids (18.9%), atherogenic index (58.7%). It increased the plasma high density lipoprotein cholesterol level (31.1%) as compared to the control group. Chyi *et al*[4] recorded that, recent studies have determined that *Hericium* spp. mushrooms, may have important physiological functions in humans, including antioxidant activities, the regulation of blood lipid levels and reduction of blood glucose levels. Gue *et al*[5] mentioned that, *Hericium erinaceum* is a medicinal and edible mushroom with anti-microbial and anti-cancer activities.

Eisenhut and Fritz[6] stated that, sawdust proved an effective, economic substrate for *H. erinaceus* growing. Fungus yields in relation to substrate averaged 29.3%. Ping and Chapman[7] stated that, *H. abietis* and *H. erinaceus* were successfully cultivated indoors on conifer sawdust (80% conifer sawdust, 18% wheat bran, 1% calcium sulfate and 1% sugar). Ehlers and Schnitzler[8] grown six strains of *H. erinaceus* on coarse and fine beech and ash saw dust with wheat bran. The highest yields (254.3 kg/kg substrate) were obtained on fine beech saw dust with 20% wheat bran. Karadzic[9] reported that *Hericium erinaceus* colonizes the living trees in the forests of Serbia and Montenegro. Siwulski and Sobieralski[10] cultivated two *H. erinaceus* strains on beech sawdust substrate enriched with wheat bran (20%), rye grain (25%), soybean meal (7%), rape meal (10%) or meat-osseous flour (6%) were studied. The highest yields were obtained on the substrate with wheat bran and soybean meal. The yields of carpophores on these substrates were more than 52 g/100 g dry matter of substrate.

Corresponding Author: Hassan, F.R.H., Food Tec. Res. Inst., Agric. Res. Center, Giza, Egypt.
Email: fathym@mail.com

Gyu *et al*[11] demonstrated that, the biological efficiency of *Hericium* spp. mushroom cultivated on oak sawdust substrate with 20% rice bran supplement was 26-70%. Also, strain selection is important to improve biological efficiency and mushroom yield in *Hericium* cultivation.

Wang *et al*[12] investigated the nutritional composition of 5 strains of *Hericium erinaceus* fruiting bodies. the highest crude protein content (28.4%) and low crude fat. Zhanxi and Zhanhua[13] found that each 100g dried *H. erinaceus* fruit bodies contained 26.3g protein, 4.2 g fat, 856mg phosphorus, 18 mg iron, 2 mg calcium, 0.69 mg vitamin B_1 and 1.89mg vitamin B_2.

MATERIALS AND METHODS

Fungal Strain: Edible mushroom *Hericium erinaceus* H 966 (monkey head or lion's mane) was kindly obtained from the Institute of Jun Cao, Fujian Agriculture Univ., China.The culture was maintained on Potato Dextrose Agar (PDA) medium and stored in refrigerator at 5 -7 °C after growth as recommended by Stamets[14] The culture was used for producing the grain spawn by the convenient method. The prepared spawn were stored at 5 °C until using them for cultivation.

Growing Media and Cultivation: Hard wood sawdust, rice straw and wheat straw were used single or binary mixed (1:1) for preparation of growing media as follows:

- Sawdust + 20%wheat bran + 1% $CaCo_3$ + 1% sugar.
- Rice straw + 20%wheat bran + 1% $CaCo_3$ + 1% sugar.
- Wheat straw + 20%wheat bran + 1% $CaCo_3$ + 1% sugar.
- Sawdust + rice straw + 20%wheat bran + 1% $CaCo_3$ + 1% sugar.
- Sawdust + wheat straw + 20%wheat bran + 1% $CaCo_3$ + 1% sugar.
- Rice straw + wheat straw + 20%wheat bran + 1% $CaCo_3$ + 1% sugar.

The moisture content of the aforementioned media formulae were adjusted to approximately 63 – 64%. Then each formula was filled in polypropylene bags (1kg each)and autoclaved at 121°C for 1 hour. After the sterilized media was cooled down, the bags were inoculated by the previously prepared grain spawn 2%(w/w), then being incubated at 22 - 27°C for spawn run (mycelium growth).

At the end of incubation time (spawn run) the bags were opened and subjected to the fruiting conditions i.e. exposure to scattered light, watering by daily water spraying, good ventilation, adjusting relative humidity to 85–90% and temperature to20-25 °C.The crop was picked after 14-20 days from the end of incubation time in consecutive flushes at intervals of 15-20 days.

As this mushroom type is newly introduced to Egypt from China (may this is the first attempt for their cultivation in Egypt) so, this experiment was carried out in three consecutive seasons to get actual and reliable results.

- The first season started in 22 Nov. 2004 until 5 March 2005.
- The second season started in17 Nov. 2005 until 2 March 2006.
- The third season started in19 Nov. 2006 until 6 March 2007.

Analysis: All determinations were carried out in triplicate. Moisture, crude protein (N x 6.25), fat,and ash contents were estimated according to the A.O.A.C[15]. Total carbohydrates were calculated by differences. Biological efficiency (BE%) was calculated as reported by Stamets[14] as follows:

$$BE\% = \frac{\text{Fresh fruiting bodies (g)}}{\text{dry weight of medium substrate}} \times 100$$

Data of spawn run time(days) and yield were statistically analyzed using analysis of variance and least significant differences (L.S.D.) according to Snedecor and Cochran[16].

RESULTS AND DISCUSSIONS

Growing Media Moisture Content: The moisture content of growing mushroom media is a very important factor hence, proper value encourages the growth,while higher or lower ones had a negative effect on growth. The data in Table (1) show that the moisture content of the tested growing media ranged from 63.88% to 64.62 % for the first season, and from 63.96%to 64.51% for the second season, while it ranged between 63.39% and 64.90 % for the third season. It could be observed that, the moisture content differs slightly among the studied media in the same season or even between the different three season. The difference between the highest and the lowest moisture content value did not exceed than 1.7% .

The present results of media moisture content are in a good harmony with the optimal moisture content for growing *H. erinaceus* recorded by Gryganski *et al*[17], 50–70% and Zhanxi and Zhanhua[13] 62 – 64 %.

Table 1: Growing media moisture content%.

	First season	Second season	Third season
Sawdust	64.62	64.27	63.39
Rice straw	63.96	64.19	64.90
Wheat straw	64.48	63.96	63.87
Sawdust+ rice straw	63.88	64.36	63.79
Sawdust+ wheat straw	64.07	64.51	64.15
Rice straw+ wheat straw	63.97	63.98	63.70

Table 2: Incubation time (days) of *H. erinaceus* grown on different media

	First season	Second season	Third season
Sawdust	44^{Aa}	46^{Aa}	43^{Aa}
Rice straw	43^{Aa}	42^{Ba}	40^{Ca}
Wheat straw	40^{Ba}	40^{BCa}	42^{ABa}
Sawdust + rice straw	40^{Bb}	42^{Ba}	43^{Aa}
Sawdust + wheat straw	37^{Cb}	39^{Cab}	40^{Ca}
Rice straw + wheat straw	39^{Ca}	38^{Ca}	40^{Ca}

Means within a column have different capital superscript are significantly different.
Means within a raw have different small superscript are significantly different.

Incubation Time: Sterilized media were inoculated by *H. erinaceus* spawn at rate of 2%, then incubated at 22- 27 ^{O}C till complete colonization by the dense mycelium (incubation time or spawn run time).

From the data in Table (2) it could be seen that, the incubation time of different media formulae ranged from 37 – 44 days in the first season. While it ranged between 38 – 46 days in the second season and from 40 – 43 days in the third season. Sawdust seems to have the longest spawn run time followed by rice straw then wheat straw. Among media formulae in the first season sawdust and rice straw media had long incubation time and differ significantly than the other formulae. On the other hand, sawdust + wheat straw and rice straw + wheat straw had the shortest spawn run time and differ significantly than the other formulae. As for the second and third seasons, sawdust had the same trend and recorded the longest spawn run time and differ significantly than the other formulae. Also, sawdust + wheat straw and rice straw + wheat straw had the same trend as first season and recorded significantly short spawn run time compared to other formulae. It could be seen that wheat straw generally recorded short spawn run time compared to sawdust and rice straw. Moreover, when wheat straw mixed with rice straw or sawdust, it shortened the spawn run time. Generally, no significant differences were detected in spawn run time of each medium throughout the three tested growing seasons except sawdust + wheat straw which shows a slight difference between season one and three.

Our results are in a good agreement with those stated by Oei[18] who recorded that spawn run time of *H. erinaceus* takes 6 weeks at 20 – 30 ^{O}C.

Yield and Biological Efficiency: The data in Table (3) indicate that, the yield of *H. erinaceus* grown on the tested media ranged from122g – 168 g / 1kg wet media with BE of 33.9 – 47.5%in the first season. As for the second season, the yield ranged between 117 to 176 g / 1kg wet media with BE of 32.5 to 49.3%, while it was 119 to 184 g / 1kgwet medium with BE of 33.9 to 50.3% for the third season. It could be observed that, sawdust recorded the highest yield and subsequently the highest BE and differed significantly than other media formulae in all seasons. Sawdust + wheat straw medium ranked the second stage of the yield and BE value. On the other hand, rice straw medium recorded the lowest yield and BE compared to other different media in season 1 and 3, while rice straw + Wheat straw in season 2 recorded the lowest yield. The yield obtained from sawdust medium did not differ significantly throughout the three season.

These results are in a good agreement with those obtained by Gyu *et al*[11] and Swiulski & Sobieralski[10].

Morphological Characteristics of *H. erinaceus*: As for The morphological characteristics of *H. erinaceus* fruit bodies the data and descriptions are given in Table 4. No special or specific characters were detected as a result of growing media .

Table 3: Yield (g/ kg medium) and BE% of *H. erinaceus* grown on different media

	First season		Second season		Third season	
	Yield	BE%	Yield	BE%	Yield	BE%
Sawdust	168^{Aa}	47.5	176^{Aa}	49.3	184^{Aa}	50.3
Rice straw	122^{Cb}	33.9	138^{Ba}	38.5	119^{Db}	33.9
Wheat straw	140^{Bb}	39.4	146^{Bb}	40.5	157^{Ba}	43.5
Sawdust + rice straw	146^{Bb}	40.4	130^{Cc}	36.5	160^{Ba}	44.2
Sawdust + wheat straw	149^{Ba}	41.4	165^{Aa}	46.5	165^{Ba}	46.0
Rice straw + wheat straw	127^{Cb}	35.3	117^{Dc}	32.5	135^{Ca}	37.2

Means within a column have different capital superscript are significantly different.
Means within a raw have different small superscript are significantly different.

Table 4: Morphological characteristics of *H. erinaceus* fruit bodies.

Item	Description
Cap color	White to yellowish
Cap shop	Oval or spherical or even irregular with thick or dense hairs or spines
Cap diameter	5 – 9 cm
Stem diameter	1.5 – 2.0 cm
Stem length	Very short
Fruit body weight	30 – 45 g
Taste	Special pleasant taste

Table 5: Chemical composition of *H. erinaceus* grown on different media*

	Moisture	Crude protein	fat	ash	Total carbohydrates
Sawdust	89.63	24.83	3.59	10.63	60.95
Rice straw	90.16	24.07	4.16	11.27	60.50
Wheat straw	90.25	26.80	3.73	10.55	58.92
Sawdust + rice straw	89.82	25.11	4.03	11.02	59.84
Sawdust + wheat straw	91.05	24.66	4.21	10.31	60.82
Rice straw + wheat straw	90.35	25.75	3.92	9.69	60.64

* season of 2005/2006

Chemical Composition of *H. erinaceus*: After harvesting the fruit bodies of *H. erinaceus* were analyzed for their moisture, crude protein, fat, and ash contents,while total carbohydrates were calculated by difference and the data are presented in Table (5). From the data in this table it could be observed that, the moisture content of *H. erinaceus* grown on different media slightly differed and ranged between 89.63 and 91.05%. As for crude protein it was found to be ranged from 24.07% for mushroom grown on rice straw medium and 26.80% for mushroom grown on wheat straw medium. Moreover, it could be seen that *H. erinaceus* contained low amount of fat being ranged from 3.95 to 4.21%. Also, ash content ranged between 9.69 and 11.27%. As for total carbohydrates the highest value 60.95 was recorded to fruit bodies grown on wheat straw, while lowest one 58.92 was recorded to those grown on wheat straw. It could be observed that, chemical constituents slightly differ according to the growing media. It is worthly to mention that cultivation of *H. erinaceus* mushroom on sawdust, wheat straw + sawdust or even wheat straw only is very promising in Egypt.

The present results are in accordance with those obtained by Wang *et al*[12] and Zhanxi & Zhanhua[13].

From the aforementioned results in the present study it could be concluded that cultivation of *H. erinaceus* mushroom that newly introduced to Egypt from China under the local environmental conditions on a cheap lignocellulosic wastes is a very important achievement. Since, *H. erinaceus* mushroom is highly prized for their nutritive and medicinal benefits.

REFERENCES

1. Chang, S.T., 2007. Mushroom cultivation using the " ZERI" principle: potential for application in Brazil, Micologia aplicada international, 19(2): 33-34
2. Mizuno, T., 1999. Bioactive substances in *Hericium erinaceus* (Bull., Fr.) pers. (Yambushitake) and its medicinal utilization. International Journal of Medicinal Mushroom, (2): 105-119.

3. Keun, Y.B., P.J. Bo and C.C. Hyun, 2003. Hypolipidemic effect of an exo- biopolymer produced from a submerged mycelial culture of *Hericium erinaceus*.Bioscience, Biotechnology and Biochemistry, 67(6): 1292-1298.
4. Chyi, W.J., H.S. Hui, W.J. Teng, C.K. Shao and C.Y. Chen, 2005. Hypoglycemic effect of extract of *Hericium erinaceus*. Journal of the Science of Food and Agriculture., 85(4): 641-646.
5. Gue, S.C., S.J. Woo, C.J. Hyo, C.C. Kwan, Y.C. Heui, C.W. Tae and H.S. Hyun, 2006. Macrophage activation and nitric oxide production by water soluble component of *Hericium erinaceum*. International–Immunopharmacology., 6(8): 1363-1369.
6. Eisenhut, R. and D. Fritz, 1995. A new edible fungus? Champignon, (383): 24-26, 28-29. Published by, Ten Speed Press, Berkeley, CA 94707.
7. Ping, X.G. and B. Chapman, 1997. Cultivation of *Hericium abietis* on conifer sawdust. Canadian Journal of Botany., 75(7): 1155-1157.
8. Ehlers, S. and W. Schnitzler, 2000. Studies on the growth of the basidomycete *Hericium erinaceus* (Bull.Ex.Fr.) pers. Champignon, (415): 147-150.
9. Karadzic, D., 2006. Contribution to the study of fungi in the genera sparasis Fr. and *Hericium* pers in our forests. Glasnik- Sumarskogs-Fakulteta, Univerzitet-u-Beogradu, (93): 83-96.
10. Siwulski, M. and K. Sobieralski, 2005. Influence of some growing substrate additives on the *Hericium erinaceum* (Bull., Fr.) pers. yield. Sodinikyste Darzininkyste, 24(3): 2250-253.
11. Gyu, K.H., P.H. Gu, P.S. Ho, C.C. Won, K.S. Hwan and P.W. Mok, 2005.Comparative study of mycelial growth and basidomata formation in seven different species of the edible mushroom genus *Hericium*. Bioresource- Tecnology. 96(13): 1439-1444.
12. Wang, M.X., D. Guan and M.D. Jing, 1992. Nutritional composition analysis of five strains of *Hericium erinaceus* and their utilization. Microbiology Beijing., 19(2): 68-72.
13. Zhanxi, L. and L. Zhanhua, 1999.The textbook for international training class, Jun-cao Technology Institute, Fujian Agricultural University, China.
14. Stamets, P., 1993. "Growing gourmet and Medicinal mushrooms" Published by, Ten Speed Press, Berkeley, CA 94707.
15. AOAC, 1995. Official methods of A.O.A.C.,International published by A.O.A.C.. InternationalSuite,400 2200 Wilson Boulevard, Arlington, Virginia, 22201 USA
16. Snedecor, G.W. and W.G. Cochran, 1980. Statistical methods.7th Ed., Iowa state Univ. Press, Ames. Iwoa, USA.
17. Gryganski, A., B. Kirchhoff and J. Wostemeyr, 1998. The edible fungus *Hericium erinaceum*. Influence of physical factors on growth and fruiting body yield. Champignon, (402): 77-82.
18. Oei, P., 1991. "Manual on mushroom cultivation." First ed. Published by Tool Publications. Amsterdam, The Netherland.