



Using of by-products of mushroom (*Pleurotus ostrateus*) growing on rice straw in Nile Tilapia (*Oreochromis niloticus*) fingerling diets

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ABSTRACT

The present study was carried out at the World Fish Abbassa Sharkia, Egypt with cooperation of Animal Production Research Institute (APRI) Agriculture Research Center Giza, Egypt. The study was conducted to investigate the possibility of incorporating by-products of mushroom growing on rice straw as an energy source and cheap alternative feed stuffs instead of the diets in all-male Nile tilapia, *O. niloticus* fingerlings Abbassa strain (G9) (6.03 ± 0.22 g) were obtained from the World Fish. Genetic improvement program. The experiment was conducted in fifteen Concrete tanks ($1 \times 2 \times 0.75$ m²) and the volume of the water in each tank was (1.5m³). About 10% of the water volume in each tank was replacing daily by aerated underground water. Five experimental diets were formulated, as iso nitrogenous (30.80 % CP) and isocaloric (4325.94 Kcal/kg diet), containing 0, 5, 10, 15 and 20% of mushroom by-product T1, T2, T3, T4 and T5, respectively and fed to monosex Nile tilapia, (*Oreochrom isniloticus*) fingerlings with average individual weight of (6.03 ± 0.12 g). Total of 150 fingerlings were randomly distributed in five treatments, triplicate groups each with stocking density of ten fish/aquarium. Fish were fed at a rate of 5 % of total biomass, tilapia were hand-fed to apparent satiation which was divided between three feeding times daily (8:00, 12:00, and 15:00 hours). The excess food in each tank was measured at the end of each day, daily food intake was recorded. Fish in each tank were sampled biweekly and feed amounts were adjusted according to the new fish biomass. The experiment period was lasted for 16 weeks. Growth performance, feed utilization and body compositions as well as the economic evaluation were monitored. The results showed no significant differences between all treatments ($P > 0.05$) in growth

performance and feed protein utilization of fish up to 20% compared with the control in Nile tilapia fingerlings diets resulted a better economic efficiency. It could be concluded that, the by-product of mushroom can be incorporated in tilapia diet up to 20 % without any adverse effects on growth performance or feed utilization of Nile tilapia.

Key words: Nile tilapia, rice straw, by-products of mushroom (*Pleurotus ostrateus*) meal, growth performance, feed and protein utilization, and economic efficiency.

INTRODUCTION

Large volume of lignocelluloses agriculture residues (wheat straw, sugarcane bagasse) are generated annually through agricultural and food processing industries **Buswell, (1991)**. In Egypt, about 45 million ton for total agriculture by products are produce annually and 2.6 million ton for rice straw **Egyptian environmental affairs agency, (2019)**. The major limitation of using these agricultural by-product as feed is low palatability, digestibility, protein and high fiber contents. These are either disposed of by burning or dumping in landfills, thus posing hazard to the environment and human health. Such global concern, therefore, necessitated alternative option or method of recycling of waste or residues into beneficial products. The possibility of recycling rice straw into value added product therefore comes into view and which would otherwise be used in the cultivation of edible and medicinal mushrooms **Atipkoet *al.*, (2006)**. Extensive research has been carried out for several decades on improving nutritive value of cereal straws for livestock using physical, chemical and biological treatments and varying degree of success has been reported **Selim *et al.*, (2004)** and **Sarnklong, *et al.*, (2010)**. Residues like straw and sugarcane bagasse have been utilized as potential substrate for mushroom cultivation. Waste recycling and supplementation technique in the production of mushrooms, especially *Pleurotus* species that survive on a wide range of substrates, would be beneficial to ensuring pollution control (**Onokpise *et al.*, 2007**).

Moreover, attempts have been done to increase the digestibility and utilization of the agricultural by-product as feed, one of them is the biological treatment by using treatment with fungi to degrade lignocelluloses into lignin, cellulose and hemicelluloses and improve crude portion, digestibility, and nutritive value **Abedel -Aziz and Ismail, (2001)**. Previous studies showed the feasibility of using these kinds of wastes to produce animal feed and as substrate for mushroom production

Yildiz *et al.*, (2002). Rice straw is being used as bedding materials for mushroom (*Agaricusbisporus*) after harvesting the straw along with small particles of mushroom is either dumped or burned as fuel for cooking. This waste material can be rich in microorganisms and extra-cellular enzymes **Ball and Jackson, (1995)** and contain relatively high levels of nitrogen, potassium, phosphorus, calcium and trace elements, notably iron and silicon, **Langar *et al.*, (1980); Burton *et al.*, (1994)** that may be used as animal feed.

Mushroom is an important food through the most world countries. Depending on the variety, they contain high quality protein with levels ranging from 21– 40% dry weight. They also contain vitamins B1, B2, B12, C, D and rich in minerals essential for human health. Nutritional analysis **Hafiz *et al.*, (2003)**. *Pleurotus ostreatus*, along with other species of mushroom, has been confirmed to have medicinal value. The biological functionality of these mushrooms ranges from anti oxidative and immune-stimulating to antiviral, anti-carcinogenic, anti-hypercholesterolaemic, and the ability to regulate blood lipid and glucose levels **Wasser and Weis (1999); Lakhanpal and Rana (2005)**. The bioactive compounds in these species have been identified as oligosaccharides, polysaccharides, dietary fibers, glycoproteins, proteins, peptides, amino acids, triterpenoids, alkaloids, alcohols, phenols, polyphenols, vitamins, and/or minerals such as zinc, copper, iodine, selenium and iron. *Pleurotus spp.* is commonly known as oyster mushroom **Hassan *et al.*, (2011)**. Another mushroom species, *Pleurotus florida* was used to replace rice bran in diet for *Clariasgariepinus* and *Oreochromis niloticus*. It was observed that 100% of rice bran could be replaced by *Pleurotus florida* without sacrificing growth performance which led to a cheaper fish diet **Muin *et al.*, (2014 and 2013)**.

Kumar *et al.*, (2014) reported that fermented by-product of mushroom could replace 6.3% of fish meal without any adverse effects on growth performance of Amur catfish (*Silurus asotus*). On the other hand, **Hasniyati *et al.*, (2015)** conducted study to assess the use of mushroom stalk an agriculture waste and soy bean meal as partial and complete replacement of fish meal protein at 0, 33, 67 and 100% in Nile tilapia fingerling diets. The result showed that good growth performance was shown in 33% replacement of fishmeal diet. **Shad *et al.*,(2019)** investigate the effects of mushroom (*Flammulina velutipes*) stem waste (MW) at 2% level can be used as potential phyto-genic feed supplement in broilers, on growth performance, antibody response, immune status, and

serum cholesterol in broiler chickens. High density lipoprotein cholesterol (HDL) was lower ($p < 0.05$) in levels of MW fed group.

On the other hand, **Deborah *et al.*, (2011)** Reported that, About 50% of the fish meal could be replaced with earthworm and mushroom meal which could achieve a good average growth rate and feed conversion ratio without causing any adverse effect of fingerlings of *Labeorohita* and *Hemigrammus caudovittatus*. Cultivation of mushroom could be considered as an economically feasible way for converting the rice straw into protein-rich food. Additionally, the spent mushroom substrate provided an alternative substrate for microorganisms in the anaerobic environment; because mushroom cultivation improved the degradation of the crystallinity and hydrolysis of polymers in lignocellulosic compounds and the content of nitrogen in rice Straw **Karimi *et al.*, (2015) and kuijk *et al.*, (2015)**. *P. ostreatus* was proved to have high relative selectivity on lignin degradation of soft wood substrates due to the presence of enzymes like laccase, Mn-peroxidase, and Lignin peroxidase. **Hou, *et al.*, (2004) and Isikhuemhen, *et al.*, (2009)**.

The aim of this study is to investigate the effect of using by-products of mushroom (*Pleurotus ostrateus*) on growing on rice straw on the growth performance, feed and protein utilization; body composition and economical in Nile tilapia (*Oreochromis niloticus*) diets.

MATERIAL AND METHODS

Design of the experiment:-

The present study was carried out at the World Fish Abbassa Sharkia, with cooperation of APRI, Agriculture Research Center Giza, Egypt. The study was conducted to evaluate the role of agricultural by-product, such as rice straw, for the development of mushroom, including the residues of fungi and their introduction into fish diets. The experiment lasted for 16 weeks from 8th of August to 28th of November 2017.

Diet formulation and Feeding system:-

The residues produced by the development of mushroom *Pleurotus ostratus* on rice straw are dried as in **Fig (1)**, analyzed and applied to the composition of the diet containing average 30.80% crude protein, 4325.94 GE kcal / kg diet.



Fig (1): Mushroom *Pleurotus ostratus* on rice straw.

Mushroom cultivation procedure was in four main steps:

First step, rice straw preparation which included reduction of size and Sterilization of Rice straw.

Secondstep, inoculation of edible mushroom layers distributed in Sterilized rice straw in closed bags till be fully colonized in suitable humidity.

Thirdstep, mudhroom growing in this stage temperature (24C), relative humidity (85-90%) and ventilation were precisely controlled, bags opened to allow the development of fruit after 10-15 days.

Finaly the last step, harvesting, after all flushes, the remaining amount of rice straw Was taken to use cultivation procedure was occurred in sundown farm (Private mushroom farm) El-kalubia Governor Egypt **Ruihong *et al.*, (2002).**

The proximate analysis of the feed ingredients used to formulate the experimental diets is shown in Table (1). Five practical tilapia diets were formulated (Table 2).The control diet (T₁) comparison group (soybean meal, yellow corn, fishmeal, wheat bran and corn gluten), the forth tested diets containing of by-products of mushroom at levels of 5,10,15 and 20%of the diet (T₂, T₃, T₄ and T₅) respectively. The averages of all diets were maintained almost isonitrogenous (30.80% CP) and isocaloric (4325.94 Kcal/kg diet). The formulated diets were processed by blending the dry ingredients into a homogeneous mixture, added 10% warm water and then passing the mixed of diet through a laboratory pellet mill with diy 2mm. The pelleted diets were dried in oven at 65°C overnight. Diets were kept in black plasticbags then stored in a refrigerator at 1°C throughout the whole experimental period.

Table (1): Proximate analysis (DM %) of the feed ingredients used in the experimental diets.

Ingredients	Moist.	Crude protein	Ether extract	Crude fiber	Ash	NFE*	GE**
Fish meal	7.80	65.00	6.89	0.88	15.49	11.74	4828
Soybean meal	9.19	44.00	1.20	7.30	5.98	41.52	4552
Wheat bran	11.00	13.41	3.90	12.00	6.20	64.49	4187
Yellow corn	11.00	7.50	3.80	2.60	1.30	84.80	4280
Mushroom By-product	8.62	6.00	2.80	21.95	31.85	37.40	2978

* Calculated by difference.

**Gross energy was calculated from their chemical composition using the factors 5.65, 9.45, 4.0 and 4.0 (Cal GE/g DM) for crude protein, ether extract, crud fiber and nitrogen free extract, respectively (Jobling, 1983).

Experimental fish and culture technique:

All-male Nile tilapia, *O.niloticus* fingerlings Abbassa strain (G9) (6.03±0.22g) were obtained from the World Fish Genetic improvement.

Program. World Fish initiated a selective breeding program in 2001 at Abbassa–Egypt to develop and produce a genetically improved Nile tilapia which was to be referred to as “Genetically Improved Abbassa Nile Tilapia (GIANT) strain”, using the same technology that produced GIFT **Rezket *et al.*, (2009)**. The GIANT strain (G9) was selected for growth and high survival rates since most tilapia farmers consider fast growth from seed to harvest size to be the most important performance trait (was 28% faster than the commercial strain), along with a high survival rate **Ibrahim *et al.*, (2013)**. The fish were acclimatized for one week and fed a commercial diet (Skretting, extruded diet, Egypt).The experiment was conducted in fifteen concrete tanks (1 × 2 × 0.75m²) and water volume in each tank was (1.5m³). About 10% of the water volume in each tank was replacing daily by aerated underground water. After the acclimatization period, ten fish were randomly stocked into each tank with three replications for each diet treatment. Fish were fed for 16 weeks on the previous tested diets and each group with three replicates in tanks. Fish were fed at a rate of 5 % of biomass **Ramos *et al.*, (2015)**, tilapia were fed to apparent satiation which was divided between three feeding times daily (8:00, 12:00, and 15:00 hours). The excess food in each tank was measured at the end of each day, daily food intake was recorded. Fish in

each tank were sampled biweekly and feed amounts were adjusted according to the new fish biomass. The feeding period in the experiment lasted for 16 weeks.

Table (2): Formulation and proximate analysis of the experimental diets (on%DM) fed to Nile tilapia (*Oreochromis niloticus*) fingerlings.

Ingredients (%)	Treatments				
	T ₁	T ₂	T ₃	T ₄	T ₅
Fish meal (65% CP)	7.00	7.00	7.00	7.00	7.00
Soybean meal (44% CP)	37.00	37.00	37.00	37.00	37.00
Gluten	10.00	10.00	11.00	11.00	11.00
Wheat bran	7.00	7.00	7.00	7.00	7.00
Yellow corn	35.00	30.00	23.00	16.00	9.00
Mushroom by-product	0.00	5.00	10.00	15.00	20.00
Corn oil	3.00	3.00	4.00	6.00	8.00
Vit. & Min. premix ¶	1.00	1.00	1.00	1.00	1.00
Total	100	100	100	100	100
Proximate analysis (%)					
Moisture	6.20	6.38	7.84	6.48	7.62
Crude protein (CP)	30.37	30.56	31.14	31.11	30.84
Ether extract (EE)	5.60	4.44	5.40	6.39	8.63
Crude fiber (CF)	4.03	3.94	4.05	4.07	4.37
Ash	12.18	12.59	12.07	13.57	13.88
NFE*	47.82	48.47	47.34	44.86	42.28
GE (Kcal/Kg) **	4319.10	4242.6	4325.2	4318.8	4424.0
Ca	0.492	0.511	0.528	0.546	0.565
P	0.532	0.522	0.511	0.496	0.480
Lysine	1.570	1.557	1.549	1.531	1.512
Meth. + Cystine	0.582	0.575	0.577	0.565	0.552

¶Contains per kg: vitamin A, 4.8 m. I.U; vitD3, 0.8 m.I.U; vit E, 4.0 g; vit. K, 0.8 g; vit B1, 0.49 g, vit.B2, 1.6 g;vit.B6, 0.6 g; vit. B12, 4 mg; Pantothenic acid 4 g; Nicotinic acid 8 g; Folic acid, 400 mg; Biotin, 20 mg; Choline chloride, 200 mg; Copper, 4.0 g ; Iodine, 0.4g ; Iron, 12 mg ; Manganese, 22 g; Zinc 22 g and Selenium 0.04 g.

*Calculated by difference.

**GE: gross energy calculated as 5.64, 9.44 and 4.12 Kcal/g of protein, lipid and carbohydrate, respectively (Jobling, 1983).

Analytical methods:

At the end of the experiment, fish in each tank were collected, weighed and frozen at -20°C for the preparation of final body composition analysis.

At the beginning, from the batch of collected fish, 30 fish were analyzed for initial carcass composition. Fish samples were minced homogenized with Ultra-Tunax. The homogenized samples were oven dried at 60 - 80°C for 48 hrs. Proximate analyses of whole body moisture, protein, fiber, lipid, and ash performed according to the methods of

AOAC (2000), while nitrogen free extract (NFE %) was calculated by difference. Gross energy (Kcal GE/Kg) contents of all the samples were calculated according to **Jobling, (1983)**. Water quality parameters were analyzed according to **APHA (1980)**.

Measurements of growth and feed utilization:

Total weight gain, average daily gain, specific growth rate, feed conversion ratio protein and energy utilization were calculated as the following:

1-Total weight gain (g/fish) = (WF-WI) Where: WF, Average of final weight (g) and WI: Average of Initial weight (g)

2-ADG (Average daily gain, g/fish/day) = total gain / duration period

3-SGR (Specific growth rate, % / day) = $100 \times (\ln \text{WF} - \ln \text{WI}) / n$.

Where: ln, Natural log and n is the duration period.

4-Feed conversion ratio (FCR) = dry matter intake (g) / total gain (g)

5-Protein productive value (PPV %) = $(\text{PT} - \text{PI}) \times 100 / \text{protein intake (g)}$

Where: PT, Protein content in fish carcass at the end and PI, Protein content at the start.

6-Energy utilization (EU %) = $(\text{ET} - \text{EI}) \times 100 / \text{Energy intake (kcal)}$

Where: ET, Energy in fish carcass (kcal) at the end and EI, Energy in fish carcass (kcal) at the start.

Statistical methods:

Collected data were subjected to one-way analysis of variance (ANOVA) using SAS procedure (**SAS, 2020**). Duncan's multiple rang test **Duncan, (1955)** was used to compare differences among individual means. Treatment effects considered significant at $P \leq 0.05$.

RESULTS AND DISSCUSION

Water quality:

In the present study, these results indicate in general that mushroom by-product meal could be incorporated in growing Nile tilapia diets (Table 2). Water temperature ranged from (27 to 28°C, dissolved oxygen 5.3 to 5.5 mg I⁻¹, pH 8 to 8.2, and total ammonia 0.07 to 0.08 mg I⁻¹. **Hasniyatiet al., (2015)** reported that, the range of pH for all diet was from 6.53 to 6.74, temperature from 29.33 to 29.54°C, dissolved oxygen from 4.34 to 4.75, total ammonia from 0.066 to 0.106 mg/L and total nitrate concentration from 0.206 to 0.246 mg/L. Water quality parameters were found to be within the acceptable range for tilapia growth **Stickney, (1979)**.

Experimental diets:

Proximate analysis as DM % of the feed ingredients used in formulating the experimental diets is presented in the Table (1). The chemical analysis of revealed the presence of 6.0 %CP, 2.80% EE, 21.95% CF and 2978 GE Kcal/kg in the dry matter of the mushroom by-product meal and chemical analysis crude protein of rice straw reported an increase from 3.35% to 6.0% after treatment with *Pleurotus ostratu* however the crude fiber decrease from 33.21 to 21.95 after fungal treatment. These findings are in agreement with **Akinfemi and Ogumwole, (2012)** showed that, the rice straw contained 7.39% CP, 2.09% EE and 20.96% CF and the same authors reported that, the proximate analysis of rice straw showed an increase in the crude protein from 4.69 % in control to 7.39 % for (*Pleurotus stratus*.(POR). Fungal treatment decreased crude fiber from 32.89 % in control to 20.96 % after treatment with fungal (POR).

Akinfemi *et al.*, (2010c) stated that fungal treatment increased the CP and ash contents of the straw compared with the control. Such apparent increase could be due to the proliferation of fungi during degradation **Belewu and Belewu, (2005)**. This agrees with the report published by **Farkas, (1979)** and **Jacqueline and Viser (1996)**, who noted that the extracellular enzymes secreting fungus contain amorphous heme and heteropolysaccharides, which are associated with fungal protein. Some authors **Belewu and Okhawere, (1998)**, and **Akinfemi, *et al.*, (2010b)** reported that colonization of substrates by fungal mycelia results in increase in their nutritional values. All the fungi used were effective in degradation of CF because the hyphae of these fungi were capable of penetrating deep into the cells of the straw. This means that fungi not only grow on the surface of the substrate but also penetrated deep into the substrates. This observation is consistent with such findings **Shoukry, *et al.*, (1985)**. The high fermentation of the insoluble but degradable fraction (b) observed in the treated straw may possibly be influenced by the carbohydrate fractions readily available to the microbial population, a reflection of its improved nutritive value **Chumpa wadee, *et al.*, (2007)**.

Growth performance and feed utilization:

As presented in Table (3) averages of initial weights ranged between 5.99 to 6.07g with no significant differences ($P > 0.05$) among the experimental groups. At the end of the experiment (16 weeks) after start, averages of final weights of the control group, 5, 10, 15 and the 20% levels the mushroom by-product meal in the diets were, 100.37, 98.71, 103.81, 103.67 and 102.84g/fish respectively ($P > 0.05$). On the other hand,

growth performance of Amur catfish, (*Silurus asotus*) fed dietary fermented by-product of mushroom, *Pleurotus ostreatus*, as an additive is the WG, SGR, PER and PPV recorded not significant (from 0.1 to 0.8%), the optimum inclusion level of dietary fermented by-product of mushroom could be 0.1% **Kumar, et al., (2016)**.

Francisca, et al., (2014) showed that, five iso-calorific (32.60kJ/g) diets containing 35% crude protein were formulated with dried cultured mushroom meal (DCMM) replacing maize meal at 0%, 25%, 50%, 75% and 100% inclusion levels representing treatments DCMM (0–100% DCMM), respectively. Significant differences ($p < 0.05$) were observed in final weight, weight gain, FCR, PER and ADC protein of experimental fish fed mushroom-based diets in line with **Mohd Din, et al., (2012)**.

Results of Table (3) indicated also that incorporation of mushroom by-product meal in Nile tilapia diets up to 20% of diet no significantly final body weights and the growth. These results are in partial agreement with that reported by **Kumar, et al., (2014)** who used five experimental diets which were formulated to contain different levels of fermented mushroom by-product, *Pleurotus ostreatus*, (FBPM) to replace 0%, 5%, 10%, 20%, and 30% of FM (FBPM₀, FBPM₅, FBPM₁₀, FBPM₂₀, and FBPM₃₀, respectively) in Amur catfish, *Silurus asotus*, and found that weight gain indicated that FBPM could replace 6.3% of FM without any adverse effects on growth performance of Amur catfish, *Silurus asotus*. On the other hand, **Hasniyati, et al., (2015)** use mushroom stalk an agriculture waste and soy bean meal as partial replacement of fish meal protein. The result showed that, the good growth performance was shown in 33% replacement of fish meal diet. The same author found that, there was no significant difference ($p > 0.05$) in terms of weight performance between all experimental diets. For all growth parameters, there was no significant difference ($p > 0.05$) among all the diets.

The effects of mushroom by-product on feed intake (FI), feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (%) and energy utilization (%) of *O. niloticus* were presented in Table (4). There were insignificant differences among treatments ($P > 0.05$) of FI respectively. The best-feed conversion ratio (FCR) were recorded with fish fed T1, T2, T3 followed by T4 diet. On the other hand, there were no significant ($p > 0.05$) increasing in protein efficiency ratio (PER), protein productive value (PPV) and energy utilization with increasing the *mushroom by-product* in the diet from level 5% up to 20%. *Pleurotus ostreatus* contains high levels of glucans, which are polymers of glucose found in the cell walls of plants, fungi and bacteria **Sonck, et**

al., (2010); **Kim *et al.*, (2011)**. It has been reported that β -glucans have the capacity to activate innate immunity, thereby enhancing defense barriers in animals including fish **Yoo, *et al.*, (2007)**; **Sonck, *et al.*, (2010)**. **Dongsheng, *et al.*, (2017)** Investigate the effects of partially replacing fish meal with Fermented mushroom bran hydrolysate (FMBH) at levels (0, 16, 32, 48, 64, and 80%) on the growth, digestive enzyme activity, and antioxidant capacity of *allogynogeneticcrucian* carp.

Table (3): Effect of different levels of by-products of mushroom (BPM) on growth Performance of Nile tilapia fingerlings.

Expe. Diets ¹	Live weight (g/fish)		Weight gain (g/fish)	SGR ² (%/day)
	Initial	Final		
T1	6.07 ± 0.03	100.37±0.94	94.29 ±0.97	2.89 ±0.01
T2	6.07± 0.08	98.71 ±1.94	92.64 ±1.94	2.87 ±0.02
T3	5.99 ± 0.01	103.81±3.41	97.82 ±3.42	2.93 ±0.03
T4	6.00 ± 0.02	103.67 ±6.84	97.67 ±6.83	2.94 ±0.07
T5	6.03 ± 0.03	102.84 ±4.07	96.81 ±4.08	2.92 ±0.04

¹Diets 1, 2,3,4 and 5 contained 0, 5, 10, 15 and 20% BPM. of the diet contains, ,respectively.

²SGR=Specific growth rate (%/day)

Table (4): Effect of different levels of by-products of mushroom (BPM) on Feed and Nutrients utilization of Nile tilapia fingerlings.

Diets ¹	Feed utilization		Protein utilization		EU ⁵ %
	Feed intake (g/fish)	FCR ²	PER ³	PPV ⁴ %	
T1	239.62 ±23.90	2.54 ±0.23	1.34 ±0.12	20.46 ±1.69	13.63 ±1.31
T2	235.39 ±22.98	2.55 ±0.30	1.34 ±0.16	21.04 ±1.90	14.79 ±1.30
T3	232.06 ±23.40	2.36 ±0.16	1.42 ±0.09	22.31 ±1.18	15.35 ±0.94
T4	230.31 ±21.82	2.35 ±0.06	1.42 ±0.04	22.48 ±0.64	15.03 ±0.44
T5	226.54 ±23.12	2.33 ±0.14	1.44 ±0.09	22.83 ±1.76	14.46 ±1.43

¹Diets 1, 2, 3, 4 and 5 contained 0, 5, 10, 15 and 20% BPM. of the diet contains, respectively.

²FCR=feed conversion ratio ³PER=protein efficiency ratio ⁴PPV=protein productive value

⁵EU =energy utilization

Fermented mushroom bran hydrolysate (FMBH) was prepared by enzymatic hydrolysis after the solid fermentation of mushroom bran (MB) inoculated with *Ganoderma lucidum* and *Saccharomyces cerevisiae*. No significant differences were noted for the specific growth ratio, feed conversion ratio, or survival rate among all groups ($P>0.05$). The results indicated that, replacing a 64%-80% proportion of dietary fish meal with

FMBH could improve the growth, protein efficiency ratio digestive enzyme activity, and antioxidant capacity of *allogynogeneticcrucian* carp, therefore, promotes the application value of mushroom bran in aquaculture feeds.

Whole body composition:

Whole body composition of experimental fish is shown in Table (6). There were no significant differences in dry matter, ash and crude protein content of the fish ($P > 0.05$). Concerning crude protein (CP) content, the highest value ($P < 0.05$) was recorded in fish whole bodies at the experiment at 20% but with no significant differences with control diet. While, Body lipid content was significantly higher ($P < 0.05$) at the end of experiment. Perhaps the reasons due to the increasing levels of mushroom by-product, the addition of oil in the diets increases to compensate for the energy content shortage resulting from the use of mushroom by-product. Meanwhile, energy content was significantly higher at the end of the experiment than that in the beginning of experiment. **Kumar, *et al.*, (2014)** reported that, the whole-body proximate composition of fish fed dietary fermented by-product of mushroom (FBPM), *Pleurotus ostreatus*, as a fish meal (FM) replacer, the crude protein content was significantly lower for the fish fed control diet than the other group fed (FBPM) diets ($p < 0.05$) from 5% to 20%.

Discussion:

A great effort of research work was done for optimal use of this by-products and increasing their feeding value. Intake and utilization of low quality roughages could be increased by supplementation with some nutrients or by applying some treatments, such as; physical, chemical and biological methods **Rangnekar *et al.*, (1982); Cheeke, (1987)**. Among these methods, biological treatments were shown to be the most effective method **Deraz, and Ismail, (2001); Morad, (2005)**. In addition, the lipase and amylase activities in the foregut and midgut were both found to be significantly elevated. These results indicate that the high-proportion replacement of dietary fish meal with FMBH could efficiently elevate intestinal digestive enzyme activity. These elevated levels of digestive enzyme activity were probably related to the rich small peptides content of FMBH. The small peptides are absorption substrates of the intestinal lumen, which can efficiently accelerate the growth of villi, promote the proactive development of the intestinal tract, and elevate intestinal digestive enzyme activity **Bamba, *et al.*, (1993)**.

Table (5): Effect of different levels of by-products of mushroom BPM on carcass composition (%) of Nile tilapia fingerlings.

Diets ¹	Dry Matter %	CP ² %	EE ³ %	Ash %	GE ⁴ (kcal/kg)
At the start	27.62	53.80	18.30	15.39	5260.30
At the end	25.34 ^a	55.38 ^a	19.07 ^{ab}	14.74 ^a	5353.91 ^a
T1	±0.10	±0.42	±0.69	±0.59	±33.89
T2	26.13 ^a ±0.84	55.48 ^a ±1.17	21.59 ^a ±0.39	13.84 ^a ±0.45	5527.87 ^{ab} ±50.04
T3	26.41 ^a ±0.40	55.57 ^a ±0.62	20.58 ^a ±0.74	15.17 ^a ±0.24	5421.25 ^{ab} ±52.69
T4	25.99 ^a ±0.55	56.89 ^a ±0.56	19.82 ^{ab} ±1.18	14.59 ^a ±0.01	5425.45 ^{ab} ±66.79
T5	25.69 ^a ±0.75	56.99 ^a ±0.47	17.53 ^b ±1.13	14.86 ^a ±0.41	5292.24 ^b ±68.82

¹Diets 1, 2, 3, 4 and 5 contained 0, 5, 10, 15 and 20% BPM. of the diet contains, respectively.

²CP=crude protein

³EE=Ether extract

⁴GE=Energy content (Kcal /1000g diet)

⁵a, b Mean bearing the same letters within each column do not differ significantly ($p \geq 0.05$).

Table (6): Cost of feeds required for producing one Kg gain of *O. niloticus* fingerlings fed the experimental diet.

Item	T1	T2	T3	T4	T5
Cost/ton feed(L.E)	7169	7029	7045	7075	7101
Change in feed cost	100	98.05	98.27	98.69	99.05
Feed intake per Kg gain (FCR)	2.54	2.55	2.36	2.35	2.33
Feed cost /1Kg fish gain (L.E)	18.21	17.92	16.63	16.63	16.55
Percentage change in feed cost to produce one kg fish gain	100	98.41	91.32	91.32	90.88

Local market price (L.E/ton) for feed ingredients used for formulating the experimental diets at the year (2017); soybean meal = 6200 L.E ; fish meal= 25000 L.E.; yellow corn= 3700 L.E; wheat bran = 3200L.E; corn gluten= 11000LE; corn oil = 12000 L.E; Mushroom by-product = 900 LE; vitamin and minerals mix = 15000 L.E, Di calcium phosphate = 11000LE.

Meanwhile, the rapid absorption of small peptides and free amino acids can trigger intracellular calcium-mediated signaling events, followed by the release of more digestive enzymes **Liou, *et al.*, (2011)**. Thus, the

present results indicated that, incorporation of 5%-20% of dietary with mushroom by-product meal led to improve the growth, protein efficiency ratio, digestive enzyme activity, and antioxidant capacity of *Oreochromis niloticus*. Thus, may be act as a biological treatment as resulted of reducing cellulose, hemicellulose and lignin compared with untreated materials (rice straw). These results might be due to the breakdown of lignocelluloses bonds where the cellulose can be hydrolyzed by fungi **El-Ashry, *et al.*, (2002b)**. **McCarthy (1986)** reported that fungus have a similar degradative mechanism, as they degrade cellulose and hemicellulose by oxidize and solublize the lignin component. **Shoukry, *et al.*, (1985)** found that, all fungi used were effective in degradation of CF because the hyphae of these fungi were capable of penetrating deep into the cells of the straw. This means that fungi not only grow on the surface of the substrate but also penetrated deep into the substrates, in which CF decreased while CP increased. This trend is consistent with decrease in NDF, ADF and ADL **Albores *et al.*, (2006)**. Mushrooms were consumed for their palatability and nutritional value in many countries worldwide. It also consumed as a functional food to enhance human health. The presence of B-glucan in mushrooms can be used as a prebiotic in human food and animal feeds **Jabir *et al.*; (2012)**. Also, **Kim *et al.*; (2011)** reported that improved growth can be achieved through lactic acid bacteria fermentation of mushroom spent substrate in post-weaning Holstein calves. They suggested that the fermentation provides lactic acid, probiotic lactic acid bacteria, and various glucans of mushroom to the feeding animals, which are all known as prebiotics and probiotics. Improved growth performance in our experiment could also be attributed to such prebiotics and probiotics, including glucans in the mushroom by-product. Whole-body proximate composition of fish was not significantly affected by mushroom by-products inclusion in the diets ($p < 0.05$). **Lim *et al.*, (2004)** also found no significant differences in whole-body proximate composition of growing rockfish, *Sebasteschlegeli*, fed dehulled soybean meal as a FM replacer. Furthermore, despite the significant differences which were found in whole-body proximate composition of juvenile rockfish by the same authors, no clear trends were observed. Also, no clear trends were found in whole-body proximate composition of juvenile olive flounder, *aralichthys olivaceus*. Although by-products of mushroom, *Pleurotus ostreatus*, have been used in ruminant feed **Kim *et al.*; (2011)**, information on the use of these ingredients in fish feed is scarce. The present investigation showed that mushroom (*Pleurotus ostreatus*) by-product can be used as a dietary additive in Nile tilapia without any adverse effects on growth performance, feeding habits,

protein utilization and body composition. **Abdel-Warith *et al.*; (2001)** recorded good growth of *Clariasgariepinus* up to 40% replacement of FM with PBM but noted depression in growth and abnormality in histological structure of fish with increasing levels of PBM in diets.

Economic efficiency:

The economic evaluation for all experimental diets were calculated and presented in Table (6). The economic efficiency was dependent on the basis of feed costs and cost of one kg gain in weight of Nile tilapia, its ratio to the control diet. Feed costs and cost per kg gain (18.21 L.E) were the highest for the control diet (L.E) and gradually decreased with the increasing levels of mushroom by-product meal until 20% of the diet. 20 % level of mushroom by-product, meal in Nile tilapia could be produced cheaper than fish fed on the control diet. The relative percentages of feed cost/ kg fish were 98.05%, 98.27%, 98.69% and 99.05% for diets T2, T3, T4 and T5 respectively, compared to control. Moreover, feed cost/ kg gain was 17.92, 16.63, 16.63 and 16.55 L.E., respectively. Table (6) incorporation of mushroom by-product meal in Nile tilapia diets, the mushroom by-product meal can be incorporated in Nile tilapia fingerlings diet up to 20% of the diet for better economic efficiency as well as better growth performance, nutrients and protein utilization.

CONCLUSION:

From the current results authors can concluded that rice straw could be biologically treated with *Pleurotus ostreatus*, up to 20 % in Nile tilapia fingerlings diet without any adverse effects on its growth performance, feeding habits; protein utilization and economic efficiency.

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استخدام مخلفات تنمية فطر عيش الغراب علي قش الارز في علائق أصبغيات البلطي النيلي

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الملخص العربي

أجريت هذه الدراسة لتقييم اثر الاستبدال الجزئي لمخلفات المشروم الناتجة من تنميه فطر عيش الغراب على قش الارز بنسب صفر، ٥، ١٠، ١٥، ٢٠٪ من مكونات العليقة على أداء النمو والكفاءة الغذائية وكفاءة البروتين والتقييم الاقتصادي لإنتاج أصبغيات البلطي النيلي ذكور التي تم تربيتها تحت نظام الاستزراع الشبه مكثف في أحواض الفيبرجلاس المزودة بنظام إعادة تدوير للمياه. حيث كان حجم الحوض ٣م^١،٥ وتم توزيع الاسماك عشوائيا في خمس مجموعات بمعدل ١٠ سمكات/ حوض وكان متوسط وزن الاسماك في بداية التجربة ٦،٠٣ جم. وتم تكوين علائق تحتوى على ٣٠،٨٠٪ بروتين خام، ٤٣٢٥،٩٤ كيلو كالوري طاقة كلية / كجم عليقة واستمرت التجربة لمدة ١٦ أسبوع. غذيت الاسماك علي العلائق التجريبية لمدة ٦ ايام في الاسبوع بمعدل ٥٪ من وزن الاسماك الي حد الشبع بمعدل ثلاث مرات يوميا ٨ صباحا و ١٢ ظهرا الي ٣ عصرا . اوضحت النتائج انه لا توجد فروق معنوية في اداء النمو وكفاءة الغذاء والبروتين حتي مستوى ٢٠٪ من المخلفات الناتجة من انتاج المشروم مقارنة بالعليقة المقارنة وباقي المجموع الاخرى.

الخلاصة:- أنه يمكن الاستبدال الجزئي لمخلفات المشروم الناتجة من تنميه فطر عيش الغراب على قش الارز حتي المستوى ٢٠٪ من مكونات العليقة بدون أي تأثيرات سلبية على أداء النمو، الكفاءة الغذائية ومحتوى الجسم و التقييم الاقتصادي لاصبغيات اسماك البلطي النيلي .