EFFECT OF TWO MUSHROOM VARIETIES INTAKE ON SERUM TRIGLYCERIDES, CHOLESTEROL FRACTIONS AND SERUM GLUCOSE LEVELS IN ALBINO RATS

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Abstract

The present investigation was carried out in an attempt to assess the effect of nutrition with the two studied mushroom varieties namely, (*Agaricus bisporus*) and (*Pleurotus ostreatus*) on triglycerides and cholesterol fractions levels in albino rats, namely: total cholesterol, HDL-cholesterol, LDL-cholesterol and glucose content in the blood serum of the experimental albino rats after feeding with the four studied mushroom varieties such 10% (*Agaricus bisporus*), 10% (*Pleurotus ostreatus*), 5% (*Agaricus bisporus*)and 5% (*Pleurotus ostreatus*).

The experiment included (56) males white albino rats (Sprague dawley strain) weighing between (100 – 120 g) divided into 6 groups with every group included 6 rats. Rats were housed individually in wire cages under the normal laboratory conditions and fed on the basal diet for a week as adaptation period. Daily administrations were continued for two successive periods (6) weeks each. In the first period one group was used as control and was fed on basal diet, including casein (12.5%), corn oil (10%), vitamin mixture (1%), salt mixture (3.5%), cellulose (5%), choline chloride (0.2%) and corn starch (67.8%). While, the other five groups were fed hyperlipidemic diet including (basal diet supplemented by 10% animal fat excluding 10% corn plus 1% cholesterol). In the second period, one group of hyperlipidiemic rats was fed on hyperlipidemic diet supplemented with different levels of the two studied mushroom varieties (*Agaricus bisporus*) and (*Pleurotus ostreatus*).

Blood samples were collected from the retro-orbital sinus under rat eye in a clean sterile centrifuge tube by the end of the experiment.

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Samples were tightly kept in a sealed aliquot tube at -20^{o}C until biochemical assays.

There were significant differences between untreated group and all other (5) studied groups of the experimental rats ($P < 0.05$) in the serum triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol, VLDL cholesterol and serum glucose levels, while group (3) (treated group fed on hyperlipidemic diet plus 10% *Agaricus bisporus*) recorded the lowest mean.

Key Words:

Mushrooms (*Agaricus bisporus*), (*Pleurotus ostreatus*), triglycerides, cholesterol, hyperlipidemic and glucose.

Introduction

In nature many thousands of species of mushrooms are located varying in form, color, size, strength and appearance and the nature of growth, taste with very tasty flavor. Most of such types have delicious flavor, however a few percentage of them are toxic kinds such as *Agaricus* compestris, *Pleurotus ostreatus*, *Lentinus Edodes*, *Flammulina Velutipes*, *Ganoderma Lucidium* and *Agaricus Blazei*. (**Hussain *et al.* 2006**).

Edible mushrooms had been widely utilized as a human foods for centuries and had been appreciated for texture and flavor as well as some medicinal and tonic attributes (**Manzi *et al.*, 2001**). However, the awarness of mushrooms as a healthy food and as an important source of biological active substances with medicinal value had only recently emerged (**Cheung, 1999**). Mushrooms are considered as healthy food because they are low in calories and fat but rich in proteins and dietary fibers (**Manzi *et al.*, 1999**).

Kuruswa *et al*. (1982) reported that Mushroom effectively lowered plasma cholesterol in laboratory animals. **Shahdat *et al*., 2003** reported that the feeding of 5% powder of the fruiting bodies of *P. ostreatus* mushrooms to hypercholesterolaemic rats reduced their plasma total cholesterol by approximately 28%, low density lipoprotein–cholesterol by approximately 55%, triglyceride by approximately 34%, non-esterified fatty acid by approximately 30% and total liver cholesterol levels by > 34%, with a concurrent increase in plasma high-density lipoprotein cholesterol concentration of > 21%. However, these effects were not observed in mushroom-fed normocholesterolaemic rats. Mushroom feeding significantly increased plasma fatty acid unsaturation in both normo- and hypercholesterolaemic rats and the 5% (*Pleurotus ostreatus*) supplementation provides health benefits, at least partially, by acting on the atherogenic lipid profile in the hypercholesterolaemic condition.

Fukushima *et al*., (2000) reported that (*Agaricus bisporous*) decreases serum low-density lipoprotein–cholesterol (LDL-C) by increasing the expression of low-density lipoprotein (LDL) receptor mRNA levels and LDL receptor activity.

Hashimoto *et al*., (1999) and Hashimoto *et al*., (2001) suggested that one of the most important food components that helped reduce serum cholesterol was its polyunsaturated fatty acid content.

Stamlo *et al*., (1986) mentioned that mushroom was lowering of high serum cholesterol levels and played a significant role in the prevention of atherosclerosis.

Higher fungi are an ideal dietary substance for the prevention and treatment of hypercholesterolemia due to the high content of dietary fiber, protein and microelements and the presence of plant sterols, as well as the low energy content. Lowering of circulating cholesterol especially the low density lipoprotein (LDLC) fraction can prevent arrest even reverse coronary atherosclerosis (**Barter** and **Rye 1996**).

Grundy (1986) reported that High-density lipoprotein (HDL) had been called the "good" cholesterol because high levels of it reduce an individual's tendency to develop atherosclerosis. HDL protects the blood vessels by removing some of the cholesterol from the arterial walls and possibly by slowing cholesterol's entry into tissues **(Mahley *et al*. 1978)**. HDL also promotes the production of prostacydin, a substance that inhibits clotting along the inner walls of arteries **(Byrne 1991)**.

Anon (2003a) reported that diabetic patients who included 50 grams of fiber in their daily diet lowered their glucose levels by 10%. The hight-fiber diet also decreased insulin levels in the blood and lowered blood lipid concentrations in patients with type II diabetes, or non insulin dependent diabetes mellitus, the most prevalent type of diabetes.

Schaeffiner *et al*. (2003) stated that when the body had too much of LDL above 160 mg/dl, the LDL or "bad cholesterol" starts to accumulate along the interior walls of arteries (blood vessels supplying oxygen to the heart and brain), causing a build up or forming a plaque and even then, blood clots could also appear on the plaque restricting oxygen, blood and nutrients from getting to the heart and brain. Such a phenomenon could inevitability cause heart disease leading to heart attack or stroke.

Oyetayo (2006), reported that total body weight gain of rats fed mushroom diets were not significantly different ($P > 0.05$) after 28 day feeding trial, plasma total cholesterol, low density lipoprotein cholesterol and triglycerides concentrations were found to be significantly lower ($P < 0.05$) than control while high density lipoprotein cholesterol were significantly higher ($P < 0.05$) and edible mushrooms have hypocholestolemic effects and could serve an important purpose in the prevention of atherosclerosis.

Bobek *et al*., (1993) found that in series of experiments that long term dietary supplementation with 5% dried oyster mushroom fruiting bodies can effectively suppress dietary induced hypercholesterolemia in rats.

Pavel *et al.*, (1997) reported that that diet supplemented with 1% oyster mushroom did not significantly affect the level of serum cholesterol or triacylglycerols and the diets supplemented with 5% oyster mushroom significantly reduced cholesterol levels, LDL, VLDL in serum in the experimental rats, while HDL was significantly higher in the serum.

El-Gengaihi *et al*. (2004) reported that vegetable oils markedly reduce blood cholesterol levels when substituted for animal fat in diets.

This investigation was carried out in an attempt to study the effect of the two studied mushrooms varieties on blood lipid profile (total cholesterol, HDL cholesterol, LDL cholesterol, VLDL cholesterol and triglycerides) in the experimental albino rats.

Material and Method

Materials:

Source of Samples:

40 kg of the two mushrooms varieties namely: (*Pleurotus ostreatus*) and (*Agaricus bisporus*) were procured from Food Technology Institute (Agriculture Research Center) and Metro local market Giza, Cairo; respectively in March 2008.

Preparation of Samples:

The mycelia were cleaned with a minimal amount of distilled water to remove the dust and solids. The rind (outer covering) of the mycelia were removed to avoid any contamination that might come from the compost and the plastic wrapping during cultivation.

Two mushroom varieties were dried in a drying oven at 55 – 60^{o}C for 6 – 8 hours to complete drying, thereafter were milled and kept in polyethylene bags at 5^{o}C until required for analysis **(Moharram *et al*., 2008)**.

Experimental Animals:

Fifty six adult male white albino rats (Sprague dawley strain) weighing between (100 and 120 g) provided from the animal house of the

Faculty of Medicine, Assiut University were housed individually in wire cages under the normal laboratory conditions and fed on the basal diet for a week as adaptation period.

Basal diet and untreated hyperlipidemic diet:

The basal diet used is outlined in Table (1), (2) and (3)

Table (1): Constituents of the basal diet for 100 gm diet*.

Item	%
Corn starch	67.8
Casein	12.5
Corn oil	10.0
Vitamins mixture	1.0
Salt mixture	3.5
Cellulose	5.0
Choline chloride	0.2
Total	100.0%

*(El-Sayed, 2001) and (Ilwy, 2003).

Table (2): Constituents of vitamins mixture used in the basal diet*.

Vitamins Mixture	
Item	**Amount (gm)**
Vitamin A plamitate 500.000 IU/gm	0.80
Vitamin D_3 100.000 IU/gm	1.00
Vitamin E acetate 500 IU/gm	10.00
Menadione sodium bisulfite 62.5% mendadione	0.08
Biotin 1.0%	2.00
Cyano cobalaming 0.01%	1.00
Folic acid	0.20
Nicotinic acid	3.00
Calcium pantothenate	1.60
Pyridoxine-Hcl	0.70
Riboflavin	0.60
Thiamin-Hcl	0.60
Sucrose	978.42
Total	1000.00

* Anon (1977).

Table (3): Constituents of the salt mixture used in the basal diet*:

Salt Mixture	
Item	**Amount (gm)**
Calcium phosphate, diabase 29.5% Ca, 22.8% P	500.00
Magnesium oxide 60.3% ug	24.00
Potassium citrate, 1 H_2O, 36.2% K	220.00
Postassium sulfate 44.9% K, 18.4% S	52.00
Sodium chloride 39.3% Na, 60.7% Cl	74.00
Chromium potassium sulfate 12.0 H_2O, 10.4% Cr	0.55
Cupric carbonate 57.5% Cu	0.30
Potassium iodate 59.3% I	0.01
Ferric citrate 21.2% Fe	6.00
Manganous carbonate 47.8% Mn	3.50
Sodium selenite 45.7% Se	0.01
Zinc carbonate 52.1 Zn	1.60
Sucrose	118.03
Total	1000.00

* Anon (1980).

The untreated hyperlipidemic diet used is outlined in tables (2), (3) and (4).

Table (4): Constituents of the hyperlipidemic diet for 100 gm diet*.

Item	%
Corn starch	66.80
Casein	12.5
Animal fat	10.00
Cholesterol	1.00
Vitamins mixture	1.00
Salt mixture	3.50
Cellulose	5.00
Choline chloride	0.2
Total	100.0%

*(El-Sayed 2001) and (Ilwy, 2003)

Design of the experiment:

The rats were randomly allocated into (6) main groups of (6) rats each. Daily administrations were continued for two successive periods (6) weeks each. In the first period one group was used as control and was fed on basal diets, while the other five groups were fed the hyperlipidemic diet as concluded by **Abd-El-Maksoud *et al.* (1996)**. In general rats were classified as following:

Group 1: Control group fed on basal diet.

Group 2: Untreated group fed on hyperlipidemic diet.

Group 3: Treated group fed on hyperlipidemic diet plus 10% dried mushroom (*Agaricus bisporus*).

Group 4: Treated group fed on hyperlipidemic diet plus 10% dried mushroom (*Pleurotus ostreatus*).

Group 5: Treated group fed on hyperlipidemic diet plus 5% dried mushroom (*Agaricus bisporus*).

Group 6: Treated group fed on hyperlipidemic diet plus 5% dried mushroom (*Pleurotus ostreatus*).

Blood sampling:

At the end of each experiment, rats were fasted overnight and anesthetized.

Blood samples were collected from the retro-orbital plexus from all animals of each group into clean, dry and labeled tube. The tubes contained heparin (10.0 IU / ml) as anticoagulant. Blood was centrifuged (3500 r-p. m for 15 min) to separate plasma which was tightly kept in sealed aliquot tubes at - 20^{o}C until biochemical assays according to Ilwy (2003).

Methods

Biochemical methods:

Prepared samples (as mentioned in 2.1.6) were used to study the following biochemical parameters using PHOTO Mech 301-D+ spectrophotometer (Optima).

Determination of serum triglycerides:

Fully enzymatic determination of total triglycerides in serum was

estimated spectrophtometrically at 500 η m according to the method of **Wahlefeld (1974).**

Determination of serum total cholesterol:

Enzymatic determination of cholesterol was carried out according to the method of **Allian *et al*. (1974)** using kits purchased from Stanbio (Texas, USA).

Determination of High Density Lipoprotein (HDL) cholesterol:

The kits were provided from Stanbio, Lab., Inc. Texas. According to **Warnick *et al*. (1983)**.

Low Density Lipoprotein (LDL) cholesterol calculation:

LDL was calculated by the difference between total cholesterol, HDL cholesterol and triglyceride, according to **Friedewald *et al*. (1972).**

Determination of serum glucose:

Serum glucose level was analyzed by calorimetric procedures kits developed by Diamond diagnostics kits Cairo, Egypt using 550 η m. according to **Trinder (1969).**

Statistical analysis:

Data was analyzed with applying of variance (ANOVA) procedures by using the MSTAT-C Statistical software package **(Russell 1983)**. Where the F-test showed significant differences among means **Duncan (1955)** performed at the 0.05 level of probability to separate means.

Results and discussion

Serum triglycerides in the two studied mushroom varieties:

The results given in table (5) revealed that the blood serum triglycerides of the experimental animals showed significant differences among all the six studied groups at ($P < 0.05$).

However, the data regarding the blood serum triglycerides were (243.1±3.89 mg / dl) for group (2) of experimental rats (untreated group fed on hyperlipidemic diet).

Likewise, the blood serum triglycerides decreased significantly at ($P < 0.05$) recording (177.2±4.61 mg / dl) for group (3) of rat (treated group fed on hyperlipidemic diet plus 10% *Agaricus bispours* / rat), (194.1±3.74

mg / dl) for group (4) of rat (treated group fed on hyperlipidemic deit plus 10% *Pleurotus ostreatus* / rat), (211.1±3.06 mg / dl) for group (5) of rat (treated group fed on hyperlipidemic diet plus 5% *Agaricus busporus* / rat) and (228.0±3.05 mg / dl) for group (6) of rat (treated group fed on hperlipidemic diet plus 5% *Pleurotus ostreatus* / rat); respectively.

The data given in table (5) revealed that the mean values among all six studied treatments recorded significant decrease starting from 193.0 and reaching 183.2 by the end of the feeding experiment.

The present data given in table (5) on blood serum triglycerides in the serum of the experimental animals was agreed with **Oyetayo (2006)** who found that, rats fed mushroom diets were significantly lower triglycerides concentrations ($P < 0.05$).

Table (5): Effect of the six studied groups on the serum triglycerides content (mg / dl) of the experimental rats.

Time of observation	Control	Hyperlipidemic diet	10% *Agaricus bisporus*	10% *Pleurotus ostreatus*	5% *Agaricus bisporus*	5% *Pleurotus ostreatus*	Mean
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	
End of 1st week ± S. E.	132.1^{s} ± 4.02	208.6^{hij} ± 0.81	190.4^{lm} ± 3.41	199.1^{jkl} ± 2.51	207.8^{ij} ± 2.66	220.0^{fg} ± 2.21	193.0^{D} ± 5.43
End of 2nd week ± S. E.	137.2^{rs} ± 3.93	227.4^{ef} ± 1.31	200.0^{jk} ± 2.90	214.8^{ghi} ± 1.87	229.6^{e} ± 1.15	242.9^{cd} ± 3.18	208.6^{B} ± 6.50
End of 3rd week ± S. E.	141.3^{qrs} ± 6.14	250.0^{c} ± 2.66	203.2^{j} ± 2.82	217.7^{gh} ± 1.75	232.2^{e} ± 1.77	247.0^{c} ± 2.10	215.2^{A} ± 6.94
End of 4th week ± S. E.	144.0^{qr} ± 4.86	258.8^{b} ± 2.90	175.8^{n} ± 5.06	192.4^{klm} ± 3.64	209.0^{hij} ± 2.72	235.8^{de} ± 1.69	202.6^{C} ± 7.15
End of 5th week ± S. E.	148.2^{pq} ± 5.30	267.6^{a} ± 1.37	155.4^{op} ± 4.60	177.7^{n} ± 3.54	200.0^{jk} ± 2.66	218.8^{fg} ± 2.67	194.6^{D} ± 7.67
End of 6th week ± S. E.	160.8^{o} ± 4.02	246.1^{c} ± 7.29	138.2^{rs} ± 2.97	163.0^{o} ± 2.64	187.8^{m} ± 3.73	203.4^{j} ± 5.04	183.2^{E} ± 6.70
Mean	143.9^{E} ± 2.45	243.1^{A} ± 3.89	177.2^{E} ± 4.61	194.1^{D} ± 3.74	211.1^{C} ± 3.06	228.0^{B} ± 3.05	

S. E. = Standard Error

Values followed by the same letter within the same column were not significantly different ($P < 0.05$).

F. Test (A) (week) = 86.96^{**} **F. Test (B) (Tre.) = 836.67^{**}**

F. Test (AB) = 31.47^{**}

Serum total cholesterol in the two studied mushroom varieties:

The results given in table (6) revealed that the serum total cholesterol values significant differences among all the six studied groups at ($P < 0.05$) in experimental period.

However, the data regarding the blood serum total cholesterol were (283.7±9.38 mg / dl) for group (2) of experimental rats (untreated group fed on hyperlipidemic diet).

Meanwhile, the blood serum total cholesterol in groups (3, 4, 5 and 6) decreased significantly at ($P < 0.05$) recording (193.5±3.02 mg / dl, 204.5±2.99 mg / dl, 221.7±3.00 mg / dl and 228.4±3.19 mg / dl); respectively for these four groups of rats (treated group fed on hyperlipidemic diet plus 10% *Agaricus bisporus*, treated group fed on hyperlimpidemic diet plus 10% *Pleurotus ostrreats*, treated group fed on hyperlipidemic diet plus 5% *Agaricus bisporus* and treated group fed on hyperlipidemic diet plus 5% *Pleurotus ostrreats* / rats); respectively.

The data given in table (6) revealed that the mean values among all six studied treatments recorded significant decrease starting from 201.2 and reaching 202.8 by the end of the feeding experiment.

The present results given in table (6) were agreed with **Stamlo *et al*., (1986)** who found mushroom was lowering of high serum cholesterol levels and played a significant role in the prevention of atherosclerosis.

Table (6): Effect of the six studied groups on the serum cholesterol content (mg / dl) of the experimental rats.

Time of observation	Control	Hyperlipidemic diet	10% *Agaricus bisporus*	10% *Pleurotus ostreatus*	5% *Agaricus bisporus*	5% *Pleurotus ostreatus*	Mean
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	
End of 1st week ± S. E.	95.4^{s} ± 2.64	223.2^{hi} ± 0.82	207.9^{k} ± 2.54	217.0^{ij} ± 2.55	227.6^{fgh} ± 2.84	236.2^{def} ± 6.12	201.2^{C} ± 9.02
End of 2nd week ± S. E.	104.2^{r} ± 3.06	233.0^{efg} ± 0.95	208.6^{jk} ± 2.60	219.4^{hi} ± 2.52	234.6^{efg} ± 3.70	243.8^{cd} ± 2.42	207.3^{B} ± 8.87
End of 3rd week ± S. E.	113.6^{q} ± 3.43	248.4^{c} ± 1.52	209.2^{jk} ± 2.52	221.0^{hi} ± 2.45	237.2^{de} ± 2.63	240.6^{cde} ± 2.18	211.7^{A} ± 8.54
End of 4th week ± S. E.	117.4^{q} ± 2.16	322.9^{b} ± 5.58	185.8^{mn} ± 2.29	198.8^{l} ± 2.44	226.4^{gh} ± 2.11	232.8^{efg} ± 2.08	214.0^{A} ± 11.48
End of 5th week ± S. E.	120.1^{q} ± 2.20	325.0^{b} ± 4.64	177.2^{op} ± 2.13	189.0^{mn} ± 1.76	210.8^{jk} ± 3.18	219.0^{hi} ± 3.91	206.9^{B} ± 11.52
End of 6th week ± S. E.	121.4^{q} ± 3.33	349.7^{a} ± 2.32	172.2^{p} ± 1.02	181.8^{no} ± 0.92	193.8^{lm} ± 2.82	197.8^{l} ± 1.24	202.8^{C} ± 13.09
Mean	112.0^{F} ± 2.03	283.7^{A} ± 9.38	193.5^{E} ± 3.02	204.5^{D} ± 2.99	221.7^{C} ± 3.00	228.4^{B} ± 3.19	

S. E. = Standard Error
Values followed by the same letter within the same column were not significantly different (P < 0.05).
F. Test (A) (week) = 18.88^{**} F. Test (B) (Tre.) = 2444.19^{**}
F. Test (AB) = 106.54^{**}

Serum HDL (High Density Lipoprotein) in the two studied mushroom varieties:

The results given in table (7) revealed that the serum HDL of the experimental animals showed significant differences among all the six studied groups at (P < 0.05) in experimental period.

However, the data showed significant differences between group (1) (control group fed on basal diet) recording (52.61±1.11 mg / dl) and all other groups in the two studied mushroom varieties namely: (*Agaricus*

bisporus) and (*Pleurotus ostrreats*).

On the other hand, significant differences between group (2) (untreated group fed on hyperlipidemic diet) recording (53.07±0.77 mg / dl) and groups (3, 4, 5 and 6) were recorded.

However, the serum HDL cholesterol in group (3) (treated group fed on hyperlipidemic diet plus 10% *Agaricus bisporus* / rat) recorded increased significantly at ($P < 0.05$) recording (81.22±3.08 mg / dl).

But, the serum HDL cholesterol in groups (4, 5 and 6) (treated group fed on hyperlipidemic diet plus 10% *Pleurotus ostreatus*, treated group fed on hyperlipidiemic diet plus 5% *Agaricus bisporus* and treated group fed on hyperlipidemic diet plus 5% *Pleurotus ostreatus* / rats) recorded (76.86±2.51 mg / dl, 72.60±2.14 mg / dl and 66.07±1.62 mg / dl); respectively.

The data given in table (7) revealed that the mean values among all six studied treatments recorded significant increase starting from 58. 52 and reaching 77.75 by the end of the feeding experiment.

The present results given in table (7) were agreed with. **Oyetayo (2006)** who found high density lipoprotein cholesterol were significantly higher ($P < 0.05$) when rats fed on mushroom diets.

Table (7): Effect of the six studied groups on the serum HDL content (mg / dl) of the experimental rats.

Time of observation	Control	Hyperlipidemic diet	10% *Agaricus bisporus*	10% *Pleurotus ostreatus*	5% *Agaricus bisporus*	5% *Pleurotus ostreatus*	Mean
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	
End of 1st week ± S. E.	51.12^{qrs} ± 1.94	52.00^{pqr} ± 2.61	67.48^{hij} ± 5.07	63.31^{ijkl} ± 2.92	59.20^{klmno} ± 2.73	58.01^{lmnopq} ± 2.55	58.52^{E} ± 1.58
End of 2nd week ± S. E.	$56.40^{lmnopqr}$ ± 1.69	52.40^{opqr} ± 2.52	58.52^{klmnop} ± 3.27	59.87^{klmn} ± 2.16	61.80^{jklm} ± 1.28	55.40^{mnopqr} ± 1.72	57.40^{E} ± 1.00
End of 3rd week ± S. E.	59.40^{klmno} ± 2.56	54.80^{mnopqr} ± 1.98	78.94^{fg} ± 2.22	73.27^{gh} ± 1.25	67.60^{hij} ± 1.50	65.20^{ijk} ± 2.48	66.54^{D} ± 1.68
End of 4th week ± S. E.	53.00^{nopqr} ± 1.05	54.40^{nopqr} ± 0.68	85.46^{de} ± 3.17	80.71^{ef} ± 1.46	76.00^{fg} ± 1.76	69.00^{hi} ± 2.77	69.76^{C} ± 2.42
End of 5th week ± S. E.	45.20^{s} ± 2.84	55.20^{mnopqr} ± 0.80	93.22^{bc} ± 2.10	87.11^{cde} ± 1.07	81.00^{ef} ± 2.07	73.00^{gh} ± 1.87	72.46^{B} ± 3.26
End of 6th week ± S. E.	50.56^{rs} ± 0.58	49.60^{rs} ± 1.44	103.70^{a} ± 3.47	96.86^{b} ± 2.09	90.00^{cd} ± 2.17	75.80^{fg} ± 2.13	77.75^{A} ± 4.04
Mean	52.61^{E} ± 1.11	53.07^{E} ± 0.77	81.22^{A} ± 3.08	76.86^{D} ± 2.51	72.60^{C} ± 2.14	66.07^{D} ± 1.62	

S. E. = Standard Error

Values followed by the same letter within the same column were not significantly different (P < 0.05).

F. Test (A) (week) = 84.15** **F. Test (B) (Tre.) = 194.31****

F. Test (AB) = 14.67**

Serum LDL (Low Density Lipoprotein) in the two studied mushroom varieties:

The results given in table (8) revealed that the serum LDL showed significant differences among all the six studied groups, all feeding weeks at (P < 0.05) in experimental period.

Meanwhile, the data regarding the serum LDL cholesterol were (182.1± 8.95 mg / dl) for group (2) of experimental rats (untreated group fed on hyperlipidemic diet).

On the other hand, the serum LDL cholesterol in groups (3, 4, 5 and 6) decreased significantly at (P < 0.05) recording (76.8±4.97 mg / dl, 88.6±4.57 mg / dl, 106.9±4.36 mg / dl and 116.2±3.80 mg / dl); respectively for two groups of mushroom varieties.

The data given in table (8) revealed that the mean values among all six studied treatments recorded significant decrease starting from 103.4 and reaching 88.3 by the end of the feeding experiment.

The present results given in table (8) were agreed with **Shahdat *et al*., (2003)** who found Mushroom feeding significantly increased plasma fatty acid unsaturation in both normo- and hypercholesterolaemic rats and the 5% (*Pleurotus ostreatus*) supplementation provided health benefits, at least partially, by acting on the atherogenic lipid profile in the hypercholesterolaemic condition.

On the other hand, **Barter** and **Rye (1996)** found that, lowering of circulating cholesterol especially the low density lipoprotein (LDL) cholesterol fraction could prevent arrest or even reverse coronary atherosclerosis.

Table (8): Effect of the six studied groups on the serum LDL content (mg / dl) of the experimental rats.

Time of observation	Control	Hyperlipidemic diet	10% *Agaricus bisporus*	10% *Pleurotus ostreatus*	5% *Agaricus bisporus*	5% *Pleurotus ostreatus*	Mean
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	
End of 1st week ± S. E.	17.9^{q} ± 3.19	129.5^{ef} ± 2.36	102.4^{k} ± 4.40	113.9^{hij} ± 1.07	126.8^{efg} ± 2.30	130.2^{def} ± 1.88	103.4^{B} ± 7.41
End of 2nd week ± S. E.	20.4^{q} ± 3.82	135.1^{cde} ± 2.22	110.1^{ijk} ± 2.70	115.0^{hi} ± 2.09	126.9^{efg} ± 3.50	139.8^{cd} ± 3.00	107.9^{A} ± 7.60
End of 3rd week ± S. E.	25.6^{q} ± 4.43	143.8^{c} ± 2.38	89.6^{l} ± 3.71	104.2^{jk} ± 3.09	123.2^{fgh} ± 3.35	126.8^{efg} ± 3.05	102.2^{B} ± 7.23
End of 4th week ± S. E.	35.6^{p} ± 2.80	216.7^{b} ± 5.57	65.2^{n} ± 4.62	79.6^{m} ± 3.41	108.6^{ijk} ± 2.22	116.6^{ghi} ± 4.27	103.7^{B} ± 10.73
End of 5th week ± S. E.	45.3^{op} ± 4.68	216.3^{b} ± 4.56	52.9^{o} ± 3.79	66.4^{n} ± 3.10	89.8^{l} ± 4.06	102.2^{k} ± 4.03	95.5^{C} ± 10.79
End of 6th week ± S. E.	38.7^{p} ± 3.88	250.9^{a} ± 5.19	40.5^{p} ± 3.02	52.4^{o} ± 2.47	66.2^{n} ± 5.00	81.3^{lm} ± 1.98	88.3^{D} ± 13.85
Mean	30.6^{F} ± 2.34	182.1^{A} ± 8.95	76.8^{E} ± 4.97	88.6^{D} ± 4.57	106.9^{C} ± 4.36	116.2^{B} ± 3.80	

S. E. = Standard Error

Values followed by the same letter within the same column were not significantly different (P < 0.05).

F. Test (A) (week) = 26.93** F. Test (B) (Tre.) = 1356.96**
F. Test (AB) = 91.54**

Serum VLDL cholesterol in the two studied mushroom varieties:

The results given in table (9) revealed that the serum VLDL cholesterol showed significant differences among all studied groups at ($P < 0.05$) in experimental period.

However, the data regarding the blood serum VLDL-cholesterol were (48.59±0.78 mg / dl) for group (2) of experimental rats (untreated group fed on hyperlipidemic diet).

Likewise, the serum VLDL-cholesterol decreased significantly at ($P < 0.05$) for groups (3, 4, 5 and 6) of experimental rats to recording (35.43±0.92 mg / dl) for group (3) of experimental rats (treated group fed on hyperlipidemic diet plus 10% *Agaricus bisporus* / rat), (38.76±0.74 mg / dl) for group (4) of rat (treated group fed on hyperlimpidemic diet plus 10% *Pleurotus ostrreats* / rat), (42.22±0.61 mg / dl) for group (5) of rat (treated group fed on hyperlipidemic diet plus 5% *Agaricus bisporus* / rat) and (45.46±0.60 mg / dl) for group (6) of rat (treated group fed on hyperlipidemic diet plus 5% *Pleurotus ostrreats* / rat); respectively.

The data given in table (9) revealed that the mean values among all six studied treatments recorded significant decrease starting from 38.60 and reaching 36.64 by the end of the feeding experiment.

The present results given in table (9) were agreed with **Pavel *et al*., (1997)** who found that, dose 5% of Oyster mushroom reduced cholesterol content very low density lipoproteins and VLDL.

Table (9): Effect of the six studied groups on the serum VLDL content (mg / dl) of the experimental rats.

Time of observation	Control	Hyperlipidemic diet	10% *Agaricus bisporus*	10% *Pleurotus ostreatus*	5% *Agaricus bisporus*	5% *Pleurotus ostreatus*	Mean
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	
End of 1st week ± S. E.	26.42^{q} ± 0.80	41.72^{ghi} ± 0.16	38.08^{jk} ± 0.68	39.82^{ij} ± 0.52	41.57^{ghi} ± 0.53	44.00^{ef} ± 0.44	38.60^{D} ± 1.09
End of 2nd week ± S. E.	27.44^{pq} ± 0.78	45.47^{de} ± 0.26	40.00^{ij} ± 0.58	42.58^{fgh} ± 0.57	45.92^{d} ± 0.23	48.58^{bc} ± 0.64	41.67^{B} ± 1.30
End of 3rd week ± S. E.	28.24^{opq} ± 1.22	49.86^{b} ± 0.61	40.64^{hi} ± 0.56	43.54^{fg} ± 0.35	46.44^{d} ± 0.35	48.60^{bc} ± 0.99	42.89^{A} ± 1.37
End of 4th week ± S. E.	28.78^{op} ± 0.97	51.78^{a} ± 0.58	35.16^{l} ± 1.01	38.48^{jk} ± 0.73	41.80^{ghi} ± 0.54	47.16^{cd} ± 0.34	40.53^{C} ± 1.43
End of 5th week ± S. E.	29.64^{no} ± 1.06	53.50^{a} ± 0.28	31.08^{mn} ± 0.92	35.54^{l} ± 0.71	40.00^{ij} ± 0.53	43.76^{ef} ± 0.53	38.92^{D} ± 1.53
End of 6th week ± S. E.	32.16^{m} ± 0.80	49.18^{b} ± 1.47	27.64^{pq} ± 0.59	32.60^{m} ± 0.53	37.56^{k} ± 0.75	40.68^{hi} ± 1.01	36.64^{E} ± 1.34
Mean	28.781^{F} ± 0.49	48.59^{A} ± 0.78	35.43^{E} ± 0.92	38.76^{D} ± 0.74	42.22^{C} ± 0.61	45.46^{B} ± 0.60	

S. E. = Standard Error

Values followed by the same letter within the same column were not significantly different (P < 0.05).

F. Test (A) (week) = 76.89^{**} **F. Test (B) (Tre.) = 797.15^{**}**

F. Test (AB) = 28.84^{**}

Serum glucose in the two studied mushroom varieties:

The results given in table (10) revealed that the serum glucose showed significant differences among all the six studied groups, all feeding weeks as well as interaction studied groups and feeding weeks at ($P < 0.05$) in experimental period.

However, the data regarding the serum glucose were (130.8± 4.17 mg / dl) for group (2) of experimental rats (untreated group fed on hyperlipidemic diet).

Likewise, the serum glucose decreased significantly at ($P < 0.05$) for groups (3, 4, 5 and 6) of experimental rats to recording (106.8 ± 1.98 mg / dl) for group (3) of experimental rats (treated group fed on hyperlipidemic diet plus 10% *Agaricus bisporus* / rat), (113.3±2.08 mg / dl) for group (4) of rat (treated group fed on hyperlimpidemic diet plus 10% *Pleurotus ostrreats* / rat), (119.8±2.37 mg / dl) for group (5) of rat (treated group fed on hyperlipidemic diet plus 5% *Agaricus bisporus* / rat) and (122.4±2.47 mg / dl) for group (6) of rat (treated group fed on hyperlipidemic diet plus 5% *Pleurotus ostrreats* / rat); respectively.

The data given in table (10) revealed that the mean values among all six studied treatments recorded significant increase starting from 91.8 and reaching 120.7 by the end of the feeding experiment.

Table (10): Effect of the six studied groups on the serum glucose content (mg / dl) of the experimental rats.

Time of observation	Control	Hyperlipi demic diet	10% *Agaricus bisporus*	10% *Pleurotus ostreatus*	5% *Agaricus bisporus*	5% *Pleurotus ostreatus*	Mean
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	
End of 1st week ± S. E.	90.8^{op} ± 2.19	90.8^{op} ± 1.77	87.6^{p} ± 1.24	91.4^{nop} ± 1.40	95.3^{mno} ± 1.79	95.1^{mno} ± 2.62	91.8^{C} ± 0.86
End of 2nd week ± S. E.	98.1^{lm} ± 5.28	119.4^{fg} ± 0.92	111.1^{ij} ± 2.81	113.6^{ghij} ± 2.98	116.1^{fghi} ± 3.37	122.4^{ef} ± 2.34	113.5^{B} ± 1.88
End of 3rd week ± S. E.	97.2^{lmn} ± 0.64	129.1^{d} ± 3.17	120.6^{ef} ± 1.17	125.6^{de} ± 1.74	130.6^{d} ± 2.88	131.6^{d} ± 3.07	122.5^{A} ± 2.37
End of 4th week ± S. E.	101.7^{l} ± 2.70	139.0^{c} ± 2.67	108.6^{jk} ± 2.58	118.7^{fgh} ± 1.06	128.7^{d} ± 1.19	130.0^{d} ± 1.46	121.1^{A} ± 2.51

End of 5th week	97.9^{lm}	148.3^{b}	109.7^{j}	117.7^{fgh}	125.7^{de}	129.0^{d}	121.4^{A}
± S. E.	± 1.84	± 2.58	± 1.29	± 0.94	± 1.72	± 1.40	± 3.01
End of 6th week	101.4^{l}	158.3^{a}	103.1^{kl}	112.8^{hij}	122.4^{ef}	126.2^{de}	120.7^{A}
± S. E.	± 2.49	± 3.70	± 1.21	± 1.40	± 2.01	± 1.46	± 3.64
	97.9^{F}	130.8^{A}	106.8^{E}	113.3^{D}	119.8^{C}	122.4^{B}	
Mean	± 1.26	± 4.17	± 1.98	± 2.08	± 2.37	± 2.47	

S. E. = Standard Error

Values followed by the same letter within the same column were not significantly different (P < 0.05).

F. Test (A) (week) = 214.87** F. Test (B) (Tre.) = 210.79**

F. Test (AB) = 18.19**

In conclusion, on the basis of above mentioned data, there were significant differences between untreated group and all other (5) studied groups of the experimental rats (P < 0.05) in the serum triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol, VLDL cholesterol and serum glucose levels, while group (3) (treated group fed on hyperlipidemic diet plus 10% *Agaricus bisporus*) recorded the lowest mean.

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تأثير تناول صنفين من عيش الغراب على مستوى الجليسريدات الثلاثية والكوليسترول والجلوكوز في فئران التجارب

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تناول البحث تقدير تأثير التغذية بنوعين من عيش الغراب (الأجاريكس والمحاري) على مستوى الجليسريدات الثلاثية والكوليسترول الكلي وكوليسترول البروتين مرتفع الكثافة وكوليسترول البروتين منخفض الكثافة وكوليسترول البروتين منخفض الكثافة جداً والجلوكوز في سيرم دم فئران التجارب بعد تغذيتها على عيش الغراب بنوعيه بالنسب الآتية (١٠٪ أجاريكس و١٠٪ محاري و٥٪ أجاريكس و٥٪ محاري).

وقد أجريت الدراسة على (٥٦) من ذكور فئران الألبينو البيضاء يتراوح وزنها ما بين (١٠٠ - ١٢٠ جم) حيث تم تقسيم هذه الفئران إلى ست مجموعات وتتكون كل مجموعة من (٦) فئران وقد تم وضع هذه الفئران لمدة أسبوع في أقفاص التجربة وتغذيتها على الوجبات الأساسية وذلك حتى تتكيف مع ظروف التجربة قبل رفع مستوى الكوليسترول بها وبدء تغذيتها على عيش الغراب بنوعيه.

وقد أجريت التجربة على مرحلتين كل مرحلة استمرت (٦) أسابيع، في المرحلة الأولى تم تغذية المجموعة الأولى الضابطة على الوجبات الغذائية الأساسية وتتكون الوجبة الأساسية في غذاء الفأر من (١٢,٥٪) كازين، (١٠٪) زيت ذرة، (١٪) خليط فيتامينات، (٣,٥٪) خليط أملاح، (٥٪) سيليلوز، (٠,٠٢٪) أملاح الصفراء والباقي (٦٧,٨٪) نشا ذرة.

بينما تم تغذية المجموعات الخمس الأخرى على وجبات غذائية تحتوي على دهن حيواني (١٠٪) بدلاً من (١٠٪) زيت الذرة وكوليسترول (١٪) وذلك لرفع مستوى الجليسريدات والكلوليسترول بها في سيرم دم فئران التجارب.

وفي المرحلة الثانية استمرت تغذية المجموعة الأولى الضابطة على الوجبات الغذائية الأساسية بينما تم تغذية المجموعات الخمس الأخرى على الوجبات الغذائية الموضحة عالية والتي تشتمل على المجموعة غير المعاملة والمجموعات الأربعة مضافاً إليها عيش الغراب بنوعيه بنسبه الأربعة المدروسة.

وقد تم سحب عينات الدم وجمعت من العين في أنابيب طرد مركزي وحفظها في المجمد (- ٢٠° م) لحين إجراء التحاليل الكيميائية عليها.

ولقد أوضحت النتائج أنه توجد فروق ذات دلالة إحصائية (٠,٠٥) بين المجموعة غير المعاملة وجميع المجموعات الأربعة المدروسة في مستوى الكوليسترول والكوليسترول مرتفع الكثافة والكوليسترول منخفض الكثافة والكوليسترول منخفض الكثافة جداً والجليسريدات الثلاثية والجلوكوز.

وكان أكثرها تأثيراً في الانخفاض مجموعة (٣) والتي تتغذى على عيش الغراب الأجاريكس (١٠٪).

الكلمات المفتاحية:

عيش غراب أجاريكس. عيش غراب محاري. جليسريدات ثلاثية. زيادة مستوى الليبيدات في الدم.