Cholesterol and Glucose Lowering Effect by Some Edible Mushrooms

A. A. Hassan & Mahmoud, A. R.
Agricultural Research Office, P.O. Box, 765, Baghdad-Iraq.
Received: 31/8/2002 *Accepted: 11/1/2003*

Abstract

Ten species of edible mushrooms (higher fungi) were tested for their ability to reduce cholesterol and glucose in mice blood. The powders of dried fruit bodies of these mushrooms were mixed with standard mice diet at 5 and 10% (on dry wt.).This diet was also supplemented with 2% of pure cholesterol and glucose. Though the significant reduction of blood cholesterol and glucose in mice fed on all tested mushrooms (at both concentrations) was recorded, maximum reduction of blood cholesterol in mice fed on 10% of *Pleurotus ostreatus* (Gray type), *Lentinus edodes, Pleurotus ostreatus* (White type), *Ganoderma lucidum and Pleurotus sajor-caju* was 52.55, 50, 48.5, 46.6 and 38.1% in males, and 50.42, 48.72, 46.4, 43.4 and 38.1% in females, respectively, after 4 weeks from feeding. On the other hand, maximum reduction of blood glucose in mice fed on 10% of *Lentinus edodes, Coprinus comatus, Pleurotus sajor-caju, Pleurotus ostreatus* (White type) and *Ganoderma lucidum* was 47, 42, 33.5, 33 and 32% in males and 45, 42, 33.5, 32 and 35% in females, respectively, after 4 weeks from feeding. These results suggest that these edible mushrooms benefit for patients suffering from hypertension, diabetes and obesity.

الخلاصة

تم اختبار مقدرة عشرة أنواع من المشروم الصالح للاكل في تخفيض نسبة الكولسترول والكلوكوز في دم الفئران. تم مزج المسحوق الجاف للاجسام الثمرية للمشروم مع العليقة القياسية وبنسبتين 5 و 10% (من اساس الوزن الجاف للعليقة). جهزت العليقة ايضاً بـ 2% من الكولسترول والكلوكوز النقي. بالرغم من تسجيل انخفاض في كولسترول وكلوكوز دم الفئران التي غذيت بالعليقة الحاوية على كلا النسبتين من مسحوق المشروم لمدة 30 يوما فان اكثر اختزال في كولسترول الدم للفئران التي غذيت بـ 10% من مسحوق الفطريات *Pleurotus ostreatus* (السلالة الرمادية) *Lentinus edodes, P.ostreatus,* (السلالة البيضاء) *Ganoderma lucidum, P.sajor-caju* بنسبة اختزال قدرها 52.2, 48.7, 46.6, 38% في الذكور و50.4, 48.7, 46.7, 43.1, 38.1% في الاناث على التوالي حيث لاتوجد فروق معنوية بين الذكور والاناث، من ناحية اخرى سجل اكثر اختزال في كلوكوز الدم في الفئران التي غذيت على العليقة المزودة بـ 10% من مسحوق المشروم *P.sajor-caju, Coprinus comatus L.edodes* و *P.ostreatus* (السلالة البيضاء) و *G.lucidum* بنسبة اختزال قدرها 47 و 42 و 33.5 و 33 و 32% في الذكور و 45 و 42 و 33.5 و 32 و 35% في الاناث على التوالي حيث لا توجد فروق معنوية لنسب انخفاض الكلوكوز في دم الذكور والاناث. تشير هذه النتائج بان تناول مثل هذه المشروم الغذائية يفيد المرضى المصابين بارتفاع ضغط الدم وتصلب الشرايين ومصابي داء السكر والسمنة لتأثير هذه الفطريات في تخفيض نسب الكولسترول والكلوكوز في الدم بالاضافة الى كون هذه الفطريات خالية تماما من النشا والكولسترول وغنية بالبروتينات والعناصر المعدنية والفيتامينات.

Introduction

Mushrooms are regarded as natural medicines with high medicinal value, many of them used by ancient doctors are still widely applied today (1,11) many edible mushrooms have been traditionally used in some countries such as China, India, Germany, England, United state and Japan for their medicinal and tonic properties (1,13). It is known that more than 220 species of fungi are of a certain medicinal value, but most of them have not been utilized well till now, hence, it has great potential in medicinal applications (11). Mushrooms are a source of good quality protein and are rich in vitamins of B- complex including folic acid and vitamin B12. As a low calorie high protein item with negligible starch and sugars, these are, the delight of the diabetic. Very high potassium: sodium ratio, low caliorie and fat (rich in linoleic acid and devoid of cholesterol) make mushrooms the choice of the dietician for those suffering with, or prone to, obesity, hypertension and atherosclerosis (13,14) in addition, these mushrooms contain other pharmacologically active substances which reduce blood pressure, blood sugar, eliminate cholesterol and inhibit platelet aggregation (12). Not only their pharmacologically active constituents have been isolated and characterised, many proprietory products have been developed and being marketed. The more active constituents from some mushrooms were polysaccharides, triterpenese, lentinan, adenosine, lingzhi-8, eritadenine butyric acid and others made these mushrooms possess significant anti-hypertension, hypoglycemic, hypolipdemic, hypocholesterolemic, antihepatitis B, immunodulatory and antiplatelet aggregation (14) in addition to antibiotic activity including antiprotozoal effects, antitumor effects and antiviral effects (2). In the recent past, a variety of medicinal preparation in form of tablets, capsules and extracts from mushrooms have been produced and marketed. In 1991, the value of world mushroom crop was estimated at 8.5 billion dollars and in the same year 1.2 billion dollars are estimated to have been generated from medicinal products from mushrooms (14). In Iraq, the cultivation of some edible mushrooms such as *Pleurotus sajor-caju, P. ostreatus* (Gray type) and *P.ostrearus* (White type) (3,4) *Coprinus comatus (5) Agaricus bisporus* and *A.bitorquis* (6) were successfully achieved. The purpose of present study is to test these cultivated mushrooms in addition uncaltivated others for their ability to lower blood cholesterol and glucose.

Materials and Methods:

Mushrooms:

Ten species of mushrooms were used in this study. The fruitbodies of those mushrooms were dried and powdered. Species and source of mushrooms were summrized in table 1.

The Animals

Five males and females (5-6 weeks old) Balb b/c-white mice were separatly housed in stainless steel cages containing hard-wood chip as bedding, the beding was changed weekly to snsure a clean environment. The mice were supplied by quality control division in chemistry research office in Iraqi Atomic Energy Commission (IAEC). They were selected from an inbred colony maintained under controlled conditions of temperature (25°C), humidity (50%) and light (10 and 14 hours of light and dark, respectively).

The mice were fed on special formula feed pellets mixed with powdered fruitbodies of each mushroom at a rate of 5 and 10% (on dry wt.). This diet was also supplemented with 2% of pure cholesterol and glucose. One group of mice were fed on diet devoid of powderd mushrooms as control. The mice were supplied with water *ad libitum*.

Blood Samples

Blood was withdrawn from mice (after 4 weeks from feeding) by sterile syringe usually in the range of 1-5 ml. The blood was transferred into tubes under aseptic conditions for serum collection. Tubes were stored in heat isolated box made of styropore until they were used after 3-4 hours of sampling for serum cholesterol and glucose assay.

Serum cholesterol and glucose assay

Enzmatic determination of cholesterol and Glucose was carried out by kits supplied from quality control division in Chemistry Research Office. Iraqi Atomic Energy Commission.

The data were statistically analysed.

Results and Discussion

Ten species of edible mushrooms were tested in this study; *Pleurotus ostreatus* (White type), *P.sajor-caju, P.ostreatus* (Gray type), *Agaricus bisporus, A.bitorquis* and *Coprinus comatus* were artificialy cultivated, the Iraqi white truffle,

Terfezia hafizi was collected from Iraqi desert, other mushrooms including *Lentinus edodes*, *Dictyophora sp.* and *Ganoderma lucidum* were obtained from Nong Da Jun-Cao technology Development Company- China-as drier fruit boodies (Table 1.)

All tested mushrooms showed significant reduction in mice blood cholesterol and glucose at 5 and 10% (on dry wt.), but maximum reduction of blood cholesterol in mice fed on 10% of *P.ostreatus* (Gray type), *L.edodes*, *P.ostreatus* (white type). *G.lucidum* and *P.sajor caju* was 52, 55, 50, 48.5, 46.6 and 38.1% in males and 50.4, 48.7, 46.4, 43.4 and 38.1% in females, respectively. (Table-2). Statisticaly, according to F-test, there is no significant difference in reduction of blood cholesterol between males and females. These results are in agreement with some related studies (9, 15).

Significant hypolipidemic and hypocholesterolemic effect of mushrooms have been recorded in many species of mushrooms especially in *L.edodes* which has been shown to lower plasma cholesterol level in animals and man (15) and the effect was attributed to acceleration of cholesterol metabolism and increased cholesterol excretion (2, 15, 16) as well as hypocholesterolemic principle in these mushrooms have been identified and caused by some substrates such as eritadenine - butyric acid which affects cholesterol, triglyceride and phospholipid levels (14).

10% of drier fruit bodies of *L.edodes*, *C.comatus*, *P.sajor-caju*, *P.ostreatus* (White type) and *G.licidum* showed more significant reduction in mice blood glucose resulting in 47, 42, 33.5, 33 and 32% in males and 45, 42, 33.5, 32 and 35% in females, respetively, after 4 weeks from feeding, whereas no significant differences in reduction of blood glucose between males and females (Table-3-) Similar trend has been reported in this respect (7, 8, 10). Hypoglycemic action of some constituents e.g. x-fraction B-1,6 main chain having (-1,4 branches) of some mushrooms are mediated not through inhibition of glucose absorption at the enteron but with the process of metabolism of absorbed glucose and are linked with insulin receptors (10). In other study, plasma glucose concentrations were reduced after 11 days in mice when fed powdered dried fruit bodies of *C.comatus* and glucose tolerance was improved with no effect on plasma insulin concentration (7).

Our results suggest that these mushrooms exert mild and slowly generated blood glucose and cholesterol lowering effect which may benefit for patients suffering with diabetes, hypertension and obesity. Further studies are conducted on crude extraction of these mushrooms for accelerated their glucose and cholesterol lowering effect.

Table 1. Species and source of tested mushrooms

Species of mushrooms	source	Reference
Pleurotus ostreatus (white type)	Cultivated	3,4
Pleurotus sajor-caju	Cultivated	3
Pleurotus ostreatus (Gray type)	Cultivated	3
Agaricus bispours	Cultivated	6
Agaricus bitorquis	Cultivated	6
Dictyophora sp. ***Lentinus edodes*** *Ganoderma lucidum*	Dried fruit bodies from Nong Da Jun - Cao Technology Development Company - China	
Terfezia hafizi (White trffule)	Iraqi local Isolate	
Coprinus comatus	Cultivated	5

Table 2.Effect of some mushrooms on mice blood Cholesterol.

Mushrooms	Concentration %on dry wt. of diet	Cholesterol mg/100 ml of blood		Reduction Ratio %	
		Male	Female	Male	Female
Pleurotus ostreatus (white type)	5 10	158 121	161 126	32.8 48.5	31.49 46.4
Pleurotus sajor-caju	5 10	189 145.4	193 145.4	19.6 38.1	17.87 38.1
Pleurotus ostreatus (Gray type)	5 10	141 111.5	145 116.5	40 52.55	38.3 50.42
Agaricus bispours	5 10	196 171	202 174	16.59 27.23	14.04 25.95
Agaricus bitorquis	5 10	189 168	188 167	19.6 28.51	20 28.93
Dictyophora sp.	5 10	182 158.5	186 160.5	22.55 32.55	20.85 31.70
Lentinus edodes	5 10	147 117.5	145 120.5	37.4 50	38.29 48.72
Ganoderma lucidum	5 10	186 125.4	184 133	20.8 46.6	21.70 43.4
Terfezia hafizi (White trffule)	5 10	182 156	183 161	22.55 33.6	22.12 31.48
Coprinus comatus	5 10	203 108	200 172	13.6 28.5	14.89 26.80
Control		235	235	-	-
L.S.D p <0.05		29.90	32.07	9.11	10.23

Table 3. Effect of some mushrooms on mice blood glucose.

Mushrooms	Concentration %on dry wt. of diet	Glucose mg/100 ml of blood		Reduction Ratio %	
		Male	Female	Male	Female
Pleurotus ostreatus (white type)	5 10	168 134	170 136	16 33	15 32
Pleurotus sajor-caju	5 10	173 133	171 133	13.5 33.5	14.5 33.5
Pleurotus ostreatus (Gray type)	5 10	190 174	186 171	5 13	7 14.5
Agaricus bispours	5 10	179 147	177 147	10.5 26.5	11.5 26.5
Agaricus bitorquis	5 10	166 142	164 138	17 29	18 31
Dictyophora sp.	5 10	179 148	176 146	10.5 26	12 27
Lentinus edodes	5 10	130 106	130 110	35 47	35 45
Ganoderma lucidum	5 10	160 136	157 130	20 32	21.5 35
Terfezia hafizi (White triffule)	5 10	171 154	179 152	14.5 23	10.5 24
Coprinus comatus	5 10	131 116	130 116	34.5 42	35 42
Control		200	200	-	-
L.S.D p <0.05		33.79	35.12	12.33	13.80

References

1. Chang, S. T. and Miles, P. G. (**1993**) *Mushrooms: Trends in production and technological development.* Genetic Engineering and Biotechology Monitor Vol. 41 and 42: 73-84.
2. Cochran, K. W. (**1978**). *Medical effect. In "The biology and cultivation of edible mushrooms"* S. T. chang and W. A. Hayes, eds. Academic Press, New York. PP. 169-187.
3. Hassan, A. A. (**1996**). *Production of Pleurotus spp. For human consumption on agricultural wastes and utilization its by product for animal feed.* Collage of Science, Baghdad University.
4. Hassan, A. A., Natheer, A. M. and Mahmoud, A. R. (**2000**) *Effect of some organic sources on oyster mushroom (Pleurotus spp.) yield.* Iraqi J. Agric. 5 (4): 185-190.
5. Hassan, A. A., Natheer, A. M., Mahmoud, A. R. and Alani A. H. (**2000**). *Cultivation trails of Coprinus Comatus in Iraqi.* Diala Journal.Vol.1.
6. Hassan, A. A., Natheer, A. M. and Mahmoud, A. R. (**2002**) *Improvement of Agronomic characters and Productivity of Agaricus bisporus lange (Imbach) using some organic sources.* Iraqi J. Agric. 7(3): 104-112.
7. Hayes, W. A., Bailey, G. J. Turner, S. and Jakeman, K. J. (**1988**). *Blood Glucose lowering effect of Coprinus comatus.* The mushroom Journal 185:575.
8. Hikino, H. Konno, C, Mirin, Y. and Hayashi, T. (**1985**). *Antidiabetes drugs; isolation and hypoglycemic activity of ganoderma A and ganoderma B,glycans of Ganoderma lucidum fruitbodies.* Planta Medica 51: 339-340.
9. Kanoda, T. and Tokuda, S. (**1966**) *Effect of various mushroom preparations on chlesterol level in rats.* J. Nutrition. 90:371-376.
10. Kubo, K. and Nanba, H. (**1996**). *Antidiabetic mechanism of Maitake (Grifola frandosa). In "Mushroom Biology and Mushroom Products.* D. J. Royse ed. Penn. State University, Pennsylvania. PP.25-222.
11. Lin, Z, and Lin, Z. (**1995**). *Fungi cultivation with Jun-Cao Asia-pacific.* Edible Mushroom Training Center. pp.110.
12. Liu, G. T. (**1993**). *Pharmacology and clinical uses of Ganoderma In "Mushroom biology and mushroom products.* S. T. Chang, J. A. Buswell and S. W. Chin eds. The Chinese University Press, Hong Kong. pp. 267-273.
13. Rai, R. D.(**1995**). *Nntritional and medicinal values of mushrooms. In "Advances in Horticulture.*, S.R.Sharma, and K.L.Chadha eds. Malhotra Publishing House, New Delhi.
14. Rai, R.D. (**1997**). *Medicinal Mushrooms. In "Mushroom biology and production.* R. D. Rai, B. L. Dhar and Verma eds. MSI, Solan pp 355.
15. Suzuki, S. and Oshima, S. (**1976**). *Influence of shiitake (Lentinus edodes) on human serum cholesterol.* Mushroom Sc. 9 (1): 43-46.
16. Tokuda, S. And Kaneda, T. (**1976**) *Reducing mechanism of plasma cholesterol by shiitake.* Mushroom Sci 9 (1): 445-462.