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Full Length Research Paper

Responses of plasma lipids to edible mushroom diets in albino rats

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The potentials of two tropical edible mushrooms: *Pleurtotus tuber-regium* and *Termitomycetes clypeatus* in altering the plasma levels of some lipids in male albino rats fed high fat diets were investigated. Rats were randomly assigned to diet containing 20% fat, *P. tuber-regium* diet and *T. clypeatus* diet. Total body weight gain of rats fed mushroom diets were not significantly different (P>0.05) from one another. After a 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). The implications of these findings highlight the hypolipidemic properties of the two tropical edible mushrooms.

Key words: *Pleurotus tuber-regium, Termitomycetes clypeatus*, lipoproteins, hypolipidemic property.

INTRODUCTION

The interest in mushroom consumption over the centuries has been due to its high nutritive and medicinal values: its protein presents a high concentration of essential amino acids especially lysine which is limiting in most plant protein sources (Oei, 1996). It possesses antitumor, antiviral, immune modulating and hypocholesterolemic properties (Bahl, 1988; Bobek et al., 1995; Wasser, 2002). It has been reported that vegetable oils markedly reduce blood cholesterol levels when substituted for animal fat in diets (El- Gengaihi et al., 2004). The search for natural substances capable of lowering blood cholesterol is ongoing in the field of nutrition. Excessive levels of blood cholesterol accelerate athreogenesis (Sloop, 1999) and lowering of high blood cholesterol reduces the incidence of coronary heart disease. However, knowledge about cholesterol subfractions level is more meaningful than simple plasma cholesterol (Shad et al., 2003).

Lowering of circulating cholesterol especially the low density lipoprotein cholesterol-cholesterol (LDL-ch) fraction can prevent arrest or even reverse coronary athreosclerosis (Barter and Rye, 1996). Diet is the most important environmental variable affecting plasma lipoprotein spectrum. Several studies have shown that edible mushrooms have hypocholestolemic effects and could serve an important purpose in the prevention of athreosclerosis. This study evaluates the effect of two tropical edible mushrooms *Pleurotus tuber-regium* and *Termitomycetes clypeatus* diets on some plasma lipids in experimental rats.

MATERIALS AND METHODS

Sample collection and preparation

Two edible mushrooms *Pleurotus tuber-regium* and *Termitomycetes clypeatus* were obtained from local markets around Ado-Ekiti and authenticated at the plant science Laboratory of the University of Ado-Ekiti, Nigeria. They were cleaned to remove extraneous substances, cut into smaller bits, oven dried at 60°C and powdered in a monolex blender. Mushroom powder was incorporated into experimental diets as in Table 1.

Twelve albino rats (4 week old) obtained from Biochemistry Department of the University of Ilorin, Nigeria, were randomly divided into 3 groups of 4 animals per group and fed the experimental diets. After 28 days, the rats were sacrificed by cervical dislocation following an overnight fast and some organs: liver, kidney, heart and brain were excised, blotted dry and weighed. Blood samples were collected by cardiac puncture into heparinized sample tubes. Serum was obtained by centrifugation at

Table 1. Composition of diets.

	1	2	3
Casein	100	100	100
Mushroom	-	50	50
Corn starch	800	600	600
Vegetable oil	200	200	200
*Vitamin/ Mineral	50	50	50

*Vitamin/mineral mixture: vitamin mineral mixture:vit A 15,000IU, vitD_3 4,400 000 IU, vitE 1,350IU, vitK 4,350mg, vit B_2 4,350mg, vit B_6 2,350mg, vitB12 11,350mg, vitC 1000mg, nicotinic acid 16,700mg,panthothenic acid 5,350mg, KCl 87,000mg, $NaS0_4$ 212,000mg, Nacl 50,000mg $MgS0_4$ 12,000mg, $CuS0_4$ 12,000mg, $ZnS0_4$ 12,000mg, $MnS0_4$ 12000mg

Table 2. Relative organ weights (g/100 g body weight) of rats fed control and mushroom diets.

Organ	Control	*P. tuber regium* diet	*T. clypeatus* diet
Kidney	0.70^a±0.01	0.69^a±0.01	0.69^a±0.01
Heart	0.36^a±0.00	0.41^c±0.01	0.39^b±0.02
Liver	3.85 b±0.01	3.95c±0.00	3.57a±0.01
Brain	1.30^a±0.01	1.55^b±0.01	1.57^c±0.01

Each value (g/100 g body weight) represent mean of triplicates. Means of the same superscript letter(s) along the same row are not significantly (P>0.05) different.

Table 3. Performance of rats fed control and mushroom diets.

Body weight	Control	*P. tuber regium* diet	*T. clypeatus* diet
Final	95.42^b±1.57	82.88^a±2.26	84.60^a±4.06
Initial	47.20^a±1.40	53.25^b±2.49	51.38^b±0.93
Total	48.28^a±2.06	29.63^b±1.29	33.23^b±3.62

Each value (g) represent mean of triplicates. Means of the same superscript letter(s) along the same row are not significantly (P>0.05) different.

3000 rpm and analyzed for total cholesterol using Randox laboratory (England) Kit based enzymatic end point method. Serum triglycerides were determined by the methods of Stens and Myers (1987) and HDL cholesterol by the methods of Hiller (1987).

Data obtained were analysed using one-way analysis of variance (SPSS 10.0). Mean were compared by Duncan multiple range test.

RESULTS AND DISCUSSION

The relative organ weights (g/100 g body weight) of rats fed *P. tuber-regium* and *T. clypeatus* diets are presented on Table 2. Only the kidney weights showed significant differences (P<0.05) from each other and from the control among all the dietary treatment groups. Allison (1955) observed that muscle and liver tissues are more susceptible to effects of dietary protein than the kidneys. Mushrooms are rich protein sources. Earlier work of Ogundana and Fagade (1982) reported the percentage crude protein of *T. clypeatus* as 31.4% while Akindahunsi and Oyetayo (2006) reported 13.8% crude protein for *P. tuber-regium* cap. The liver weight of rats fed *T. clypeatus* diet was significantly lower (P<0.05) than those fed *P. tuber-regium* and the control diets, while the heart weight was significantly lower (P<0.05) in rats fed *T. clypeatus* than *P. tuber-regium*. The brain weight was such that *T. clypeatus* diet fed rats had significantly (P<0.05) higher weight than *P. tuber-regium* fed rats.

Performance of rats fed mushroom diets is shown on Table 3. Despite the high fat concentration in the mushroom diets the final and total body weight gained of rats fed mushroom diets were not significantly lower (P<0.05) than the control. This could result from the high fibre content of edible mushrooms. Ola and Oboh (2001) reported crude fibre as high as 16.2% for the stalk of *Lentinus subnudus*, a species of edible mushroom. Fibres are indigestible in the human gastrointestinal tract inhibiting glucose release into the blood stream (Guthrie, 1989). High blood glucose might otherwise lead to raised plasma lipids (especially the low density lipoprotein, LDL) or diminished levels of high density lipoprotein (HDL) which are conditions associated with pathogenesis of the inner layers of the arteries. Hence, *P. tuber-regium* and

Table 4. Plasma lipids distribution (mmol/ L) of rats fed control and mushroom diets.

Body Lipids	Control	*P. tuber regium* diet	*T. clypeatus* diet
Cholesterol	3.07 c±0.01	3.03 b±0.01	2.97a±0.01
Triglycerides	1.77 b±0.01	0.75a±0.01	0.76a±0.01
HDL-ch	2.02a±0.01	2.13b±0.01	2.23c±0.01
LDL-ch	1.44c±0.01	0.12a±0.01	0.88b±0.01
LDL/ HDL	0.71c±0.00	0.05a±0.01	0.39b±0.01
CRI*	1.52	1.43	1.33

*Coronary risk index
Each value (mmol/ L) represent mean of triplicates. Means of the same superscript letter(s) along the same row are not significantly (P>0.05) different

T. clypeatus may be of interest to the dieticians for formulation of weight restriction diets.

Table 4 presents the plasma lipid distribution of rats fed experimental diets. Plasma total cholesterol was found to be significantly higher (P<0.05) in rats fed control diet than those fed mushroom diets. This could be because it was solely a casein diet unlike the other diets, which were supplemented with mushroom. The ingestion of casein has been reported to increase plasma cholesterol in rats since they excrete less bile acids and neutral lipids compared to their counterparts fed soy diets (Srinivassan and Shanmugasundaram, 1989). The simultaneous ingestion of high fat diets and mushroom in diets significantly decreased (P<0.05) the total cholesterol levels in the mushroom diets fed rats, with *T. clypeatus* fed diet rats exhibiting the lowest total cholesterol level. Several studies have reported the ability of edible mushrooms in reducing plasma total cholesterol level. Studies in rats have suggested that mushroom β-glucans are effective cholesterol lowering polysaccharides (Cheung, 1996). It has been hypothesized that upon ingestion soluble dietary fibres, such as β-glucans increase small intestinal viscosity resulting in reduced bile acid and cholesterol absorption thus lowering plasma cholesterol (Chen and Anderson, 1986). Ogundana and Fagade (1982) have reported 7.9% as crude fibre concentration of *P. tuber-regium*. Hence the crude fibre content might have important implications in lowering plasma cholesterol levels.

Plasma triglyceride distribution was such that rats fed mushroom diets showed no significant difference (P>0.05) from each other but both were significantly lower than the control. However, earlier reports of Chorvathova et al. (1993) on feeding a 4% *Pleurotus ostreatus* diet to hyperlipoproteinemia rats showed no significant effect on plasma triglyceride levels. The triglyceride concentrations obtained in this report resulted from high HDL-ch levels observed in the mushroom diets fed rats as HDL-ch increases the rate of triglyceride catabolism (Tiez, 1986) and elevated triglyceride levels are frequently associated with low HDL-ch levels (Kelly, 1992). Knowledge of the levels of cholesterol subfractions is more meaningfully than simple plasma total cholesterol level. The higher the LDL-ch, the greater the athreosclerosis risk and conversely the higher the HDL-ch, the lower the risk. This is true for humans in different racial and ethnic groups and at all adult ages (Baron, 2000). HDL-ch concentrations were significantly higher (P<0.05) in rats fed mushroom diets than the control, with rats fed *T. clypeatus* diets recording higher HDL-ch levels. HDL-ch concentrations vary reciprocally with plasma triglyceride concentration and directly with the activity of lipoprotein lipase (Murray et al., 2003). Conversely, LDL-ch levels were significantly lower (P<0.05) in rats fed mushroom diets than the control. *T. clypeatus* diets fed rats LDL-ch levels were significantly lower than those fed *P. tuber-regium* diets. Hence, the LDL/ HDL cholesterol ratio which is thought to be the athereogenic index of lipoproteins (El- Gengaihi et al., 2004) were lower in the mushroom diets fed than the control rats. This could be due to the high concentration of polyunsaturated fatty acid linoleic acid present in mushrooms. Cheung (1992) reported about 72% linoleic acid from mushroom fat. A study on women by Muller (2003) showed that serum LDL/ HDL cholesterol ratio was influenced more favourably by exchanging saturated fat for unsaturated fat than reducing saturated fat composition of diets. The ratio is the most predictive relation of coronary heart disease; the lower the ratio, the less athreogenic the lipoprotein profile is thought to be (Murray et al., 2003). Hence, *P. tuber-regium*.diet fed rats, despite their significantly lower HDL-ch than the *T. clypeatus* diets fed rats, had a lower lipoprotein index and it is likely to be less athreogenic than the other mushroom diet. Hence a low HDL-ch pose no risk in the absence of elevated LDL-ch or total cholesterol (Goldbout et al., 1997).

The cornary risk index (CRI), a ratio of total to HDL-ch (Alladi and Shanmugasundarem, 1989) was however found to be lower in *T. clypeatus* diets fed rats than *P. tuber-regium*.diet fed rats but both were significantly lower (P<0.05) than the control. Srinivassan (1989) have stated that plant proteins have a strong tendency to lower coronary risk index. The foregoing suggests that diets made from the fruitbodies of *P. tuber-regium* and *T. clypeatus* lowered total cholesterol, LDL-ch, and triglyceride concentrations in the plasma and raised HDL-ch levels in the experimental rats. However, *T. clypeatus* fed rats had a better cholesterol lowering capacity than *P. tuber-regium* diets. These findings highlight the hypolipidemic properties of these mushrooms.

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