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Current Research Findings on the Effects of Selected Mushrooms on Cardiovascular Diseases

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ABSTRACT: For about 50 years, scientists have studied the biological activities of Macromycetes on different pathologies. In this article different fungal activities that reduce the effects of risk factors for cardiovascular diseases are reviewed. Among the 17 species tested on animals, 16 demonstrated at least one of the following activities: ability to reduce hypercholesterolemia or to cure dyslipoproteinemia, possibility to decrease arterial hypertension or hyperglycemia, and ability to cure disturbances in platelet aggregation.

KEYWORDS: Fungi, Basidiomycotina, Ascomycotina, cardiovascular diseases, cholesterol, diabetes, thrombosis, hypertension.

INTRODUCTION

Cardiovascular diseases are a primary cause of mortality in the Western Hemisphere. In France, for example, 167,500 deaths were attribute to this pathology in 1994 (Ministère du Travail et des Affaires Sociales, 1996). The progression is slow and quite often cryptic but the outcome is often fatal or has important sequelae.

The two main diseases are ischemic cardiopathologies (e.g., angina pectoris and infarction) and cerebral vascular accidents. Pulmonary embolism, viral pericarditis, and rheumatoid arthritis are also considered as cardiovascular diseases, as are phlebitis, varicose veins, and arteritis.

The main risk factors are hypercholesterolemia and dyslipoproteinemia, disturbances in blood platelet binding, high blood pressure, and diabetes.

We present the results of current research on the biological activities of 17 higher fungi with regard to these pathologies. Further data on the traditional use of fungi for similar indications (as well as in other pathologies) are considered in another article (Francia et al., 1999).

MATERIALS AND METHODS

Seventeen mushroom species have been identified as reducing the effects of risk factors on cardiovascular diseases. Fourteen species are specifically determined but three species (marked with an asterisk in the following list) are cited only after their genus.

ABBREVIATIONS

HDL: high-density lipoprotein; **LDL:** low-density lipoprotein.

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The species studied are: *Agaricus bisporus* (J. Lge) Imbach, *Agaricus campestris* L.: Fr., *Agrocybe aegerita* (Brig.) Fay., *Auricularia auricula-judae* (Bull.) Wettstein, **Calyptella* sp., *Coprinus comatus* (Müll.: Fr.) Pers., *Cordyceps sinensis* (Berk.) Sacc., *Ganoderma lucidum* (Curt.: Fr.) P. Karst., *Grifola frondosa* (Dicks.: Fr.) S. F. Gray, **Kuehneromyces* sp., *Lentinus edodes* (Berk.) Sing, *Neolentinus adhaerens* (Alb. and Schw.: Fr.) Redhead and Ginns, **Panus* sp., *Pleurotus ostreatus* (Jacq.: Fr.) Kumm., *Tremella aurantia* Schw.: Fr., *Tremella fuciformis* (Berk.), and *Tricholoma mongolicum* Imai (nomenclature according to Courtecuisse and Duhem, 1994).

RESULTS AND DISCUSSION

Effects of Macrofungi on Lipids and Cholesterol

Hypercholesterolemia is defined as a blood cholesterol ratio higher than 2 g/l. Dyslipoproteinemia coincides with a disturbance of diverse lipoprotein levels, resulting in formation of a lipidic sediment on the arterial walls, which reduces their diameter and slows down the blood flow. Cholesterol is commonly called "bad cholesterol" when carried by the LDL (low-density lipoprotein) and "good cholesterol" when carried by the HDL (high-density lipoprotein).

Seven fungi have an effect on lipids in general and cholesterol in particular:

1. Six species reduce the total cholesterol level:
   Auricularia auricula-judae (Fan et al., 1989)
   Cordyceps sinensis. The activity could be due to a polysaccharide, the CS-F30, composed of galactose, glucose, and mannose (Kiho et al., 1996)
   Ganoderma lucidum (Kabir et al., 1988)
   Grifola frondosa (Kubo and Nanba, 1997)
   Pleurotus ostreatus (Bobek et al., 1991)
   Tremella fuciformis (Cheung, 1996)
2. Two species reduce the "bad cholesterol" level:
   Auricularia auricula-judae (Fan et al., 1989)
   Tremella fuciformis (Cheung, 1996)
3. Three species reduce the triglyceride level:
   Cordyceps sinensis Sacc. (Kiho et al., 1996)
   Grifola frondosa (Kubo and Nanba, 1997)
   Lentinus edodes (Kabir and Kimura, 1989)
4. Remark
   Agaricus campestris, although studied, demonstrated no hypocholesterolemic activity (Beynen et al., 1996).

Macrofungi Reducing Blood Platelet Binding

Arterial thromboses originate in the formation of a lipid sediment on the arterial wall. This deposit injures the arterial covering and blood clots may arise, blocking the vessel and impeding blood flow.

Venous thromboses develop mainly in the lower limbs and in the pelvic region, following a long immobilization that produces a slowed blood flow. Consequently, there is wall deterioration and formation of clots that block the veins but may also loosen and migrate.

The slowing of the blood flow produces a diminution of the oxygen inflow and a necrosis of the involved tissues.

Six species reduce platelet binding (*in vitro*):

Auricularia auricula-judae (Fan et al., 1989)

Calyptella sp. The demonstrated active compound is the 5-hydroxy-3-vinyl-2(5*H*)-furanone (Lorenzen et al., 1995).

Ganoderma lucidum. The antibinding activity is due to adenosine (Shimizu et al., 1985).

Kuehneromyces sp. The active compound is kuehneromycine B (Erkel et al., 1995).

Neolentinus adhaerens. The demonstrated active compound is 2-methoxy-5-methyl-1,4-benzoquinone (Lauer et al., 1991).

Panus sp. The activity is due to two compounds: panudial and nematolon (Lorenzen et al., 1994).

Macrofungi with an Arterial Blood Pressure Lowering Effect

According to the WHO (Saux et al., 1993), high blood pressure is defined as an arterial systolic pressure equal to or higher than 160 mm Hg and an arterial diastolic pressure equal to or higher

than 95 mm Hg. In 80% of cases, the exact reasons for high blood pressure are unknown; in such cases, it is called essential high blood pressure.

High blood pressure worsens angina pectoris and increases the risks associated with atherosclerosis, for example.

Three fungal species may reduce the arterial pressure:

Ganoderma lucidum (Kabir et al., 1988)

Grifola frondosa (Kabir and Kimura, 1989)

Tricholoma mongolicum. The decrease of arterial pressure is attributable to a lectin (Wang et al., 1996).

Macrofungi Reducing Glycemia

Diabetes is defined as a fasting glycemia above 1.4 g/l evaluated on two different blood samples. Two kinds of diabetes exist: insulin-dependent diabetes (IDD), corresponding to a disorder in insulin secretion and non-insulin-dependent diabetes (NIDD), corresponding to a disorder in insulin activity.

In IDD, cardiovascular complications are due to the important and lasting hyperglycemia causing the persistence of proteins in the urine.

In NIDD, cardiovascular complications are due to hyperglycemia but also to other factors such as hyperinsulinemia, hypertriglyceridemia, diminution of the levels of "good cholesterol" (carried by the HDL), and increase of the blood arterial pressure.

The most frequently observed cardiovascular complications are toe gangrene, infarct, and cerebral vascular accidents.

Six species may decrease glycemia:

1. Four species are active in IDD:
   Agaricus bisporus (Swanston-Flatt et al., 1989).
   Agrocybe aegerita. The glycemia lowering is due to two polysaccharides: AG-HN1, a polysaccharide of high molecular weight composed of glucose and AG-HN2, a polysaccharide of low molecular weight composed of fucose, galactose, glucose, and mannose (Kiho et al., 1994).
   Cordyceps sinensis. Its properties could be due to the CS-F30, a polysaccharide composed of galactose, glucose, and mannose (Kiho et al., 1996).
   Tremella aurantia. The active compound is the TAP (*Tremella* acidic polysaccharide) reported by Kiho et al. (1995).
2. One species is active in NIDD:
   Grifola frondosa. This polypore is able to diminish glycemia but also insulinemia and the blood level of triglycerides (Kubo et al., 1994).
3. One species shows an activity only in non diabetic animals:
   Coprinus comatus (Bailey et al., 1984).

CONCLUSION

Although only a few species were studied, almost all of them demonstrated an undeniable effect in preventing or curing the risk factors for cardiovascular diseases.

Nevertheless, the mechanisms of action remain to be elucidated before considering an eventual human treatment application for prevention or cure of cardiovascular diseases.

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