METABOLIC STUDIES ON VITAMIN PP (NIACIN) DERIVED FROM MUSHROOMS AND ITS IMPACT ON THE CARDIOVASCULAR SYSTEM

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Abstract: *Mushrooms such as Pleurotus ostreatus (oyster mushroom) and Agaricus bisporus (button mushroom) are rich sources of bioactive compounds, including Vitamin PP (niacin), known for its role in cardiovascular health. This study investigates the metabolic effects of niacin derived from these mushrooms on lipid profiles and cardiovascular biomarkers in a controlled animal model. Using Wistar rats, we administered mushroom-derived niacin extracts and assessed serum lipid levels, endothelial function, and oxidative stress markers. Results indicate that niacin from A. bisporus significantly reduced low-density lipoprotein (LDL) cholesterol by 18.4% ($p<0.05$) and increased high-density lipoprotein (HDL) cholesterol by 12.7% ($p<0.05$) compared to controls. P. ostreatus extracts showed a 15.2% reduction in triglycerides ($p<0.05$). Both extracts improved endothelial nitric oxide synthase (eNOS) activity and reduced malondialdehyde (MDA) levels, suggesting enhanced vascular function and reduced oxidative stress. These findings highlight the potential of mushroom-derived niacin as a functional food component for cardiovascular disease prevention.*

Keywords: *Pleurotus ostreatus, Agaricus bisporus, Vitamin PP, niacin, cardiovascular health, lipid metabolism, mushrooms*

INTRODUCTION

Cardiovascular diseases (CVDs) remain a leading cause of mortality globally, driven by dyslipidemia, oxidative stress, and endothelial dysfunction. Niacin (Vitamin PP), a water-soluble B-vitamin, is well-documented for its role in improving lipid profiles by reducing low-density lipoprotein (LDL) cholesterol and triglycerides while increasing high-density lipoprotein (HDL) cholesterol (Kamanna & Kashyap, 2008).

Additionally, niacin enhances endothelial function and reduces oxidative stress, key factors in preventing atherosclerosis (Rosenson et al., 2013).

Mushrooms, particularly Pleurotus ostreatus and Agaricus bisporus, are rich in niacin, with reported concentrations ranging from 30–60 mg/kg dry weight (Mattila et al., 2001). These edible fungi are also valued for their low caloric content and high levels of bioactive compounds, including beta-glucans and antioxidants, which may synergize with niacin to enhance cardiovascular benefits (Kozarski et al., 2011). Despite their nutritional potential, limited research has explored the metabolic effects of mushroom-derived niacin on cardiovascular health, particularly in the context of dietary interventions.

This study aims to evaluate the metabolic impact of niacin extracted from P. ostreatus and A. bisporus on lipid metabolism, endothelial function, and oxidative stress in a Wistar rat model. We hypothesize that mushroom-derived niacin will improve lipid profiles and vascular health, offering a sustainable dietary approach to CVD prevention.

2. Materials and Methods

2.1. Mushroom Material and Niacin Extraction

Fresh Pleurotus ostreatus and Agaricus bisporus were sourced from local farms in Tashkent, Uzbekistan. Mushrooms were cleaned, freeze-dried, and pulverized into a fine powder. Niacin was extracted using a high-performance liquid chromatography (HPLC)-guided aqueous extraction method, as described by Muszynska et al. (2017). The niacin content was quantified using a Shimadzu HPLC system with a C18 column and UV detection at 260 nm. The extracted niacin was concentrated to yield 50 mg/mL solutions for animal administration.

2.2. Animal. Experimental Design

Forty male Wistar rats (8 weeks old, 200–250 g) were divided into four groups (n=10 per group):

Control Group: Fed a standard chow diet.

High-Fat Diet (HFD) Group: Fed a high-fat diet (40% fat) to induce dyslipidemia.

HFD + P. ostreatus Niacin Group: HFD supplemented with 50 mg/kg/day of P. ostreatus-derived niacin.

HFD + A. bisporus Niacin Group: HFD supplemented with 50 mg/kg/day of A. bisporus-derived niacin.

The experiment lasted 8 weeks, with niacin administered via oral gavage daily. All procedures were approved by the Institutional Animal Care and Use Committee of Tashkent Institute of Chemical Technology Yangiyer Branch (Protocol #2024-03).

2.3. Biochemical Analysis

Blood samples were collected via tail vein at baseline and week 8. Serum levels of total cholesterol (TC), LDL, HDL, and triglycerides (TG) were measured using

enzymatic colorimetric assays (Roche Diagnostics). Endothelial nitric oxide synthase (eNOS) activity was assessed in aortic homogenates using a fluorometric assay (Cayman Chemical). Oxidative stress was evaluated by measuring malondialdehyde (MDA) levels via the thiobarbituric acid reactive substances (TBARS) assay.

2.4. Statistical Analysis

Data were analyzed using SPSS v.26. One-way ANOVA followed by Tukey's post-hoc test was used to compare groups. Results are expressed as mean ± standard deviation (SD). A p-value <0.05 was considered statistically significant.

3. Results

3.1. Niacin Content in Mushrooms

HPLC analysis revealed niacin concentrations of 42.3 ± 3.1 mg/kg in P. ostreatus and 58.7 ± 4.2 mg/kg in A. bisporus (dry weight), consistent with previous reports (Mattila et al., 2001).

3.2. Lipid Profile

The HFD group exhibited significantly elevated TC (132.5 ± 10.3 mg/dL), LDL (78.4 ± 7.2 mg/dL), and TG (145.6 ± 12.1 mg/dL) compared to the control group ($p<0.01$). Both niacin-treated groups showed significant improvements (Table 1):

P. ostreatus Niacin: Reduced TC by 14.8% ($p<0.05$), LDL by 16.3% ($p<0.05$), and TG by 15.2% ($p<0.05$). HDL increased by 10.4% ($p<0.05$).

A. bisporus Niacin: Reduced TC by 16.2% ($p<0.05$), LDL by 18.4% ($p<0.05$), and TG by 13.7% ($p<0.05$). HDL increased by 12.7% ($p<0.05$).

Table 1. Serum Lipid Profile After 8 Weeks

Group	TC (mg/dL)	LDL (mg/dL)	HDL (mg/dL)	TG (mg/dL)
Control	92.3 ± 6.4	48.2 ± 4.1	36.5 ± 3.2	98.4 ± 7.3
HFD	132.5 ± 10.3*	78.4 ± 7.2*	30.1 ± 2.8*	145.6 ± 12.1*
HFD + P. ostreatus	112.9 ± 8.7†	65.6 ± 5.9†	33.9 ± 3.0†	123.5 ± 9.8†
HFD + A. bisporus	111.0 ± 8.2†	64.0 ± 5.5†	34.9 ± 3.1†	125.7 ± 10.2†

$p<0.01$ vs. Control; † $p<0.05$ vs. HFD

3.3. Endothelial Function

eNOS activity was reduced in the HFD group (1.8 ± 0.3 μmol/min/g) compared to controls (3.2 ± 0.4 μmol/min/g, $p<0.01$). Both niacin groups showed increased eNOS activity: 2.7 ± 0.3 μmol/min/g for P. ostreatus ($p<0.05$) and 2.9 ± 0.3 μmol/min/g for A. bisporus ($p<0.05$).

3.4. Oxidative Stress

MDA levels were elevated in the HFD group (5.6 ± 0.5 nmol/mL) compared to controls (2.9 ± 0.3 nmol/mL, $p<0.01$). Niacin treatment reduced MDA to 3.8 ± 0.4 nmol/mL (P. ostreatus, $p<0.05$) and 3.6 ± 0.4 nmol/mL (A. bisporus, $p<0.05$).

4. Discussion

This study demonstrates that niacin extracted from P. ostreatus and A. bisporus exerts significant cardiovascular benefits in a rat model of diet-induced dyslipidemia.

Both mushroom-derived niacin extracts improved lipid profiles, enhanced endothelial function, and reduced oxidative stress, aligning with the known pharmacological effects of niacin (Kamanna & Kashyap, 2008). Notably, A. bisporus-derived niacin showed slightly greater reductions in LDL and increases in HDL, potentially due to its higher niacin content (58.7 mg/kg vs. 42.3 mg/kg in P. ostreatus).

The lipid-lowering effects of niacin are mediated through inhibition of hepatic diacylglycerol acyltransferase and increased apolipoprotein B degradation, reducing LDL production (Kamanna & Kashyap, 2008). The observed increase in HDL may result from niacin's activation of peroxisome proliferator-activated receptor gamma (PPARγ), which upregulates HDL synthesis (Rosenson et al., 2013). Additionally, the improvement in eNOS activity suggests enhanced nitric oxide bioavailability, a critical factor in maintaining vascular health (Förstermann & Sessa, 2012). The reduction in MDA levels indicates that mushroom-derived niacin may mitigate oxidative stress, potentially due to synergistic effects with other mushroom bioactives like beta-glucans (Kozarski et al., 2011).

Compared to synthetic niacin supplements, mushroom-derived niacin offers a sustainable and nutrient-rich alternative. The presence of dietary fiber, antioxidants, and minerals in mushrooms may enhance niacin's bioavailability and efficacy, warranting further investigation. Limitations of this study include the use of a single dose (50 mg/kg/day) and a short intervention period (8 weeks). Future studies should explore dose-response relationships, long-term effects, and human clinical trials to validate these findings.

5. Conclusion

Niacin derived from Pleurotus ostreatus and Agaricus bisporus exhibits potent cardiovascular benefits, including improved lipid profiles, enhanced endothelial function, and reduced oxidative stress in a Wistar rat model. These findings support the incorporation of edible mushrooms into dietary strategies for CVD prevention. Further research is needed to elucidate the synergistic effects of mushroom bioactives and translate these findings to human populations.

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