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Effect Of Antioxidant Substances In Experimental Alloxan-Induced Diabetes

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Abstract: The aim of this study was to investigate the effects of antioxidant substances on carbohydrate and lipid metabolism in experimental alloxan-induced diabetes mellitus. The experiment was carried out on 60 male white rats weighing 180–200 g. Diabetes mellitus was induced by intraperitoneal injection of alloxan monohydrate. The development of diabetes was accompanied by severe hyperglycemia and disturbances in lipid metabolism. Among the tested substances, quercetin and sodium dichloroacetate demonstrated significant hypoglycemic and hypolipidemic effects, indicating their potential therapeutic value in the correction of metabolic disorders associated with diabetes mellitus.

Keywords: Diabetes mellitus, antioxidants, sodium dichloroacetate, glutathione, quercetin.

Introduction: Diabetes mellitus is one of the most significant medical and biological problems worldwide. It is characterized by chronic hyperglycemia resulting from impaired insulin secretion, insulin action, or both. Oxidative stress plays a key role in the pathogenesis of diabetes mellitus and its complications, leading to damage of cellular structures, lipid peroxidation, and depletion of antioxidant defense mechanisms.

Experimental alloxan-induced diabetes is widely used to study oxidative damage to pancreatic β-cells and associated metabolic disturbances. In recent years, increasing attention has been paid to antioxidant substances capable of modulating oxidative stress and improving carbohydrate and lipid metabolism. Therefore, the aim of this study was to evaluate the effects of various antioxidant agents on metabolic parameters in experimental diabetes mellitus.

METHODS

The study was performed on 60 male white rats weighing 180–200 g, kept under standard laboratory conditions with free access to food and water. Experimental diabetes mellitus was induced by intraperitoneal administration of alloxan monohydrate at a dose of 12 mg/kg body weight after a fasting period.

The animals were randomly divided into six experimental groups (n = 10): an intact control group, a diabetic control group, and four diabetic groups receiving antioxidant treatment, including dietary antioxidant supplementation, sodium dichloroacetate, reduced glutathione, and quercetin.

Biochemical parameters, including plasma glucose concentration, total cholesterol, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triglycerides, were determined using standard enzymatic methods. Statistical analysis was performed using one-way analysis of variance (ANOVA). Differences were considered statistically significant at $p < 0.05$.

RESULTS

Alloxan administration resulted in the development of severe diabetes mellitus in experimental animals. Plasma glucose concentration in the diabetic control group increased markedly compared to intact controls, indicating pronounced hyperglycemia.

Treatment with quercetin reduced plasma glucose levels by 47%, whereas sodium dichloroacetate reduced glucose concentration by 33–36% compared to the diabetic control group. Antioxidant dietary supplementation and glutathione administration did not produce a significant hypoglycemic effect.

Diabetes mellitus was accompanied by disturbances in lipid metabolism. Total cholesterol, LDL cholesterol, and triglyceride levels increased significantly in diabetic

animals. Quercetin demonstrated the most pronounced hypolipidemic effect, reducing total cholesterol, LDL cholesterol, and normalizing triglyceride levels. Sodium dichloroacetate also improved lipid profile parameters, though to a lesser extent.

Table 1. Plasma glucose and lipid profile parameters in experimental rats (mmol/L)

Group	Glucose	Total cholesterol	LDL	HDL	TG
Control	5.03±0.60	3.14 ± 0.45	2.04 ± 0.22	0.91 ± 0.14	0.42 ± 0.05
Diabetic	34.67±4.80	5.22 ± 1.04	4.05 ± 0.49	0.87 ± 0.24	0.65 ± 0.15
Quercetin	18.51±2.70	4.26 ± 0.80	3.04 ± 0.40	0.61 ± 0.11	0.47 ± 0.13

DISCUSSION

The obtained results confirm the important role of oxidative stress in the development of metabolic disturbances in diabetes mellitus. Antioxidant therapy demonstrated different degrees of effectiveness depending on the mechanism of action of the substances used.

Quercetin exhibited strong hypoglycemic and hypolipidemic effects, which may be attributed to its free radical scavenging activity and its influence on key metabolic enzymes. Sodium dichloroacetate improved carbohydrate and lipid metabolism, possibly through enhancement of mitochondrial oxidative processes and reduction of metabolic acidosis.

CONCLUSION

Antioxidant substances exert different corrective effects on metabolic disturbances in experimental diabetes mellitus. Quercetin and sodium dichloroacetate demonstrated the most promising results in reducing hyperglycemia and dyslipidemia. These findings support the potential use of antioxidant-based approaches in the complex therapy of diabetes mellitus and justify further investigation of their molecular mechanisms.

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