

EFFECT OF A BIOACTIVE SUPPLEMENT BASED ON CHITOSAN AND WHEY POWDER ON HEPATIC METABOLIC ENZYMES AND DETOXIFICATION PROCESSES

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Abstract

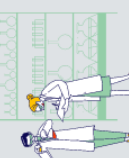
This study investigated the effect of a complex biological supplement composed of chitosan sulfate and whey powder on hepatic microsomal enzymes and lipid peroxidation processes under metabolic syndrome conditions. The findings demonstrated that metabolic syndrome induction reduces NADPH–cytochrome C reductase and amidopyrine demethylase activity and increases lipid peroxidation 2.7-fold. Administration of the chitosan–whey complex restored enzyme activity by 89–93% and reduced MDA levels by 52%. The results scientifically justify the hepatoprotective potential of the bioactive complex and its possible application in veterinary and biomedical fields.

Keywords: Liver, metabolic syndrome, chitosan, whey powder, detoxification, NADPH reductase, cytochrome P-450, lipid peroxidation, antioxidant system.

Introduction

The liver is the primary biochemical center of the body, where protein, lipid, and carbohydrate metabolism, hormone biotransformation, and xenobiotic detoxification predominantly occur [9; 17]. Metabolic syndrome is a systemic disorder characterized by insulin resistance, abdominal obesity, oxidative stress, and lipid metabolism disturbances [6; 23; 25]. This pathology leads to decreased hepatic microsomal enzyme activity, mitochondrial dysfunction, and development of fatty hepatitis.

Chitosan is a natural polymer derived from chitin that shows membrane-protective, free-radical scavenging, and lipid-modulating effects [13; 26]. Whey powder is rich in cysteine, which enhances glutathione biosynthesis and supports the antioxidant defense system [4; 15; 21]. Literature sources indicate a possible synergistic hepatoprotective effect when both agents are used together [14; 16].



Purpose of the Study

To determine the effect of the chitosan–whey complex on hepatic microsomal enzymes, antioxidant parameters, and lipid peroxidation levels under metabolic syndrome.

Materials and Methods

The study was conducted on 60 male rabbits weighing 2050–3400 g over a period of 2 months. Metabolic syndrome was induced using Sa'idov's model: 5% glucose drinking solution, dietary addition of 250 mg/kg cholesterol, and subcutaneous insulin administration at 0.1 unit/100 g [11].

Experimental Groups:

1. Control
2. MS (Metabolic syndrome)
3. MS + chitosan (25 mg/kg)
4. MS + whey powder
5. MS + chitosan–whey complex
6. MS + Glucofage (7.14 mg/kg) – comparative therapy

Biochemical Analysis:

- Cytochrome P-450 and cytochrome b_5 – Omura & Sato method [7]
- NADPH–cytochrome C reductase – Williams–Kamin spectrophotometry [10]
- Antioxidant system: GSH, GPx, SOD – commercial kits [17; 22]
- Lipid peroxidation – MDA measurement via TBARS [18; 27]

Results

The metabolic syndrome group demonstrated a sharp decline in hepatic microsomal enzymes:

- NADPH–cytochrome C reductase: –41%
- Amidopyrine-demethylase: –37% [9; 19]

MDA – the end-product of lipid peroxidation – increased 2.7-fold [27; 28].

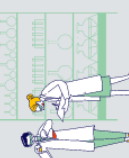
Administration of the chitosan–whey complex produced the following results:

- NADPH reductase – restored by 89% ($p < 0.05$)
- Amidopyrine demethylase – restored by 93%
- MDA – decreased from 2.7-fold to 1.3-fold baseline
- GSH – +46%, GPx – +39%, SOD – +41% [4; 13; 21]

These effects can be justified by the membrane-stabilizing properties of chitosan [14; 16; 26] and the glutathione-enhancing mechanism of whey [4; 21].

Discussion

In metabolic syndrome, detoxification phases I and II slow down due to decreased microsomal enzyme activity [8; 23; 27]. Chitosan binds lipoproteins, stabilizes membrane lipid structures, and reduces free-radical formation [13; 14; 26]. Whey protein acts as a cysteine precursor and



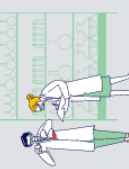
stimulates glutathione biosynthesis, thereby increasing GPx and SOD activity [4; 15; 22]. The synergy of both compounds contributed to the protection of hepatocytes from oxidative stress and restoration of detoxification pathways.

Conclusion

1. Metabolic syndrome significantly suppresses hepatic microsomal enzyme activity and increases lipid peroxidation.
2. The chitosan–whey complex restored NADPH reductase and amidopyrine demethylase activity, enhanced glutathione-dependent antioxidant defenses, and reduced MDA by 52%.
3. These findings support its potential use as a hepatoprotective biological supplement in veterinary and biomedical applications.
4. Further toxicological safety and clinical trials are necessary before practical application [30].

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