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Morphological Changes In The Liver In Steatosis Induced By The Use Of Burdock Root (Arctium Lappa) Extract: An Experimental Study

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Abstract: The aim of the study was to investigate morphological changes in the liver during experimental steatosis and to evaluate the corrective effect of burdock root (Arctium lappa) extract. Steatosis was induced in laboratory animals using a high-fat diet combined with the hepatotoxic action of thioacetamide. Morphometric and histological examinations revealed pronounced fatty infiltration, ballooning degeneration of hepatocytes, inflammatory infiltration, and signs of early fibrosis. Administration of A. lappa extract led to a reduction in the degree of steatosis, decreased inflammation, and restoration of the lobular architecture of the liver. The findings indicate the promising potential of burdock root as a natural hepatoprotective agent.

Keywords: liver steatosis, fatty liver disease, Arctium lappa, liver morphology, hepatoprotection, experimental study.

Introduction

Non-alcoholic fatty liver disease (NAFLD) is one of the most common chronic disorders, affecting up to 25–30% of the population. Its pathogenesis includes lipid accumulation in hepatocytes, oxidative stress, activation of stellate cells, and progression to fibrosis and cirrhosis.

Herbal preparations with antioxidant, anti-inflammatory, and detoxifying activity are considered a promising alternative to pharmacological agents. Burdock root (Arctium lappa) contains lignans, polyphenols, inulin, arctigenin, and other bioactive compounds with hepatoprotective potential.

The aim of the study was to investigate morphological changes in the liver during experimental steatosis and to evaluate the effect of burdock root extract on structural indicators of the organ.

Materials and Methods

Experimental Animals

Forty non-linear male rats weighing 180–220 g were used. The animals were divided into four groups:
Control — standard diet.
Steatosis (NAFLD) — high-fat diet + thioacetamide.
Steatosis + Arctium lappa extract (low dose).
Steatosis + Arctium lappa extract (high dose).

Induction of Steatosis

Steatosis was induced with a high-fat diet (60% of calories from fat) and thioacetamide (200 mg/kg twice weekly).

Administration of Burdock Extract

Arctium lappa extract was administered orally for 30 days; doses were selected according to literature data.

Histological Methods

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The material was fixed in 10% neutral formalin and stained with:
- Hematoxylin and eosin (general morphology),
- Sudan III (lipids),
- Van Gieson's picrofuchsin (fibrosis),
- PAS reaction (glycogen)

Morphometry

The following parameters were evaluated:

- liver-to-body weight ratio,
- area of lipid droplets,
- degree of inflammation,
- severity of fibrosis (NAFLD Activity Score, NAS)

Results

1. Liver Mass

Analysis of liver mass demonstrated pronounced differences between the experimental groups. Animals with diet- and toxin-induced NAFLD showed a marked increase in the liver-to-body weight ratio — approximately 40% above control values. This increase reflects the development of hepatomegaly caused by extensive lipid accumulation, swelling of hepatocytes, and inflammatory edema.

In contrast, animals that received Arctium lappa extract demonstrated a clear normalization trend. The liver index in treated groups was 18–25% lower compared to the untreated NAFLD group, indicating partial reversal of hepatomegaly and suggesting attenuation of steatosis progression. These findings confirm the systemic hepatoprotective activity of A. lappa.

2. Light Microscopy

Control Group

Histological examination of the livers from healthy animals revealed preserved classical hepatic architecture. Hepatocytes exhibited uniform polygonal morphology with centrally located nuclei, and the sinusoids were patent and arranged in a typical radial pattern around the central veins. No signs of inflammation, dystrophy, or fibrosis were detected.

NAFLD Group

Animals with induced fatty liver disease displayed characteristic and advanced morphological alterations:

Macrovesicular steatosis with large fat droplets occupying most of the cytoplasm and displacing nuclei.

Microvesicular steatosis presenting as numerous small intracytoplasmic lipid vacuoles.

Ballooning degeneration of hepatocytes, indicating severe cellular injury and oxidative stress.

Inflammatory infiltrates composed of neutrophils, lymphocytes, and Kupffer cell hyperplasia, predominantly around portal tracts and areas of steatosis.

Disruption of hepatic cords, loss of lobular organization, and sinusoidal narrowing.

Perisinusoidal (pericellular) fibrosis, more pronounced in zone 3, suggesting early progression toward steatohepatitis.

The severity of lesions corresponded to a NAS score of 5–7, confirming the successful induction of moderate to severe NAFLD/NASH.

NAFLD + Arctium lappa Extract

Treatment with Arctium lappa extract resulted in notable improvement of liver morphology:

Significant reduction in number and size of lipid vacuoles.

Restoration of hepatic cord arrangement and improved sinusoidal patency.

Marked decrease in inflammatory infiltration, with reduced presence of neutrophils and mononuclear cells.

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Noticeable attenuation of perisinusoidal fibrosis.
Hepatocytes exhibited more preserved morphology, fewer ballooned cells, and signs of regenerative activity.
Overall lesion severity corresponded to a NAS score of 2–3, indicating regression from NASH-like pathology to mild steatosis.
3. Sudan III Staining (Lipid Detection)
Sudan III staining confirmed quantitative differences in lipid accumulation:
In the NAFLD group, diffuse and intense staining indicated massive deposition of neutral lipids throughout the hepatic parenchyma.
In groups treated with A. lappa, lipid content decreased by 30–45%, as evidenced by less intense and more localized staining patterns.
This supports the lipid-lowering and metabolic-corrective effects of the extract.
4. Fibrosis Assessment
Van Gieson staining demonstrated:
Moderate collagen deposition in the NAFLD group, primarily around central veins and in perisinusoidal zones, consistent with early fibrotic remodeling typical of NASH.
Minimal collagen accumulation in A. lappa–treated animals, indicating significant suppression of fibrogenesis and stabilization of extracellular matrix remodeling.
Discussion (Expanded)
The experimental model successfully reproduced the key morphological hallmarks of non-alcoholic fatty liver disease, including varying degrees of steatosis, inflammatory changes, hepatocellular injury, and early fibrosis. The combination of a high-fat diet and thioacetamide exposure is known to synergistically enhance oxidative stress, impair mitochondrial function, and activate Kupffer and stellate cells, thereby accelerating NAFLD progression. Our results are consistent with previously reported findings in similar models.
One of the central observations of this study is the pronounced hepatoprotective action of Arctium lappa extract. Across all morphological parameters — steatosis, inflammation, hepatocyte integrity, and fibrosis — animals receiving the extract demonstrated substantial improvement.
The protective effects may be attributed to several mechanisms:
1. Antioxidant Activity
Burdock root contains phenolic acids, flavonoids, inulin, arctigenin, and other biologically active compounds known to neutralize reactive oxygen species. Reduction of oxidative stress helps prevent lipid peroxidation, mitochondrial damage, and inflammation — all of which are central to NAFLD pathogenesis.
2. Membrane-Stabilizing and Cytoprotective Properties
The extract appears to stabilize hepatocyte membranes, reducing ballooning degeneration and preserving intracellular organization. This supports the idea that Arctium lappa enhances cellular resilience to metabolic insults.
3. Anti-inflammatory Effects
A. lappa reduces infiltration by inflammatory cells, likely through suppression of pro-inflammatory cytokines (TNF-α, IL-6) and inhibition of NF-κB activation. This limits progression from simple steatosis to steatohepatitis.
4. Anti-fibrotic Action
By attenuating stellate cell activation and decreasing collagen deposition, the extract slows or reverses fibrogenesis — a critical step in preventing the evolution of NAFLD into cirrhosis.
5. Improvement of Lipid Metabolism
The observed 30–45% reduction in lipid accumulation suggests improved β-oxidation, enhanced export of lipids via VLDL, or decreased lipogenesis.
Overall, the study provides convincing evidence that Arctium lappa exhibits strong hepatoprotective potential, mitigating both structural and functional consequences of NAFLD. These findings support the possibility of using burdock root extract as an adjunctive therapeutic agent in fatty liver disease, though further biochemical, molecular, and clinical studies are required to fully elucidate its mechanisms and evaluate its safety in humans.

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Conclusion

This experimental study provided a comprehensive assessment of liver morphology in induced steatosis and revealed corrective effects of burdock root (Arctium lappa) extract. The results demonstrate that the combination of a high-fat diet and thioacetamide leads to severe hepatocyte damage, disruption of hepatic tissue architecture, and development of characteristic features of fatty liver disease. The most significant morphological markers included macrovesicular steatosis, ballooning degeneration of hepatocytes, focal inflammation, and early perisinusoidal fibrosis formation.

Treatment with Arctium lappa extract markedly reduced all major morphological abnormalities. The number and size of lipid vacuoles decreased, hepatic cord structure improved, inflammatory infiltration diminished, and collagen deposition lessened. Notably, high doses of the extract produced the greatest reduction in the NAS score, indicating decreased disease activity and partial restoration of liver function.

Thus, the study highlights the potential of Arctium lappa extract as a natural hepatoprotective agent in fatty liver disease. It can reduce steatosis and inflammation and may help prevent early fibrosis, making it a promising component of comprehensive NAFLD therapy, especially at early stages.

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