EFFECTS OF WHITE MILK THISTLE (SILYBUM MARIANUM L. GAERTN.) SEED EXTRACT, "METADOXINE", AND "TETURAM" ON THE MORPHO-ANATOMICAL AND HISTOLOGICAL STRUCTURE OF THE LIVER IN RATS DURING ALCOHOL INTOXICATION AT DIFFERENT PHYSIOLOGICAL AGE PERIODS

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ABSTRACT:

This study analyzed the effects of a local white milk thistle (Silybum marianum L. Gaertn.) seed extract on the morpho-anatomical and histological structure of the liver in rats with alcohol intoxication at different physiological age periods (5–25 and 60–80 days), using "Metadoxine" and "Teturam" (Disulfiram) as reference drugs. The effects of both acute and chronic alcohol intoxication were evaluated in different age groups of rats, and the mortality rate was found to be relatively higher under acute intoxication. Chronic alcohol intoxication induced histopathological changes in the liver, including hydropic degeneration, vacuolization, microvesicular steatosis, inflammatory infiltration, dilation of sinusoidal capillaries, and disruption of the normal radial architecture of hepatocytes. No signs of fibrosis or necrosis were observed in the 5–25-day-old rats, whereas fibrosis developed in 23.18±0.17% of the 60–80-day-old rats. Administration of Silybum marianum L. Gaertn. seed extract and "Metadoxine" reduced the severity of dystrophic changes, inflammatory infiltration, and vacuolization, while promoting restoration of hepatocyte structure toward normal physiological conditions. In contrast, treatment with "Teturam" (Disulfiram) did not produce a significant therapeutic effect on the histological changes associated with alcohol intoxication.

Key words: Silybum marianum L. Gaertn. seed extract, alcohol intoxication, rat liver, morpho-anatomical structure, histological structure.

I. INTRODUCTION

Relevance of the topic. As is well known, the metabolism of various hepatotoxins and the process of detoxification take place in the liver; analyzing the morpho-anatomical and structural-physiological changes that occur in the liver during this process is therefore of considerable theoretical and practical relevance for developing therapeutic approaches and new agents in the field of hepatoprotection [Serov and Severgina, 1996; pp. 61–64; Chernyak et al., 2014; pp. 50–54; Kwekel et al., 2010; pp. 1–15; Nurmagomaev et al., 2016; pp. 77–91].

The purpose of this study was to analyze the effects of a local white milk thistle (Silybum marianum L. Gaertn.) seed extract, together with the reference drugs "Metadoxine" and "Teturam," on the morpho-anatomical and histological structure of the liver in rats under alcohol-intoxication conditions at different physiological age periods (5–25 and 60–80 days).

II. RESEARCH MATERIALS AND METHODS

The research was carried out in 2026 at Berdakh Karakalpak State University, at the laboratory of the specialized medical institution of the Republican Children's Infectious Diseases Hospital located in Nukus, and at the Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnologies.

To prepare the white milk thistle (Silybum marianum L. Gaertn.) seed extract, seeds (m = 200 g) were incubated in a thermostat at +60±0.5°C for 48 hours and mechanically ground; the resulting powder was extracted in a glass flask (250 ml) with an 80% ethanol solution for 48 hours, then evaporated at +50±0.5°C using an RE100-Pro rotary evaporator ("Beijing Zetron Technology" Co., Ltd., China). The resulting extract was used for analysis in the study [Pal et al., 2014; pp. 1–10; El-Din Fahmy et al., 2021; pp. 2773–2778].

For comparison, drugs used in clinical alcoholism therapy — "Metadoxine" ("Doppel Farmaceutici" SrL, Italy) and "Teturam" (Disulfiram) ("Pharmstandard" JSC, Russian Federation) — were used.

The experiments used outbred white rats (Rattus norvegicus; ♀/♂, 5–25 days old, m = 20–35 g; 60–80 days old, m = 160–220 g) housed under standard conditions (+20±5°C, relative air humidity 75±10%, 12:12-hour light regime) and fed a standard diet (water), at the vivarium of the Karakalpakstan Republic branch of the Republican Anti-Plague Prevention Center and the Laboratory of Animal Disease Diagnostics and Food Safety of the Republic of Karakalpakstan. Work with experimental animals complied with the international bioethics requirements established by CIOMS (The Council for International Organizations of Medical Sciences, 1985) and the European Convention for the

Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes (Strasbourg, 1986). Prior to dislocation decapitation, rats were anesthetized by tail-vein injection of a sodium thiopental solution (20 ml/kg) ("Sintez" JSC, Russian Federation) [Motuziuk et al., 2024; pp. 1–15].

Based on an analysis of the available literature, partially modified chronic and acute alcohol-intoxication experimental models were used. The chronic alcohol-intoxication model was induced by oral administration of "Qarataw" vodka (a 45% ethanol solution; manufactured by "Uzvinosanoat-holding" JSC, "Nukus Wine Factory" JSC, Republic of Karakalpakstan, Nukus, 34 Kanyazov Street) at a dose of 2 ml/kg body weight, twice daily, for 7 days. The acute alcohol-intoxication model was induced by intraperitoneal injection at a dose of 3 ml/kg body weight, once daily, for 3 days. The control group received an equivalent volume of distilled water instead of the ethanol solution [Sergeeva, 2007; pp. 3–25; Pal et al., 2014; pp. 1–10; Ayrapetov et al., 2019; pp. 380–384].

Analysis of the liver's color and morpho-anatomical structure is known to be important for evaluating the degree of structural-functional changes occurring in the hepatocytes of experimental animals. Accordingly, hepatocyte arrangement, dystrophic changes, lipid droplets (infiltration), dilation of central vein blood vessels, hemorrhage, dilation of perivascular areas, foci of necrosis and infiltration, cytoplasmic vacuolization in hepatocytes, and the occurrence of fibrosis were evaluated [Lepekhova, 1999; p. 128; Alyabyev et al., 2014; pp. 71–74].

Histological analysis of rat liver under physiological-norm, alcohol-intoxication, and pharmacological-correction conditions was carried out using a standard method [Tadic et al., 2002; pp. 1057–1068; Mahli et al., 2015; pp. 1–8; Motuziuk et al., 2024; pp. 1–15; Bellamkonda et al., 2025; pp. 1412–1423].

After decapitation/dislocation euthanasia, the rat's abdominal cavity was opened surgically with a scalpel and, to prevent autolysis, the liver was rapidly excised (biopsy) and incubated for 24 hours at t = 20±0.5°C in a 10% formalin solution at a 1:10 ratio (pH = 7). This step inhibited biochemical (autolytic) processes in the liver and preserved the original state of the microstructures. After fixation, the tissue was rinsed under running distilled water to remove paraffin residues, dehydrated sequentially through 75%, 80%, and 96% ethanol and absolute ethanol (45 minutes each), cleared of ethanol in xylene (120 minutes), and then embedded in paraffin (t = 60±0.5°C, 120 minutes) in special molds (infiltration). Once the paraffin blocks had hardened, 3–5-µm sections were cut using a Rotary Microtome CUT4050 ("microTec Laborgeräte" GmbH, Germany), floated on distilled water in a water bath (t = +45±0.5°C), and deparaffinized in xylene. The material was then dehydrated in the reverse sequence

(100%, 96%, 80%, and 75% ethanol, 5 minutes each), rinsed in distilled water for 5 minutes, mounted on a microscope slide, and stained with hematoxylin–eosin (H&E) — 10 minutes in hematoxylin and 60 minutes in eosin (hematoxylin stains the hepatocyte nuclear region blue-violet, while eosin stains the cytoplasm pinkish-red). Slides were rinsed in distilled water for 3 minutes, dehydrated in ethanol, cleared with xylene, and, once the coverslip was applied, treated with a drop of Canada balsam ("Merck", Germany; refractive index n = 1.52–1.54) to optimize the optical properties of the preparation (the essential oils in the balsam prolong the preparation's shelf life). Microstructures were visually analyzed under a MIC-1000i biolaboratory light microscope ("Chongqing MIC Technology" Co., Ltd., China) at 200× and 300× magnification, and histological micrographs were captured through the display mounted on the microscope [Tadic et al., 2002; pp. 1057–1068; Mahli et al., 2015; pp. 1–8; Motuziuk et al., 2024; pp. 1–15; Bellamkonda et al., 2025; pp. 1412–1423] (Fig. 2.1).

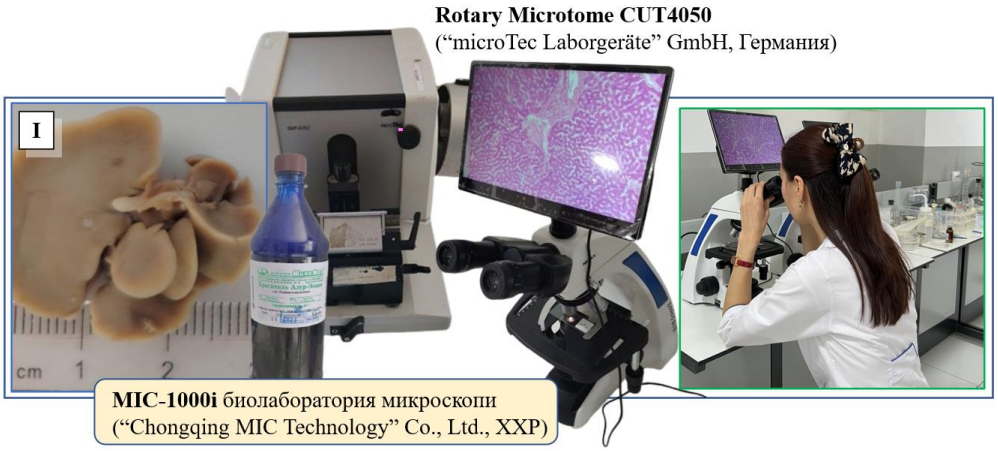


Fig. 2.1. Process of analyzing the histological structure of rat liver. I. Morpho-anatomical structure of a rat liver incubated in 10% formalin solution. The azure–eosin stain (according to Romanovsky) ("MiniMed-R", Russian Federation) consists of azure I thiazine, which stains cell nuclei and basophilic structures violet, and eosin (xanthene), which stains the cytoplasm and granular structures pinkish-red; methylene blue enhances staining and differentiation (0.75 alcohol–glycerin solution). In this stain, alcohol (methanol) acts as the solvent and fixative, while glycerin counteracts precipitate formation. The working solution was prepared by dissolving the stain in distilled water (phosphate buffer, 10 ml) at a ratio of 1:10 (pH = 6.4–6.8).

In this study, the structure of the histological preparations of rat liver was analyzed using a standard method, based on comparison with existing experimental histological photographic data [Suvarna et al., 2013; p. 603; Khramykh et al., 2018; pp. 9–13; Rostami et al., 2025; pp. 426–

437; Bellamkonda et al., 2025; pp. 1412–1423; Kalkan et al., 2026; pp. 69–79].
In this study, the histological structure of the rat liver under physiological-norm and alcohol-intoxication conditions was evaluated, based on an analysis of existing methodological literature, according to the following modified grading scale (points) [Serov and Severgina, 1996; pp. 61–64; Chernyak et al., 2014; pp. 50–54; Altamirano et al., 2014; pp. 1231–1239; Nurmagomaev et al., 2016; pp. 77–91; Lackner et al., 2021; pp. 810–819] (Table 2.1):

Table 2.1

Scale for evaluating the histological structure of rat liver under physiological norm and alcohol intoxication (points)

No.	Description of liver histological structure	Grading scale (points)
1.	Hepatocyte cords are arranged radially from the central vein; no significant changes in histological structure.	0
2.	Hydropic degeneration and vacuolization in hepatocytes, with mild dilation of sinusoidal areas (no fibrosis or necrosis).	1
3.	Marked hydropic degeneration in hepatocyte regions, widespread vacuolization, hemorrhage in sinusoidal areas, and moderate dilation.	2
4.	Lipolytic vacuolization, intensified hydropic degeneration in hepatocytes, hemorrhage, neutrophilic infiltration, and areas of fibrosis and necrosis are noted.	3

Statistical processing of the experimental results obtained was carried out using standard methods with “Microsoft Excel 2007” (Microsoft, USA) and OriginPro v.8.5 SR1 (EULA, USA) software packages. Results, obtained from experiments repeated n = 3–4 times, are presented as M±m, where M is the arithmetic mean and m is the standard error. The statistical significance of differences between experimental results and the control group was calculated using Student’s t-test, with $p<0.05$ and $p<0.01$ considered statistically significant [Plokhinsky, 1970; pp. 20–367].
In this study, analysis of the lipid vacuolization area (%) (FVA — Fat Vacuoles Area) and the sinusoidal space area (SSA — Sinusoidal Space Area) in the histological preparations of rat liver

was carried out by image processing based on the original code using "QuPath-v0.7.0," "ImageJ segmentation" ("Wayne Rasband (NIH)", USA), and "StarDist" ("European Molecular Biology Laboratory", Germany) software.

III. RESULTS AND DISCUSSION

In this study, the age-dependent effects of chronic and acute alcohol intoxication in rats were first compared. It was found that the changes occurring in the morpho-anatomical and histological structure of the liver under the chronic-intoxication condition (oral administration of "Qarataw" vodka [45% ethanol solution] at 2 ml/kg body weight, twice daily, for 7 days) were more pronounced than under the acute-intoxication model (intraperitoneal injection at 3 ml/kg body weight, once daily, for 3 days).

It was also found that mortality-rate values differed between the alcohol-intoxication experimental models and the physiological age groups of the animals (Table 3.1).

Table 3.1

Mortality rate in rats depending on physiological age period in chronic and acute alcohol-intoxication experimental models (M±m)

No.	Experimental group	5–25 days (%)	60–80 days (%)
1.	Chronic alcohol intoxication	8.08±0.09	10.16±0.12*
2.	Acute alcohol intoxication	21.43±0.25	34.16±0.37**

*Note: * — p<0.05, ** — p<0.01, relative to control in the alcohol-intoxication group (n=3–4).*

Accordingly, it was found that 8.08±0.09% of the experimental animals in the 5–25-day age group and 10.16±0.12% in the 60–80-day age group died under chronic alcohol intoxication, while 21.43±0.25% and 34.16±0.37%, respectively, died under acute alcohol intoxication.

It was found that, in animals that died under acute alcohol intoxication, the external morpho-anatomical appearance of the liver changed dramatically: the color became pale, hemorrhagic areas were clearly evident, and pale protrusions formed on the smooth outer surface of the liver (Fig. 3.1).

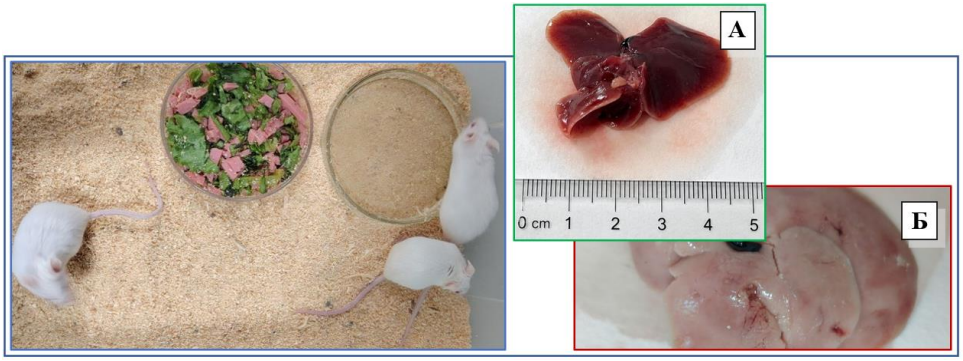


Fig. 3.1. External morpho-anatomical appearance of the surgically excised rat liver, within 3 minutes after death, in a healthy/control animal (A) versus an animal from the acute alcohol-intoxication experimental model (5–25-day age period) (B).

Based on the analysis of these results, the chronic alcohol-intoxication experimental model was used in the subsequent stages of the experiments.

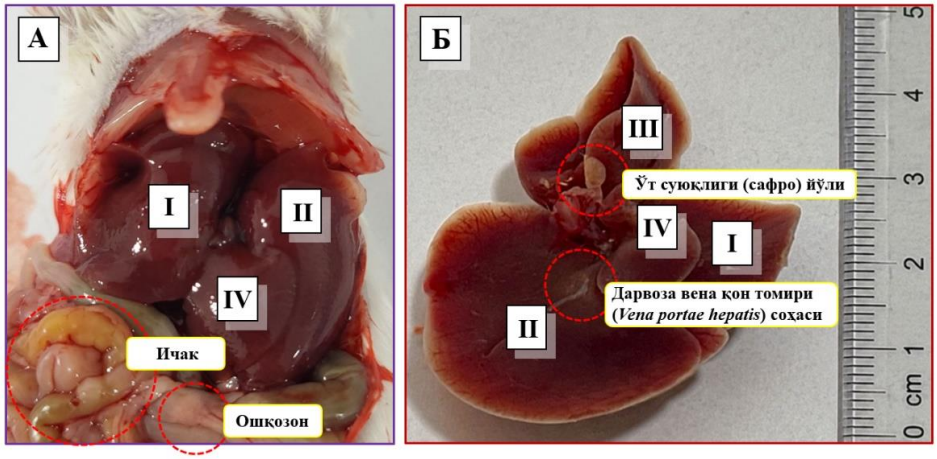


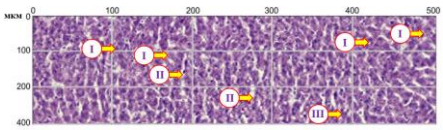
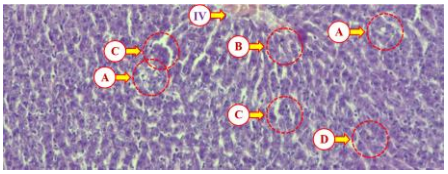
Fig. 3.2. Topological localization (A) and morpho-anatomical structure (B) of the rat liver. Here, I — right liver lobe (Lobus hepatis dexter), II — left liver lobe (Lobus hepatis sinister), III — caudate lobe (Lobus caudatus), IV — median lobe (Lobus medianus) (Laboratory of the specialized medical institution of the Republican Children's Infectious Diseases Hospital, Nukus, Republic of Karakalpakstan, June 29, 2026).

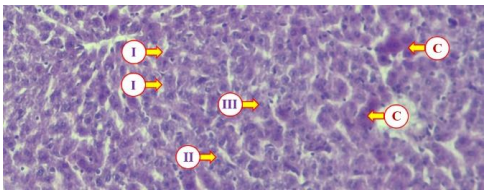
In the experiments, under physiological-norm (control group) conditions, the histological architectonic structure of the rat liver was found to be close to the standard state (Table 3.2) [Nurmagomaev et al., 2016; pp. 77–91].

Table 3.2

Pharmaco-corrective effect of local white milk thistle (Silybum marianum L. Gaertn.) seed extract on the histological structure of the liver in rats with chronic alcohol intoxication

Liver histological structure	Description
1. Physiological norm (control group)	

	The cytoplasm is dark pink (eosinophilic) and the nuclear region is dark pink (basophilic); polygonal parenchymal hepatocytes are arranged radially from the center outward (I), with no pathological/dystrophic changes (fibrosis, necrosis). Microcapillaries between hepatocyte cords appear as pale spaces in the sinusoidal regions (II), where endothelial and Kupffer (macrophage) cells stain dark violet. Hepatocyte cord regions (III) are clearly defined (the central vein and portal tract are not visible in this image) (H&E, magnification 100×, eyepiece 20, objective 10).
2. Chronic alcohol intoxication	
	Under chronic alcohol intoxication, hydropic degeneration, vacuolization, and microvesicular steatosis (B) were observed in hepatocyte regions (A); infiltration (C) and marked dilation of sinusoidal capillary areas were noted, together with disruption of the radial structure of hepatocyte cords (D); vacuolization also occurred in the central vein region (IV) (H&E, magnification 100×, eyepiece 20, objective 10).
3. White milk thistle (Silybum marianum L. Gaertn.) seed extract (250 mg/kg)	

	In hepatocyte regions (I), the degree of pathological/dystrophic changes was markedly reduced; changes in sinusoidal regions (II) were reduced; hepatocyte cord regions (III) showed a structure close to the physiological norm (polygonal arrangement); infiltration areas (C) and the degree of vacuolization were reduced (H&E, magnification 300×, eyepiece 10, objective 30).
4. "Metadoxine" (250 mg/kg)	

Note: H&E indicates that the histological preparation was stained with hematoxylin and eosin.

Under physiological-norm conditions, hepatocytes forming associations with sinusoidal areas around the central vein are typically observed in the histological structure of the rat liver. The histological structure of rat liver (200–400×) is characterized by hepatocytes with relatively small, basophilic granular structures [Kondashevskaya et al., 2018; pp. 41–44].

Under alcohol intoxication, pale protrusions form on the surface of the rat liver, indicating serious pathological changes at the hepatocellular level. Under pathophysiological conditions, increased liver weight results from inflammation and cytolytic processes [Lepekhova, 1999; p. 128].

Thus, in the alcohol-intoxication group, the liver color became pale brownish, the surface developed rough protrusions, and the consistency changed. In the histological preparations, the sinusoidal capillary regions and central vein region of hepatocytes were clearly distinguishable. Compared with the control, the radial arrangement of hepatocytes was significantly disrupted in the alcohol-intoxication group; lipid droplets of varying size (lipolytic degeneration) accumulated in the hepatocyte cytoplasm; dilation was observed in the central vein and triad vessel regions; and hemorrhage was observed. Foci of lymphocytic infiltration formed in the hepatocyte triad regions.

Injection of white milk thistle (Silybum marianum L. Gaertn.) seed extract (250 mg/kg) and "Metadoxine" (250 mg/ml) markedly reduced the degree of pathological/dystrophic changes and the changes in sinusoidal regions of hepatocyte areas; the hepatocyte cord regions showed a structure closer to the physiological norm (polygonal

arrangement), and infiltration areas and the degree of vacuolization were reduced. It was also found that injection of "Teturam" (Disulfiram) (250 mg/ml) did not produce significant therapeutic changes in the morpho-anatomical and histological structure of the rat liver relative to alcohol intoxication (Table 3.3).

Table 3.3

Scale for evaluating the histological structure of rat liver under physiological norm and alcohol intoxication (points)

No.	Experimental group	Grading scale (points)
1.	Control (physiological norm)	0
2.	Alcohol intoxication	3
3.	White milk thistle (Silybum marianum L. Gaertn.) seed extract (250 mg/kg)	2
4.	"Metadoxine" (250 mg/kg)	2
	"Teturam" (Disulfiram) (250 mg/kg)	3

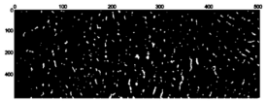
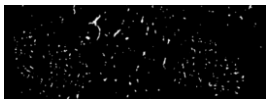
According to the analysis of the liver's histological structure, no fibrotic or necrotic dystrophic changes were found in rats in the 5–25-day age period. It was also found that fibrosis signs occurred in 23.18±0.17% of cases in the liver histological structure of experimental animals in the 60–80-day age period.Changes occurring in liver microstructure under the influence of various factors (hepatotoxins, etc.) are typically evaluated based on the degree of steatosis, hepatocellular ballooning or hydropic degeneration, inflammatory foci, and fibrosis (collagen-fiber infiltration) in the portal/sinusoidal regions. Specifically, the degree of lipid infiltration in hepatocyte regions is graded as follows: <5% — steatosis grade 0 (macrovesicular infiltration), 5–33% — grade 1 (microvesicular infiltration), 33–66% — grade 2 (mixed-type infiltration), >66% — grade 3 [Elmas et al., 2020; pp. 626–632].

Thus, based on analysis of the lipid vacuolization area (Fat Vacuoles Area) in the histological preparations of rat liver, lipid infiltration was found to be 1.1% in the control group, FVA = 5.74% in the chronic alcohol-intoxication group, and FVA = 0.8% in the group treated with white milk thistle (Silybum marianum L. Gaertn.) seed extract (250 mg/kg) (pharmaco-correction group) (Table 3.4).

Table 3.4

Pharmaco-corrective effect of local white milk thistle (Silybum marianum L. Gaertn.) seed extract on the degree of steatosis in the

histological structure of the liver in rats with chronic alcohol intoxication

No.	FVA	Lipid infiltration area (%)	Steatosis (points)
1.		1.1	0
2.		5.74	1
3.		0.8	0

Note: FVA — indicates the lipid vacuolization area (Fat Vacuoles Area). Mild hepatocellular ballooning or hydropic degeneration, and formation of Mallory–Denk bodies, can be observed in hepatocyte regions. In this study, the lipid vacuolization area (%) (FVA) and sinusoidal space area (SSA) in the histological preparations of rat liver were analyzed by image processing based on the original code using "QuPath-v0.7.0," "ImageJ segmentation" ("Wayne Rasband (NIH)", USA), and "StarDist" ("European Molecular Biology Laboratory", Germany) software.It was also found that the sinusoidal space area (SSA) was 10.14% in the control group, 23.46% in the chronic alcohol-intoxication experimental model, and SSA = 12.67% in the group treated with white milk thistle (Silybum marianum L. Gaertn.) seed extract (250 mg/kg) (pharmaco-correction group).

Thus, since the liver is structurally and functionally highly sensitive to various endo/exotoxicants, hepato-histological analysis is of considerable importance in evaluating the therapeutic effects of various corrective agents [Myshkin et al., 2011; pp. 131–136; Chuykin et al., 2022; pp. 215–224].

Studies have shown that, with ethanol consumption exceeding 100 ml/day, hepatitis symptoms sharply intensify in liver functional status, along with encephalopathy, gastrointestinal vascular varices, and increased blood bilirubin concentration; this is associated with intensified inflammatory processes and accumulation of neutrophils (infiltration) in hepatocytes [Altamirano et al., 2014; pp. 1231–1239].

Under ethanol exposure, increased expression of the adhesion factor ICAM-1 (Intercellular Adhesion Molecule-1) on the surface of hepatocyte neutrophils, and of E-selectin on sinusoidal endothelial cells,

increases neutrophil circulation [Altamirano et al., 2014; pp. 1231–1239].

Studies have shown that, when rats were given ethanol (5%) in drinking water for 3 weeks, the blood-clotting (hemolysis) period lengthened, and levels of alanine transaminase (ALT), aspartate transaminase (AST), total bilirubin, malondialdehyde (MDA), peroxynitrite radical content, and xanthine oxidase activity increased; under the influence of silymarin (2–4 mg) isolated from Silybum marianum L. Gaertn. seeds, these indicators approached the physiological norm, and the degree of liver histological changes associated with lipid accumulation was reduced [Alkatib and Taha, 2020; pp. 95–110].

Under CCl4-induced intoxication (2 ml/kg body weight), Silybum marianum L. Gaertn. extract (oral, 20–100 mg/kg body weight) was found to significantly optimize the “liver index,” the morpho-histological indicators of the liver, and serum ALT and AST levels in rats [Mahli et al., 2015; pp. 1–8].

Studies have confirmed that, under prolonged (14-day) acute alcohol intoxication, the histological structure of rat liver developed foci of fibrosis, dystrophic vacuolization, and regenerative foci, along with necrosis, lymphocyte/neutrophil infiltration, marked dilation of the central vein, and hemorrhage, as well as increased total bilirubin concentration and De Ritis ratio [Kapralov et al., 2024; pp. 1–4].

Studies have shown that, under alcohol intoxication (5 ml/kg body weight), injection of “Disulfiram” (100 mg/kg body weight) significantly reduced hepatocyte degeneration, inflammatory-cell infiltration, fibrosis, and hemorrhage in renal tubules; this pharmaco-corrective effect has been suggested to relate to the drug’s anti-inflammatory and antioxidant activity [Kalkan et al., 2026; pp. 69–79].

It has also been confirmed that fibrosis arising from infiltration of extracellular matrix material biosynthesized by stellate cells under CCl4 exposure in hepatocytes is significantly attenuated by “Disulfiram” [Yang et al., 2022; pp. 1–10].

Conclusions

Thus, it was found that 8.08±0.09% of rats in the 5–25-day age group and 10.16±0.12% in the 60–80-day age group died under chronic alcohol intoxication, while 21.43±0.25% and 34.16±0.37%, respectively, died under acute alcohol intoxication.Under chronic alcohol intoxication, the histological structure of rat liver showed hydropic degeneration, vacuolization, and microvesicular steatosis in hepatocyte regions, together with marked dilation of sinusoidal capillary regions, disruption of the radial structure of hepatocyte cords, and vacuolization in the central vein region.

Under chronic alcohol intoxication, no fibrotic or necrotic dystrophic changes were observed in the liver histo-structure of

rats in the 5–25-day age period, whereas fibrosis signs occurred in 23.18±0.17% of cases in the 60–80-day age period.

Injection of white milk thistle (Silybum marianum L. Gaertn.) seed extract (250 mg/kg) and “Metadoxine” (250 mg/ml) markedly reduced the degree of pathological/dystrophic changes and the changes in sinusoidal regions of hepatocyte areas; the hepatocyte cord regions showed a structure closer to the physiological norm (polygonal arrangement), and infiltration areas and the degree of vacuolization were reduced. It was also found that injection of “Teturam” (Disulfiram) (250 mg/ml) did not produce significant therapeutic changes in the morpho-anatomical and histological structure of rat liver relative to alcohol intoxication.The results obtained can serve as a scientific basis for developing an effective hepatoprotective drug based on white milk thistle (Silybum marianum L. Gaertn.) seed extract for the therapy and prevention of alcohol intoxication.

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Notes:

[1] The analysis of the morpho-anatomical structure of the rat liver in this study was carried out based on data from Khramykh T.P., Ermolaev P.A., Barskaya L.O. Features of regeneration of the remaining part of rat liver in the early period after maximum permissible resection // Operative Surgery and Clinical Anatomy. — 2018. — No.3. — P.9-13.

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