10.21608/avmj.2025.370035.1642 Assiut University web-site: www.aun.edu.eg

HEPCIDIN AS A PREDICTIVE MARKER IN HEPATIC AND DIABETIC DISORDERS

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Received: 9 April 2025; **Accepted:** 20 May 2025

ABSTRACT

In the absence of additional risk factors that contribute to metabolic syndrome, such as hypertriglyceridemia and obesity, type-2 diabetes mellitus may be a risk factor for the development and progression of liver disease. A key component of metabolism is the liver. As a result, it is extremely vulnerable to toxicity caused by chemicals. The present work aimed at studying the effects of T2DM and ethanol induced liver disorders on hepcidin with iron status and some hematological parameters. Fifty adult male albino rats alienated evenly into equal five groups. Group I: normal control group (C), Group II: control iron (CI), Group III: diabetic iron (DI), Group IV: hepatic iron (HI) and Group V: hepatic diabetic iron (HDI). The obtained results showed that the hematological profile was significantly reduced ($P<0.05$) by T2DM induction and chronic ethanol treatment, while levels of HbA1C, aspartate transaminase (AST), alanine transaminase (ALT), total bilirubin (TB), hypo-albuminemia, and fasting blood glucose (FBG) were elevated. Moreover, significant changes in serum hepcidin and serum iron profile (iron, ferritin, total iron binding capacity and transferrin saturation %) were recorded in this study. It could be concluded that ethanol administration and T2DM persuade revocable alterations in hematology and biochemical markers.

Keywords: Hepcidin, Hepatic, Diabetic Disorders, Rats

INTRODUCTION

Alcohol drinking is a significant clinical, social, and financial issue **(**Axley *et al.,* 2019). Numerous illnesses, including gastrointestinal damage, alcoholic liver disease (including cirrhosis), pancreatitis, hepatocarcinoma, esophageal cancer, breast cancer, hypertension, and strokes, can be brought on by prolonged alcohol use (Zhou *et al.,* 2016).

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Acute and chronic alcohol-induced liver injury is possibly due to the fact that the liver is the main organ of alcohol metabolism (Osna *et al.,* 2017). It is now well established that ethanol is a hepatotoxin (Clemens, 2007). Chronic consumption of ethanol damages the liver by changing the metabolism of methionine, particularly by reducing the amount of methionine synthase (MS), an essential enzyme that remethylates homocysteine (Kharbanda and Barak, 2005; Kharbanda, 2013). MS is characterized by an increase in S-adenosyl homocysteine (SAH) and a decrease in hepatic S-adenosylmethionine (SAM). A fatty liver and liver damage results from the impairment of many vital

methylation processes caused by the drop in the intrahepatic SAM: SAH ratio (Kharbanda, 2013; Ganesan *et al.,* 2016; Arumugam *et al.,* 2022).

The pathophysiology of T2DM is significantly influenced by the liver and kidney. T2DM, a metabolic disorder that is growing more prevalent, is typified by insulin resistance and hyperglycemia in tissues, such as the liver, pancreas, muscle, and adipose (Wong *et al.,* 2014). Since high bodily iron reserves can lead to T2D, the iron regulating hormone Hepcidin may have a direct or at least indirect role in the aetio-pathogenesis of T2D (Aregbesola *et al.,* 2015). Elevated ferritin and serum iron levels, as well as excessive iron deposition in key organs, such as the liver, pancreas, and heart, were characteristics of diabetes. Interestingly, more than 20% of people with genetic hemochromatosis have diabetes (Guo *et al.,* 2013).

Hepcidin, ferritin, and transferrin are hepatic iron metabolism-regulating proteins. Apart from their functions in iron metabolism, these proteins are acute-phase reactants, and inflammation or hepatic or systemic damage might change how they are expressed (Bloomer and Brown, 2021).

The liver, adipose tissue, pancreas, and intestinal cells all produce hepcidin, a cysteine-rich 25-amino acid antimicrobial peptide (Hentze *et al.,* 2010). Iron reserves promote hepcidin synthesis, which is downregulated during erythropoiesis and hypoxia and upregulated during infections and inflammations (Jiang *et al.,* 2011). It controls the release of iron from hepatocytes, enterocytes, and macrophages to achieve its regulatory action. By internalizing and then lysosomally degrading its receptor, the cellular iron exporter ferroportin in the duodenum and macrophages, Hepcidin negatively controls the amount of iron that enters the bloodstream. This lowers tissue iron content and controls intestinal iron absorption and plasma iron concentration (Ganz and Nemeth, 2012). Raising hepcidin can reduce iron-mediated oxidative stress by downregulating iron transporters, which lowers the amount of iron in the brain of rats that are iron-overloaded (Du *et al.,* 2015). It's uncertain if elevated hepcidin might alleviate cerebral iron deposition and cognitive impairment in T2D, despite the fact that its therapy has proven to be an effective treatment for iron overload (Cong *et al.,* 2015).

Iron (Fe) has a potential role in diabetes, as it is a powerful pro-oxidant that causes an increase in ROS and OS, contributing directly to tissue damage, raising the risk for diabetes (Rajpathak *et al.,* 2009). Transferrin is the iron transporter from locations of absorption to locations of usage, whereas ferritin is in charge of storing iron. Serum ferritin levels are known to strongly correlate with bodily iron stores (Ponka *et al.,* 1998). However, transferrin saturation is utilized in conjunction with serum ferritin concentration to evaluate the real iron status, as serum ferritin concentrations reflect both inflammation and body iron reserves (Park *et al.,* 2015). Conflicting findings have been reported, nevertheless, the relationships between transferrin saturation and diabetes has not been thoroughly examined (Yeap *et al.,* 2015).

This study is designed to evaluate iron status, ferritin and its regulator Hepcidin hormone with a hyperlipidemic hyperglycemic diet in hepatic and diabetic rat model.

MATERIALS AND METHODS

Experimental animals and design

Fifty mature male albino rats (local strain) weighing between 100 and 250 g were acquired from Zagazig University's Faculty of Veterinary Medicine's animal house. Plastic cages measuring thirty

inches in length, eighteen inches in breadth, and twenty-four inches in height were used to house the animals. In the animal house of Zagazig University. The rats were kept in cages under sanitary circumstances, with unrestricted access to a regular meal. Every rat had unrestricted access to water, was kept at a reasonable temperature (20 to 24 ^{o}C), and was kept on a regular light-dark cycle. The animals were acclimated to the circumstances of the animal home for three weeks prior to the commencement of the investigation. The rats were divided equally into 5 groups: group I: control group (NC), group II: control+iron (CI), group III: diabetic+iron (DI), group IV: hepatic+iron (HI) and group V: hepatic diabetic+iron (HDI).

Liver Disease Induction: Ethanol and distilled water (10 mL/kg) in varying concentrations (high dose 1: 1 (m/v), medium dose 1: 5, and low dose 1: 10) were administered daily to rats of group IV (HI) and group V (HDI). Ethanol was given according to the following ways: 35% ethanol (v/v) at a dose of 3 g/kg body weight for 7 days, 40% ethanol (v/v) at a dose of 4 g/kg body weight for the next 7 days, and 52% ethanol (v/v) at a dose of 5 g/kg body weight on the 15th day. All the intervention methods were intragastric administration (Zhang *et al.,* 2016).

Diabetes Induction in Rats: An antibiotic called streptozotocin (STZ) is frequently used in experiments to create a model of type 2 diabetes. It causes insulin insufficiency and hyperglycemia. STZ (Sigma Chemicals, St. Louis, MO) was injected intravenously into adult rats in groups III: (DI) and group V: (DHI) at a single dose of 60 mg/kg of body weight to induce diabetes (Karunanayake *et al.,* 1975). To verify the induction of diabetes, the fasting blood glucose (FBG) level was assessed three days (72 hours) following the injection of STZ® using a Glucometer (Accu Chek Active Performa, Roche, Germany). Diabetic rats were defined as having blood glucose levels between 220 and 250 mg/dl. All groups were kept in metabolic cages under feeding and metabolism control.

Dietary Protocol and Composition: The control group I (NC) was nourished with normal balanced food, which contains the following: cornstarch (400 g/kg), casein (150 g/kg), soybean oil (80 g/kg), salt mixture (50 g/kg), cellulose (20 g/kg), vitamin mixture (10 g/kg), and choline (4 g/kg). The control iron group II (C+Iron) was fed the control diet and given iron dextran solution (100 g Fe^{2+}/L) by intraperitoneal inoculations. Iron dextran injections at dosages of 10 mg/d for 5 days were administered to the rats during week 6 after they had been fed the diets for 8 weeks (Turbino-Ribeiro *et al.,* 2003).

The other groups (III D+Iron), (IV H+Iron) and (VD H+Iron) were fed with a diet containing high carbohydrate and cholesterol (glycemic and hyperlipemic diet), and iron dextran solution, as previously mentioned. The hyperlipemic and glycemic diet contained the following: corn starch (700 g/kg), cellulose (200 g/kg), soybean oil (250 g/kg), casein (125 g/kg), salt mixture (50 g/kg), cholesterol (10 g/kg), vitamin mixture (15 g/kg), and choline (4 g/kg) (AOAC, 1980).

Blood sampling: Rats were given no food for the whole night, and then given an intraperitoneal injection of pentobarbital at a dose of 60 mg/kg body weight to the end of the protocol. Blood samples were collected from the brachial plexus either in tubes containing EDTA for hematology assay or in plain test tubes without anticoagulant for serum separation by centrifugation at 4000 g for 10 minutes. The obtained sera were stored at −20°C until biochemical analysis.

Hematological analysis: Red blood cell count (RBC), hemoglobin concentration

(Hb), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were determined using a Spinreact 3-Part-Diff. Hematology Analyzer according to the manufacturer's recommendation.

Biochemical analysis: Serum hepcidin was determined using rat hepcidin ELISA Kit (Cat. No. MBS2021087) MyBioSource, Inc. San Diego, CA 92195-3308, USA. Serum ferritin level was measured using Rat Ferritin ELISA Kit Catalog Number EEL129 Rev 2.0, Thermo Fisher Scientific inc., Waltham, 168 3rd Ave, USA. Rat blood HbA1C levels were measured using Rat HbA1C ELISA kit (Fine Test®, Catalogue No.: ER 1030, Revision: V4.0, Wuhan, 430074, Hubei, China), strictly following the manufacturer's instructions. Transferrin saturation percentage was calculated as serum iron/TIBC × 100. Serum total iron was measured using a colorimetric assay by a LAbOSPECT 008AS automatic biochemical analyzer (Roche Diagnostics). The total iron-binding capacity (TIBC) was estimated by an automated chemistry analyzer (Cobas C702; Roche, Mannheim, Germany). Blood glucose was measured by the enzymatic colorimetric method using the Rx Monza analyzer. Liver transaminases (ALT and AST), total bilirubin (TB), and albumin were estimated by using commercially accessible diagnostic kits (Thermo Electron, Santa Cruz, CA, USA).

Statistical analysis: SPSS version 21 software (SPSS Inc., Chicago, IL, USA) was used to analyze the results obtained. Statistical significance was defined as $P<0.05$, and the findings were presented as mean ± standard error (SE).

RESULTS

Statistical analysis of Hematological parameters revealed considerable increases in RBC count and HCT values in group II control iron-treated rats (CI), with non-significant ($P>0.05$) alterations in Hb levels, compared to group I normal control rats (C), as illustrated in Table 1. However, the red blood indices (RBC count, Hb and HCT) in the diabetic iron group (DI) were significantly lower than normal control and CI groups ($P<0.05$). Appreciable reductions were also observed in the red blood indices in HI and HDI-treated rats (groups IV and V) when matched with the CI group, although the changes in HCT were not significantly ($p> 0.05$) different from the values of the normal control group (C). Erythrocyte indices (MCV, MCH and MCHC) displayed nonsignificant variations among groups: III (DI), IV (HI) and V (HDI), compared to the control groups (I&II), indicated normocytic normochromic anemia (Table 1).

Regarding biochemical parameters, the mean fasting blood sugar (FBS), HbA1C, hepcidin, iron, ferritin, TIBC, and transferrin saturation varied statistically significantly among all studied groups (Table 2). Compared with the controls (C& CI), the mean FBS showed significant elevation in DI, HI and HDI groups. The highest increase was observed in rats of the DI group. The HbA1C values in diabetic and hepatic diabetic iron groups (DI &HDI) were significantly increased ($P<0.05$) in association with the group's controls (C&CI), however, it showed non-statistical variation in the HI group. There is no significant difference in serum hepcidin between control (C) and control iron (CI) groups, however, it significantly ($P<0.01$) decreased and increased in HI and HDI groups, respectively. The serum iron, ferritin, and TIBC were statistically higher in CI than C group, however, they were significantly ($P<0.01$) diminished in DI and increased in HI group, compared to CI, except TIBC, which significantly ($P<0.001$) decreased in both DI and HI groups. On the contrary, the iron, ferritin, and TIBC serum levels were not

statistically (P=0.678) different for the HDI and CI groups, but increased when coordinated with group I normal rats (C). Transferrin saturation percentage exhibited an elevation in DI, HI, and HDI groups, paralleled with control one. Diabetic rats (DI) showed no statistical variations in serum iron, ferritin, TIBC, and percentage of transferrin saturation, while they increased in the HI and DHI groups, compared to the control (C). Table 3 indicates that the serum of the HI and HDI groups had considerably higher levels (P<0.001) of liver transaminases ALT and AST activity and TB levels than the control group, while the serum albumin levels were significantly (P<0.01) lower than the control group. Diabetic rats (DI) showed a known (P<0.001) increase in serum ALT and TB levels, with a drop (P<0.01) in serum albumin levels, compared to control groups (I&II). However, serum AST activity was not significantly (P>0.05) increased when compared with the normal control group.

Table 1: Erythrocyte indices in rat groups: control (C), control iron (CI), diabetic iron (DI), hepatic iron (HI) and hepatic diabetic iron (HDI) (Mean ±SE) (n=15).

Variables	C	CI	DI	HI	HDI
Hb (g/dl)	13.31±0.20^{a}	13.60±0.21^{a}	12.43±0.21^{b}	12.15±0.20^{bc}	11.75±0.20^{c}
RBCs(x10^{6}/mm^{3})	7.42±0.03^{b}	7.72±0.05^{a}	7.22±0.04^{c}	6.92±0.03^{d}	6.77±0.05^{e}
HCT (%)	48.94±0.32^{b}	50.34±0.33^{a}	48.54±0.33^{b}	48.34±0.31^{b}	47.94±0.33^{b}
MCV (fL)	65.96±1.01^{ab}	65.22±1.03^{ab}	67.23±0.3^{ab}	69.86±0.02^{a}	70.81±0.03^{a}
MCH (pg)	17.94±0.02^{a}	17.62±0.03^{a}	17.22±0.04^{a}	17.56±0.02^{a}	17.36±0.03^{a}
MCHC (g/dL)	27.19±0.40^{a}	27.11±0.22^{a}	25.64±0.32^{ab}	25.14±0.14^{ab}	24.54±0.12^{ab}

Statistically significant differences (P<0.05) are shown by values with distinct superscripts along a row.

Table 2: Biochemical variables in rats of control (C), control iron (CI), diabetic iron (DI), hepatic iron (HI) and hepatic diabetic iron (HDI) groups (Mean ±SE) (n=15).

Variables	C	CI	DI	HI	HDI
FBS (mg/dl)	77.84±3.21^{d}	88.56±3.14^{d}	296.86±8.84^{a}	147.90±6.11^{c}	266.2±10.99^{b}
HbA1C (%)	4.79±0.12^{b}	4.85±0.13^{b}	5.86±0.16^{a}	5.17±0.13^{b}	5.59±0.14^{a}
Hepcidin (ng/mL)	50.57±1.52^{ab}	47.53±1.43^{b}	50.38±1.51^{ab}	39.33±1.43^{c}	52.40±1.57^{a}
Iron (Ug/dL)	103.70±3.49^{c}	120.77±3.47^{b}	101.46±3.89^{c}	151.88±4.52^{a}	120.77±3.47^{b}
Ferritin (ng/mL)	155.55±5.24^{c}	181.16±5.20^{b}	152.20±5.83^{c}	227.83±6.78^{a}	181.16±5.20^{b}
TIBC (Ug/dL)	395.99±7.26^{b}	494.99±9.08^{a}	340.55±6.25^{c}	272.44±5.00^{d}	217.95±4.00^{e}
% Transferrin saturation	26.47±1.23^{bc}	24.65±1.02^{c}	30.09±1.46^{b}	56.08±2.36^{a}	55.95±2.33^{a}

Statistically significant differences (P<0.05) are shown by values with distinct superscripts along a row.

Table 3: Liver function indicators in rats of control (C), control iron (CI), diabetic iron (DI), hepatic iron (HI) and hepatic diabetic iron (HDI) groups (Mean ±SE) (n=15).

Variables	C	CI	DI	HI	HDI
ALT activity (U/L)	13.47±0.85^{c}	16.07±0.97^{bc}	21.07±1.30^{b}	39.47±2.40^{a}	36.67±2.22^{a}
AST activity (U/L)	38.27±2.32^{c}	40.6±2.47^{bc}	42.13±2.57^{bc}	49.33±2.97^{a}	52.33±3.16^{a}
TB (mg/dL)	0.25±0.01^{d}	0.29±0.02^{c}	0.34±0.01^{b}	0.35±0.02^{b}	0.42±0.01^{a}
Albumin (g/dL)	3.71±0.11^{a}	3.63±0.12^{a}	3.12±0.10^{b}	2.37±0.10^{c}	2.31±0.09^{c}

Statistically significant differences (P<0.05) are shown by values with distinct superscripts along a row.

DISCUSSION

The high rate of morbidity in diabetic patients is due to complications of the illness, which are shown by anomalies in the biochemical, histological, and hematological parameters as the disease progresses (Rashid *et al.,* 2019; Fagbohun *et al.,* 2020). Impaired glucose homeostasis, or DM, is a common endocrine condition that causes many systems to malfunction. Hyperglycemia is the final outcome of diabetes-related systemic and metabolic abnormalities (Anand *et al.,* 2007). In experimental animal models, streptozotocin (STZ) is a well-known diabetogenic chemical agent that causes both types of diabetes mellitus. It does this by causing specific cytotoxicity to pancreatic β-cells, which in turn affects endogenous insulin discharge or action, or both, raising the fasting blood glucose level (Nastaran *et al.,* 2011).

In the present study, there were significant changes in the RBC, Hb, and HCT levels of the diabetic rats, along with non-significant changes in the erythrocyte indices (MCV, MCH, and MCHC), pointing to the occurrence of normocytic normochromic anemia, which has been linked to increased non-enzymatic glycosylation of RBC membrane proteins and decreased erythro-poietin production by failing kidneys (Oyedemi *et al.,* 2011; Fagbohun *et al.,* 2020). These long-lasting diabetogenic changes in rats with STZ-induced diabetes followed a similar pattern to prior findings (Usman *et al.,* 2018; Rehman *et al.,* 2023). Fagbohun *et al.* (2020) also noted a decline in MCH, MCHC, and Hb concentration, which are critical for erythrocyte function. These alterations can result in injured erythrocytes rapidly initiating apoptosis, which lowers their lifetime and oxygen-carrying capacity due to an increase in hemolysis rate. This situation lowers HCT in rats with STZ-induced diabetes. The hematological parameters in ethanol-induced liver disorders were represented by a decline in RBCs, Hb and HCT as related to other treatment groups.

In the process of detoxifying the chemicals in the blood, the liver is subjected to high concentrations of toxicants and toxic metabolites, which makes it susceptible to damage (Mohamed *et al.,* 2018). Through the control of ALD-1, alcohol metabolism generates cytotoxic aldehyde, which is then oxidized into acetate by the ALDH-2 enzyme, followed by the creation of ROS, which causes hemolysis of red blood cells (Boby *et al.,* 2021). The reduction in RBC count, Hb and HCT parameters in the hepatic diabetic iron treated group (HDI) was higher than other treated groups (CI, DI, HI). Such findings may be attributed to chronic diseases (DM and liver damage induced by ethanol) and may be associated with the liberation of superoxide, hydroxyl radicals and hydrogen peroxide. These reactive species have an adverse effect on blood, such as hemolysis, and are regarded as hemotoxic agents (Kola-Ajibade *et al.,* 2021).

HbA1c is a product of the nonenzymatic glycation between the N-terminus of the h-chain (valine) amino groups and glucose on Hb protein. From the perspective of molecular biology, HbA1c is a member of a broad class of compounds known as advanced glycation end-products (AGEs). Relative HbA1c values in each person, whether they have diabetes or not, indicate the length and intensity of hyperglycemic episodes, as well as their total exposure to the extracellular glucose in their blood. HbA1c values were developed as biomarkers for both the premorbid chronic glycemic management and the diagnosis of diabetes at different cut-offs (Chamberlain *et al.,* 2016). Diabetes induction by STZ in rats was verified by a significant rise in blood glucose levels. According to reports, alcohol and diabetes have a strong and synergistic relationship that induces oxidative toxicity. It has also been shown that ethanol has cytotoxic effects on

hepatocytes, which leads to a decrease in the antioxidants that exacerbate diabetes-induced hepatic dysfunction (Kodidela *et al.,* 2022). In this study, FBG and HbA1c% displayed an elevation in DI, HI and HDI groups compared with the control rats' groups (C& CI), however, HbA1c showed non statically (P> 0.05) variation in HI group. One often used biomarker for determining the severity of T2D and its effects is HbA1c% (Jiao *et al.,* 2023). Similarly, rats given STZ showed hyperglycemia, expressed by increased glucose in the blood and HbA1c (Al-Amarat *et al.,* 2021). Elevated blood HbA1c percentages can either directly or indirectly accelerate the development of liver disease by activating receptors for advanced glycation end products, promoting hypoxia, and inhibiting NO release (Kitade *et al.,* 2017; Chen *et al.,* 2020). Our results were consistent with those of Hafez *et al.* (2024), who reported that rats with STZ-induced diabetes revealed significantly higher fasting glucose and HbA1c % compared to the normal control group. These findings suggest a higher grade of inflammatory cascade in the liver caused by diabetes. Research has demonstrated that the prevalence and progression of T2D can be influenced either directly or indirectly by iron metabolism markers, such as transferrin, ferritin, hepcidin, transferrin saturation, and others (Liu *et al.,* 2020).

Hepcidin is a peptide hormone made by the liver. It is essential for iron metabolism because it prevents the cellular iron exporter ferroportin-1 from becoming active (Galy *et al.,* 2024). Hepcidin is chiefly produced by hepatocytes and is increased during iron overload, infections, inflammation, chronic kidney disease, obesity-related metabolic disorders, and chronic liver diseases (Afsar *et al.,* 2021).

The serum hepcidin levels in the current study revealed no significant difference in diabetic rats (DI group) but significantly decreased in HI and increased in HDI groups compared with other treated rat groups. According to earlier reports, there was no noteworthy relationship between the serum hepcidin concentrations and the jeopardy factors for T2D, such as body mass index, glycosylated hemoglobin, FBS levels, etc. (Liu *et al.,* 2020). Inconsistent with our findings, serum hepcidin concentrations are much higher in diabetics than in controls and are strongly associated with the risk of type 2 diabetes, which contradicts our findings (Guo *et al.,* 2013). Higher hepcidin levels, however, may help lower T2DM incidence, according to a previous investigation (Guo *et al.,* 2018).

The levels of iron, ferritin, and TIBC in serum were higher in CI than C group, however, they were significantly (P<0.01) diminished in DI and increased in HI group when compared with CI, except for TIBC that profoundly dwindled in both DI & HI groups. The former parameters were not statistically dissimilar for the HDI and CI groups but increased, compared to the normal control group (I). Because changing glucose metabolism changed the iron profile and vice versa, there is a close link between the two conditions. The changed iron profile or the fact that free iron causes oxidative stress and inflammatory cytokines is the origin of this reciprocal interaction (Manikandan *et al.,* 2015). Foregoing reports have indicated that transferrin saturation ≥50% is concomitant with augmented diabetes hazard Ellervik *et al.* (2011). The iron profile in this study agreed with Lagisetty (2022) and partially close to that of Dhakad *et al.* (2019), who stated that the plasma fasting glucose, HbA1C, Fe, saturation percentage and ferritin were statistically increased while TIBC and Hb were statistically declined in T2DM subjects as synchronized to healthy control subjects. However, serum levels of ferritin were increased in diabetic patients with no significant differences in the iron level,

compared to the healthy group (Kuba *et al.,* 2022). Equated with normal control, diabetic rats showed no statistical variations in serum iron, ferritin, TIBC, and % transferrin saturation, while increased in HI and DHI groups. These results are analogous to those of a previous study (Manikandan *et al.,* 2015). On the contrary, another report showed that the diabetic group had a considerably greater ferritin level, which is thought to be a sensitive indicator of iron status. There is no positive link seen with the other measures, such as iron, TIBC, and Hb (Chhabra *et al.,* 2017). Regarding the changes of iron profile in HI and HD groups, the effect of dietary iron on the liver and adipose tissue is a significant factor in the risk of metabolic diseases. (Miranda *et al.,* 2019). Iron buildup in the liver can interfere with insulin's capacity to lower hepatic glucose assembly, which can result in insulin resistance (Tagi *et al.,* 2019). Iron can be oxidized to produce an extremely reactive, lipid-soluble iron–oxygen complex (Zhao, 2019). A former study concluded that the increased hepcidin may restrain the iron release from the cells by affecting the expression of ferroportin, which is probably associated with the development of diabetic complications (Chen *et al.,* 2015). Hepcidin and ferritin are related to inflammation due to diabetes, both being acute phase proteins. During inflammation, an increase of hepcidin induces a decrease of circulating iron and an increase of ferritin due to inflammation (Ganz and Nemeth, 2012).

A diagnostic tool for determining systemic toxicity caused by xenobiotics, biological agents, and intrinsic factors (Petlevski *et al.,* 2006) or diabetes (Pitocco *et al.,* 2013) is the measurement of AST and ALT activities in the blood and liver. Serum aminotransferases (ALT & AST) increased in diabetic rats, indicating increased de novo synthesis of the enzymes brought on by the need for an alternate energy source through gluconeogenesis, which may result in increased liver catabolism of amino acids (Asagba *et al.,* 2019). According to the findings of the current investigation, in STZ-induced type 2 diabetes, the elevated levels of hepatic enzymes may be caused by the release of enzymes from the hepatic tissue into the plasma (Eguavoen *et al.,* 2019). Chronic administration of ethanol (HI& DHI groups) significantly raised the levels of aminotransferases and TB, with a decline in albumin in the serum matched with the control group, which specified the existence of liver injury.

One of the most prevalent and significant causes of chronic liver diseases worldwide is still alcohol intake (Ahmad *et al.,* 2022). The increase in these serum indicators' activity can be linked to cytosolic enzymes escaping into the bloodstream as a result of hepatic parenchyma injury, disruptions in the machinery involved in enzyme production, and changes in membrane permeability (Hoek and Pastorino, 2002). One of the key components of ethanol-induced liver damage is oxidative stress (Liu *et al.,* 2020). The main causes of oxidation-induced damage in hepatocytes are the production of a lot of ROS and the consumption of antioxidant molecules (Cichoż- Lach and Michalak, 2014).

Earlier studies showed that alcohol consumption causes fatty acid synthesis with accumulation of fat in the liver, which results in steatosis (Donohue, 2007), because alcohol increases the expression of SREBP-1c (sterol regulatory element-binding protein-1c) at both the gene and protein levels, which controls the proteins involved in lipid synthesis by activating ATP citrate lyase and fatty acid synthase (Osborne, 2000). The oxidative stress, inflammation, and hepatic cell death are among the cellular mechanisms involved in the pathophysiology of ethanol-induced liver disease (Luo *et al.,* 2023; Mohd Ali *et al.* (2013); Olanrewaju *et al.* (2017); Boby *et al.* (2021). Moreover, chronic ethanol

administration led to hepatotoxicity as evidenced by the increased levels of serum ALT, AST and ALP (Ahmad *et al.,* 2022). The primary cause of ethanol-induced hepatotoxicity is the production of free radicals by the ethanol active metabolite acetaldehyde, which in turn causes oxidative stress and inflammation in the liver tissues (Ganapathi *et al.,* 2021). Similar findings revealed that giving ethanol (7.9g/kg/day) for sixty days negatively affected serum TP, albumin and A/G ratio with increased TB levels (Saravanan *et al.,* 2006). A similar study showed augmented bilirubin and diminished albumin levels in the serum of ethanol-induced hepatotoxicity in rats (Shankari *et al.,* 2010; Madrigal-Santillán *et al.,* 2015). Declined albumin is linked to an adverse metabolic profile, which includes elevated glucose, obesity, and inflammation of adipose tissue, as well as a higher risk of T2D (Chang *et al.,* 2019). The decrease in liver absorption and increased bilirubin or conjugation production are the primary causes of the higher pattern of serum bilirubin levels in STZ-induced type 2 diabetes (Chang *et al.,* 2019).

CONCLUSION

The existing study describes the regulating role of hepcidin on iron status, either cause or an effect, and that hepato-toxicity caused by ethanol administration was due to free radical formation that affects the hematological and biochemical profiles. Disorders of iron metabolism may play a role in the pathogenesis of liver disease and diabetes.

Acknowledgments:
Not applicable.

Declaration of conflict of interest:
The authors declare that there is no conflict of interest.

Funding Statement:
The authors declare that no funds were received during this study.

Ethical approval:
The University of Zagazig's ethics committee authorized the experimental procedure utilized in this study, which complies with the university's guidance on animal care and use

REFERENCES

Afsar, R.E.; Kanbay, M.; Ibis, A. and Afsar, B. (2021): In-depth review: is hepcidin a marker for the heart and the kidney? *Mol Cell Biochem*., 476(9), 3365–81.

Ahmad, S.B.; Rashid, S.M.; Wali, A.F.; Ali, S.; Rehman, M.U.; Maqbool, M.T.; Nadeem, A.; Ahmad, S.F. and Siddiqui, N. Myricetin (2022): (3,3',4',5,5',7-hexahydroxyflavone) prevents ethanol-induced biochemical and inflammatory damage in the liver of Wistar rats. *Hum ExpToxicol*., 41, 9603271211066843.

Al-Amarat, W.; Abukhalil, M.H.; Althunibat, O.Y.; Alfwuaires, M.A.; Alnamshan, M.M.; Alqosaibi, A.I.; Ahmeda, A.F.; Kamel, E.M.; Arab, H.H. and Mahmoud, A.M. Galangin (2021): Attenuates Liver Injury, Oxidative Stress and Inflammation, and Upregulates Nrf2/HO-1 Signaling in Streptozotocin-Induced Diabetic Rats. *Processes,* 9(9), 1562.

Anand, P.; Murali, K.Y.; Tandon, V.; Chandra, R. and Murthy, P.S. (2007): Preliminary studies on antihyperglycemic effect of aqueous extract of Brassica nigra (L.) Koch in streptozotocin induced diabetic rats. *Indian J Exp Biol*., 45, 696–701.

AOAC (Association of Official Analytical Chemists). (1980): Official methods of analysis. Washington: AOAC.

Aregbesola, A.; Voutilainen, S.; Virtanen, J.K.; Aregbesola, A. and Tuomainen, T.P. (2015): Serum hepcidin concentrations and type 2 diabetes. *World J Diabetes*, 6(7), 978-82.

Arumugam, M.K.; Chava, S.; Perumal, S.K.; Paal, M.C.; Rasineni, K.; Ganesan, M.; Donohue, T.M.; Osna, N.A. and Kharbanda, K.K. (2022): Acute ethanol induced liver injury is prevented by betaine administration. *Front. Physiol*., 13,940148.

Asagba, S.O.; Kadiri, H.E. and Ezedom, T. (2019): Biochemical changes in diabetic rats treated with ethanolic extract of Chysophyllumalbidum fruit-skin. *JoBAZ,* 80, 42.

Axley, P.D.; Richardson, C.T. and Singal, A.K. (2019): Epidemiology of alcohol consumption and societal burden of alcoholism and alcoholic liver disease. *Clin.Liver Dis*. 23 (1), 39–50.

Bloomer, S.A. and Brown, K.E. (2021): Hepcidin and Iron Metabolism in Experimental Liver Injury. *The American Journal of Pathology*, 191(7), 1165-1179.

Boby, N.; Lee, E.B.; Abbas, M.A.; Park, N.H.; Lee, S.P.; Ali, M.S.; Lee, S.J. and Park, S.C. (2021): Ethanol-Induced Hepatotoxicity and Alcohol Metabolism Regulation by GABA-Enriched Fermented Smilax china Root Extract in Rats. *Foods*, 10(10):2381.

Chamberlain, J.J.; Rhinehart, A.S.; Shaefer, C.F. and Neuman, (2016): A. Diagnosis and Management of Diabetes: Synopsis of the 2016 American Diabetes Association Standards of Medical Care in Diabetes. *Ann. Intern. Med.,* 164, 542–552.

Chang, D.C.; Xu, X.; Ferrante, A.W. and Krakoff, J. (2019): plasma albumin predicts type 2 diabetes and is associated with greater adipose tissue macrophage content and activation. *Diabetol Metab Syndr.,* 11, 14.

Chen, C.; Zhu, Z.; Mao, Y.; Xu, Y.; Du, J.; Tang, X. and Cao, H. (2020): HbA1c may contribute to the development of non-alcoholic fatty liver disease even at normal-range levels. *Biosci Rep.,* 40(1), BSR20193996.

Chen, Y.; Yin, H.Q.; Liu, H.L.; Xiu, L. and Peng, X.Y. (2015): Hepcidin and iron metabolism in non-diabetic obese and type-2 diabetic rats. *J HuazhongUnivSciTechnolog Med Sci.,* 35(6), 851-857.

Chhabra, R.J.; Kapai, N. and Mangukiya, K. (2017): Study of Iron Status in type 2 Diabetes mellitus. *Sch. J. App. Med. Sci.,* 5(5A), 1744-1749.

Cichoż-Lach, H. and Michalak, (2014): A. Oxidative stress as a crucial factor in liver diseases.*World J Gastroenterol*., 20(25), 8082-91.

Clemens, D.L. (2007): Effects of ethanol on hepatic cellular replication and cell cycle progression.*World J Gastroenterol*. 13(37), 4955-9.

Dhakad, G.S.; Sharma, A.K.; Kanwar, G.; Singh, A.K. and Sharma, S. (2019): Evaluation of iron profile in type 2 diabetes mellitus patients of tertiary care center of central India. *Int J ClinBiochem Res.,* 6(1),15-19.

Donohue, T.M.Jr. (2007): Alcohol-induced steatosis in liver cells.World J. Gastroenterol. 13, 4974.

Du, F.; Qian, Z.M.; Luo, Q.Q.; Yung, W.H. and Ke, Y. (2015): Hepcidin suppresses brain iron accumulation by downregulating iron transport proteins in iron-overloaded rats. *Mol Neurobiol.,* 52, 101-114.

Eguavoen, C.; Ekpo, D.E. and Ebeire, E.N. (2016): Effect of seven keys herbal

formulation on plasma concentrations of liver transaminases of alloxan-induced diabetic rats. *Br. J. Pharm. Res.,* 11:1–11.

Ellervik, C.; Mandrup-Poulsen, T.; Andersen, H.U.; Tybjærg-Hansen, A.; Frandsen, M.; Birgens, H. and Nordestgaard, B.G. (2011): Elevated transferrin saturation and risk of diabetes: three population-based studies. *Diabetes Care,* 10, 2256-8.

Erukainure, O.L.; Ebuehi, O.A.T. and Adeboyejo, F.O. (2013): Hematological and biochemical changes in diabetic rats fed with fiber-enriched cake. *J. Acute Med.,* 3, 39–44.

Fagbohun, O.F.; Awoniran, P.O.; Babalola, O.O.; Agboola, F.K. and Msagati, T.A.M. (2020): Changes in the biochemical, hematological and histopathological parameters in STZ-Induced diabetic rats and the ameliorative effect of Kigeliaafricana fruit extract. *Heliyon,* 6(5), e03989.

Galy, B.; Conrad, M. and Muckenthaler, M. (2024): Mechanisms controlling cellular and systemic iron homeostasis. Nat Rev Mol Cell Biol., 25(2), 133–55.

Ganapathi, S.C.; Holla, R.; Shankara, S.; Mundugaru, R.; Sunilkumar, K.N.; Rajagopal, R.; Alfarhan, A. and AlAnsari, A. (2021): Protective effect of ethanolic extract of Actinoscirpusgrossus tubers against ethanol induced liver toxicity in albino rats. *Journal of King Saud University – Science*, 33(1), 101253.

Ganesan, M.; Feng, D.; Barton, R.W.; Thomes, P.G.; McVicker, B.L.; Tuma, D.J.; Osna, N.A. and Kharbanda, K.K. (2016): Creatine supplementation does not prevent the development of alcoholic steatosis. *Alcohol Clin. Exp. Res.,* 40 (11), 2312–2319.

Ganz, T. and Nemeth, E. (2012): Hepcidin and iron homeostasis. Biochim Biophys Acta; 1823, 1434-1443.

Gong, J.; Du, F.; Qian, Z.M.; Luo, Q.Q. and Ke, Y. (2016): Pre-treatment of rats with ad-hepcidin prevents iron-induced oxidative stress in the brain. *Free Radic Biol Med.;* 90,126–132.

Guo, L.N.; Yang, Y.Z. and Feng, Y.Z. (2018): Serum and salivary ferritin and hepcidin levels in patients with chronic periodontitis and type 2 diabetes mellitus. *BMC Oral Health*, 18(1):63.

Guo, X.; Zhou, D.; An, P.; Wu, Q.; Wang, H.; Wu, A.; Mu, M.; Zhang, D.; Zhang, Z.; Wang, H.; He, L.; Liu, Y. and Wang, F. (2013): Associations between serum hepcidin, ferritin and Hb concentrations and type 2 diabetes risks in a Han Chinese population. *Br J Nutr.,* 110(12), 2180-5.

Hafez, M.H.; EzElarab, S.M.; Tohamy, H.G. and El-Far, A.H. (2024): Thymoquinone attenuates diabetes-induced hepatic damage in rat via regulation of oxidative/nitrosative stress, apoptosis, and inflammatory cascade with molecular docking approach. *Sci Rep.,* 14(1), 13016.

Hentze, M.W.; Muckenthaler, M.U.; Galy, B. and Camaschella, C. (2010): Two to tango: regulation of mammalian iron metabolism. *Cell*, 142, 24-38.

Hoek, J.B. and Pastorino, J.G. (2002): Ethanol, oxidative stress and cytokine-induced liver cell injury. *Alcohol*, 27, 63-8.

Jiang, F.; Sun, Z.Z.; Tang, Y.T., Xu, C. and Jiao, X.Y. (2011): Hepcidin expression and iron parameterschange in type 2 diabetic patients. *Diabetes Res ClinPract.,* 93,1–6.

Jiao, X.; Zhang, Q.; Peng, P. and Shen, Y. (2023): HbA1c is a predictive factor

of severe coronary stenosis and major adverse cardiovascular events in patients with both type 2 diabetes and coronary heart disease. *Diabetol Metab Syndr.,* 15(1), 50.

Karunanayake, EH.; Hearse, DJ. and Mellows, G. (1975): The metabolic fate and elimination of streptozocin. *Biochemical Society Transactions*, 3(3), 410-14.

Kharbanda, K.K. (2013): Methionine metabolic pathway in alcoholic liver injury. *Curr. Opin. Clin. Nutr. Metab. Care,* 16 (1), 89–95.

Kharbanda, K.K. and Barak, A.J. (2005): Defects in methionine metabolism: Its role in ethanol-induced liver injury," in Comprehensive handbook of alcohol-related pathology. Editors V. R. Preedy and R. R. Watson (San Diego, CA: Elsevier Academic Press), 735–747.

Kitade, H.; Chen, G.; Ni, Y. and Ota, T. (2017): Nonalcoholic Fatty Liver Disease and Insulin Resistance: New Insights and Potential New Treatments. *Nutrients,* 9, 387–400.

Kodidela, W.; Shaik, F.B.; Mittameedi, C.M.; Chintha, V. and Nallanchakravarthula, V. (2022): Alcohol exacerbated biochemical and biophysical alterations in liver mitochondrial membrane of diabetic male wistar rats – A possible amelioration by green tea. *Clinical Nutrition Open Science*, 42, 130-147.

Kola-Ajibade, I.R.; Jegede, R.J. and Olusola, A.O. (2021): Biochemical Changes in Hematological and Liver Parameters in Albino Rats Exposed to Azo Dye Adulterated Palm Oil. *J Toxicol Risk Assess*, 7, 042.

Kuba, R.H.; Saheb, E.J. and Mosa, I.S. (2022): Detection of Iron and Ferritin in Diabetes Mellitus Type 2 Patients. *Mal J Med Health Sci.,* 18(SUPP4), 7-10.

Lagisetty, L. (2022): Iron Profile in Patients with Type II Diabetes Mellitus in A study in a Tertiary Care Hospital. *Perspectives in Medical Research*, 10(2), 42-46.

Liu, J.; Li Q.; Yang Y. and Ma, L. (2020): Iron metabolism and type 2 diabetes mellitus: A meta-analysis and systematic review. *J Diabetes Investig.,* 11(4), 946-955.

Luo, J.; Song, G.; Chen, N.; Xie, M.; Niu, X.; Zhou, S.; Ji Y.; Zhu, X.; Ma, W.; Zhang, Q. and Yu, D. (2023): Ferroptosis contributes to ethanol-induced hepatic cell death via labile iron accumulation and GPx4 inactivation. *Cell Death Discov.,* 9(1), 311.

Madrigal-Santillán, E.; Bautista, M.; Gayosso-De-Lucio, J.A.; Reyes-Rosales, Y.; Posadas-Mondragón, A.; Morales-González, Á.; Soriano-Ursúa, M.A.; García-Machorro, J.; Madrigal-Bujaidar, E.; Álvarez-González, I. and Morales-González, J.A. (2015): Hepatoprotective effect of Geranium schiedeanum against ethanol toxicity during liver regeneration. *World J Gastroenterol.*, 21(25), 7718-29.

Manikandan, A.; Ganesh, M. and Silambanan, S. (2015): Study of iron status in type-2 Diabetes Mellitus. *International Journal of Clinical Biochemistry and Research*, 2(2), 77-82.

Miranda, MA.; St Pierre, CL.; Macias-Velasco, JF.; Nguyen, HA.; Schmidt, H.; Agnello, LT.; Wayhart, JP. and Lawson, HA. (2019): Dietary iron interacts with genetic background to influence glucose homeostasis. *Nutr Metab (Lond),* 16, 13.

Mohamed, A.H.; Kamal, H.H.; Ahmed, W.M.S. and Saeed, H.E. (2018): Effect of liver diseases on hormonal and biochemical parameters in

Wistar albino rat. *J. Vet. Med. Res.,* 25 (1), 11-29.

Mohd Ali, N.; MohdYusof, H.; Long, K.; Yeap, S.K.; Ho, W.Y.; Beh, BK.; Koh, S.P.; Abdullah, M.P. and Alitheen, N.B. (2013): Antioxidant and hepatoprotective effect of aqueous extract of germinated and fermented mung bean on ethanol-mediated liver damage. *Biomed Res Int.,* 2013: 693613.

Nastaran, J.S. (2011): Antihyperglycaemia and antilipidaemic effect of Ziziphus vulgaris L on streptozotocin induced diabetic adult male Wistar rats. *Physiol. Pharmacol.,* 47, 219–223.

Olanrewaju, E.; Anyaehie, B.; Ezeh, C.O.; Onyekwelu, K.C. and Ezeh, R.C. (2017): Effect of Methanolic Extract of Hibiscus sabdariffa in Ethanol-Induced Hepatotoxicity. *Afr. J. Biomed.Res.*, 20, 99- 102.

Osborne, T.F. (2000): Sterol regulatory element-binding proteins (SREBPs): Key regulators of nutritional homeostasis and insulin action. *J. Biol. Chem.*, 275, 32379–32382.

Osna, N.A.; Donohue, T.M.; Jr., and Kharbanda, K.K. (2017): Alcoholic liver disease: Pathogenesis and current management. *Alcohol Res.* 38 (2), 147–161.

Oyedemi, S.O.; Yakubu, M.T. and Afolayan, A.J. (2011): Antidiabetic activities of aqueous leaves extract of Leonotisleonurus in streptozotocin induced diabetic rats. *J Med Plant Res.,* 5, 119–125.

Park, R.J. and Moon, J.D. (2015): Low transferrin saturation is associated with impaired fasting glucose and insulin resistance in the South Korean adults: the 2010 Korean National Health and Nutrition Examination Survey. *Diabet Med.* 32(5), 673-8.

Petlevski, R.; Hadzija, M.; Bajalo, J.L. and Juretić, D. (2006): Effect of acarbose on alanine aminotransferase and aspartate aminotransferase activities in the liver of control and diabetic CBA mice. *Acta Pharm*., 56(1), 87-93.

Pitocco, D.; Tesauro, M.; Alessandro, R.; Ghirlanda, G. and Cardillo, C. (2013): Oxidative stress in diabetes: implications for vascular and other complications. *Int J Mol Sci.,* 14(11), 21525-50.

Ponka, P.; Beaumont, C. and Richardson, D.R. (1998): Function and regulation of transferrin and ferritin. *Semin Hematol,* 35, 35–54.

Rajpathak, S.N.; Crandall, J.P.; Wylie-Rosett, J.; Kabat, G.C.; Rohan, T.E. and Hu, F.B. (2009): The role of iron in type 2 diabetes in humans. *Biochim Biophys Acta,* 1790(7):671-81.

Rashid, U.; Khan, M.R. and Sajid, M. (2019): Antioxidant, anti-inflammatory and hypoglycemic effects of Fagoniaolivieri DC on STZ-nicotinamide induced diabetic rats - In vivo and in vitro study. *J Ethnopharmacol.,* 242,112038.

Rehman, H.U.; Ullah, K.; Rasool, A.; Manzoor, R.; Yuan, Y.; Tareen, A.M.; Kaleem, I.; Riaz, N.; Hameed, S. and Bashir, S. (2023): Comparative impact of streptozotocin on altering normal glucose homeostasis in diabetic rats compared to normoglycemic rats. *Sci Rep.,* 13(1), 7921.

Saravanan, R.; Viswanathan, P. and Pugalendi, K.V. (2006): Protective effect of ursolic acid on ethanol-mediated experimental liver damage in rats. *Life Sci.*, 78(7), 713-8.

Shankari, S.G.; Karthikesan, K.; Jalaludeen, A.M. and Ashokkumar, N. (2010): Hepatoprotective effect of

morin on ethanol-induced hepatotoxicity in rats. *J Basic ClinPhysiolPharmacol.* 21(4), 277-94.

Tagi, V.M.; Giannini, C. and Chiarelli, F. (2019): Insulin Resistance in Children. *Front Endocrinol (Lausanne)*, 10, 342.

Turbino-Ribeiro, S.M.; Silva, M.E.; Chianca, D.A.Jr.; De Paula, H.; Cardoso, L.M.; Colombari, E. and Pedrosa, M.L. (2003): Iron overload in hypercholesterolemic rats affects iron homeostasis and serum lipids but not blood pressure. *J Nutr.* 133 (1), 15-20.

Usman, M.; Ali, M.Z. and Qureshi, A.S. (2018): Short term effect of dose dependent camel milk in alloxan induced diabetes in female albino rats. *J. Anim. Plant Sci.,* 28, 1292–1300.

Wong, V.W.; Wong, G.L.; Yeung, D.K.; Abrigo, J.M.; Kong, A.P.; Chan, R.S.; Chim, A.M.; Shen, J.; Ho, C.S.; Woo, J.; Chu, W.C. and Chan, H.L. (2014): Fatty pancreas, insulin resistance, and β-cell function: a population study using fat-water magnetic resonance imaging. *Am J Gastroenterol*., 109(4), 589-97.

Yeap, B.B.; Divitini, M.L.; Gunton, J.E.; Olynyk, J.K.; Beilby, J.P.; McQuillan, B.; Hung, J. and Knuiman, M.W. (2015): Higher ferritin levels, but not serum iron or transferrin saturation, are associated with Type 2 diabetes mellitus in adult men and women free of genetic haemochromatosis. *ClinEndocrinol (Oxf),* 82(4), 525-32.

Zhao, Z. (2019): Iron and oxidizing species in oxidative stress and Alzheimer's disease. *Aging Med (Milton)*, 2(2), 82–87.

Zhou, Y.; Zheng, J.; Li, S.; Zhou, T.; Zhang, P. and Li, H.B. (2016): Alcoholic Beverage Consumption and Chronic Diseases. *Int J Environ Res Public Health.* 13(6):522.

القيمة التنبؤية للهيبسيدين كدلالة كيميائية حيوية في الاعتلالات الكبدية والسكرى

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اجريت هذه الدراسة على ٥٠ جرذًا تزن حوالي ١٠٠-٢٥٠ جرامًا مقسمة إلى ٥ مجموعات متساوية ، المجموعة الأولى: المجموعة الضابطة (C) ، المجموعة الثانية: مجموعة الضابطة المغذاة بالحديد (CI) ، المجموعة الثالثة: مجموعة السكري المغذاة بالحديد (DI) ، المجموعة الرابعة: مجموعة الكبد المغذاة بالحديد (HI) والمجموعة الخامسة: مجموعة مصابة بالسكري والكبد المغذاة بالحديد (HDI). تم الفحص المخبري لجميع المجموعات و الذى يشمل قياس مستويات الهيبسيدين والفريتين والهيموجلوبين السكرى فى الدم باستخدام اختبار الاليزا ELISA بالاضافة للقياسات االروتينية لجلوكوز الدم وصورة الدم، ووظائف الكبد.وتعيين قدرة ربط الحديد الكلي (TIBC) وحساب نسبة تشبع الترانسفيرين وتم جدولة النتائج وتحليلها إحصائيًا ومناقشتها. اظهرت النتائج ان المجموعات التي تشمل جرذان مصابة بالتهاب الكبد لديهم تركيزات مستوي الهيبسيدين اقل من المجوعة السليمة التي لاتعاني من اى امراض للكبد او اى امراض اخرى وكذلك تم ملاحظه ارتفاع مستوي او نسبه الفريتين في حالات التهاب الكبد عن المجموعة السليمة التي لاتعاني من اى امراض للكبد او اى امراض اخرى. والمجموعات التي تشمل جرذان مصابة بالمرض السكرى أظهرت بعضها ارتفاع مستوي الهبسيدين مقارنة بالجرذان السليمة التي لا تعانى من مرض السكرى والبعض أظهر انخفاضا. كما اظهرت النتائج الى وجود انيميا واختلال وفى وظائف الكبد فى المجموعات المصابة بالتهابات الكبدية والجرذان المصابة بمرض السكرى مقارنة بالمجموعات الضابطة. وبناء علي ما تقدم فقد اثبتت الدراسة انه عند اصابة الكبد بالالتهاب الكبدى الوبائى سى يقل مستوى الهيبسيدين المنتج من الكبد كما يقابلها زياده تركيز الفريتين ,بينما يرتفع مستوى الهبسيدين عند الإصابة بمرض السكرى في بعض الحالات ويتناقص في حالات أخرى وذلك لان الهيبسيدين هو المنظم الرئيسى للحديد بالجسم وبالتالى فمن المهم متابعة مستوى الهيبسدين والفريتين تجنبا لتراكم الحديد فى خلايا الكبد مما يؤدى الى تليف الكبد والذى بدوره قد يؤدى الى سرطان الكبد.