COMPARISON OF THE EFFECT OF MORINGA EXTRACT AND THE DRUG ATORVASTATIN IN ALLEVIATING HISTOLOGICAL AND PHYSIOLOGICAL DISORDERS IN THE AORTA AND LIVER CAUSED BY HYPERLIPIDEMIA IN MALE RATS

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Abstract
This Research was designed to ascertain the impact of the hydroalcoholic extract of Moringa oleifera leaves in suppressing the tissue and physiological changes arising from male rat hyperlipidemia that was induced. The experiment was conducted for five weeks. The results showed a rise in the concentration of lipid profile, liver enzymes, and MDA, and a decrease in HDL-C and GSH in the affected group. As for the groups that were dosed with moringa leaf extract and the drug atorvastatin, they showed a decrease and normalization in the results. The results of the aortic tissue also showed many tissue abnormalities, separation of the elastic lamellae at a high rate, and infiltration. Inflammatory cells, degeneration of smooth muscle fibers, increased thickness of the aortic wall, and blood colloid increased in the negative control group. It also showed in the liver the presence of cirrhosis, thickening of the central vein wall, congestion of the blood vessel, infiltration of inflammatory cells, explosion and degeneration within the liver stroma, thickening of the nuclei, and the appearance of ghost cells. However, moringa leaf extract and the drug atorvastatin showed a positive role in improving and normalizing the tissue lesions in the aorta and liver resulting from excessive Fats. It is concluded that moringa leaf extract and atorvastatin together have a more effective role in improving and normalizing the tissue and physiological changes resulting from hyperlipidemia than using both moringa leaf extract and atorvastatin alone.
Keywords: Moringa, Hyperlipidemia, Oxidative stress, Aorta, Liver.

Introduction

A problem or deficiency in the metabolism and function of fats results in an abnormal increase in the levels of fats or lipoproteins, which is referred to as hyperlipidemia. Hyperlipidemia is thought to be especially significant for predicting the development of atherosclerosis (AS), coronary artery diseases, and cerebral vascular diseases because patients with There might be a higher danger associated with it of developing cardiovascular disorders [1]. Atherosclerosis is a long-lasting, chronic inflammatory condition. As a result, it damages the blood vessel walls, resulting in the development of plaques that may be extremely harmful and result in cardiovascular disease by rupturing or blocking the major arteries [2]. According to [3], additional cardiac illnesses that lipids can induce include depletion of myocardial striation, loss of Troponin I, increased interstitial fibrosis, and a rise in the rate of programmed cell death. The genus Moringa, the sole member of the Moringa family, contains 13 species, including the Moringa oleifera Lam tree. The leaves of the moringa tree are rich in antioxidants and may help prevent cancer, therefore there are many uses for this tree in addition to its many health benefits [4] The product can also be used to manage pneumonia, bronchitis and asthma because it contains flavonoids and vitamins such as A, C, E as well as B group vitamins among others for instance skin or eye diseases [5]. Moringa plant leaves have flavonoids which engage the body's defense enzymatic system as well as protecting against body pollution arising from environmental stressors; They also have the antioxidant called quercetin which help in protecting the liver from toxins and cancer [6,7]. Statins have long been used as a remedy for Hyperlipidemia. They work by blocking an essential enzyme called hydroxy-3-methylglutate coenzyme A reductase (HMG-CoA-3), which is required for cholesterol production thereby raising its concentration in the blood. It is when the enzyme changes to methanolic acid in the liver stopping cholesterol synthesis [8].

Materials and Methods

Materials

In Salah Al Deen Governorate/Iraq, collected leaves from Moringa oleifera plants, which were put in a 70% alcohol and 30% water extract. 400mg of body weight per kilogram was an effective dose. A concentration of 2.06 mg/kg Atorvastatin drug (ATOR), was used on rats [9].

Experiment design

The rats were divided into groups of equal weight following their acclimatization. Accordingly, forty adult male white rats were placed into eight groups for the current study. These are;

the very first cohort (health control treatment), In the five-week trial's span, this group was administered distilled water and fed a typical diet devoid of cholesterol. In the five-week study, a high-fat diet (HFD) and distilled water was administered to the high-fat control group. For the third group, they were provided high-fat diet and moringa extract, where it was given 400 mg/kg bodyweight after maintaining on a HFD for 1 week. They were then placed back on HFD and left until the end of our experiments. One more group (high-fat diet + drugs): This group was fed a high-fat diet (HFD) for the initial week of the experiment. Subsequently, they received 2.06 mg/kg atorvastatin and were left to continue feeding on high-fat diets. The fifth group (administration of drugs and extracts with a high-fat content) after initiating therapy within the initial week relied on typical high-fat ration (HFD). They later took an extract from the moringa leaves and atorvastatin 2.06mg/kg concurrently with maintaining the high-fat diet throughout the study period. Those rats in group six who solely received the extract underwent a standard fat free diet plus 400mg/kg moringa leaf extract together with distilled water during its experiment period. The seventh group was only put on treatment that involved taking only atorvastatin together with a normal diet but without any fats; water distilled all through the research. The drug dosage was set at 2.06 mg per kilograms. The eighth group that received both an extract and drug therapy received a normal fat-free meal of 400 mg/kg moringa oleifera leaf extract and 2.06mg/kg atorvastatin, throughout the study carried out.

Collection of Blood Samples and Aorta and Liver Resection

The rats were given sedatives and had their organs removed five weeks into the experiment. After being transformed into serum, After drawing blood from the heart, the samples were stored in tubes. Subsequently, the liver and aorta were extracted and put into boxes with 10% diluted formalin to be fixed until the procedure was followed. Using a pre-made diagnostic kit, blood samples were examined to determine the levels of antioxidants, liver enzymes, and lipid profiles in the serum of rats, following the guidelines provided by the French business Biolabo. Aortic and hepatic histological sections were prepared.

Statistical Analysis

The Analysis of Variance test was used to statistically examine the data, and significant differences were found at a significance level of ($P \geq 0.05$) using Duncan's multiple ranges test, utilizing SAS software.

Results

Estimation of Lipid Profile Concentration in Blood Serum

Estimation of Blood Serum's Lipid Profile Concentration As indicated by Table (1), the animals in the hyperlipidemia-induced group had significantly higher concentrations ($P \geq 0.05$) of Triglycerides, low-density lipoproteins, total cholesterol, and atherosclerosis index, and significantly lower concentrations of high-density lipoproteins when in contrast to the group of healthy controls. Regarding the animal groups that received doses of moringa leaf extract, ATOR, and moringa leaf extract + ATOR to induce hyperlipidemia, In comparison to the group, they displayed a substantial rise in the concentration of high-density lipoproteins and a significant reduce in the concentration of Low-density lipoproteins, total cholesterol, triglycerides, and signs of atherosclerosis, respectively. regulated hyperlipidemia. In comparison to the healthy control group, no adverse signs or symptoms were observed in the groups of healthy animals dosed with moringa leaf extract only, ATOR medicine just, or moringa leaf extract plus ATOR drug.

Table (1) Effect of Moringa Extract and The Drug Atorvastatin on Blood serum's Lipid Profile of Male Albino Rats in Which Hyperlipidemia Was Induced.

Parameters / Groups	Total Cholesterol (mg/dl)	Triglyceride (mg/dl)	HDL-c (mg/dl)	LDL-c (mg/dl)	VLDL-c (mg/dl)	Atherogenic index
Control	209.35±2.44^{c}	84.77±1.06^{cd}	127.36±8.33^{ab}	65.04±10.25^{c}	16.95±0.21^{cd}	1.68±0.13^{b}
HFD	359.36±15.94^{a}	171.65±6.70^{a}	59.18±10.40^{e}	265.85±20.65^{a}	34.33±1.34^{a}	7.09±1.50^{a}
HFD + MOR	209.54±2.06^{c}	93.54±4.23^{c}	103.89±2.11^{cd}	86.94±2.65^{c}	18.71±0.85^{c}	2.02±0.03^{b}
HFD + ATR	246.55±16.95^{b}	113.45±4.64^{b}	96.40±2.68^{d}	127.46±16.16^{b}	22.69±0.93^{b}	2.56±0.16^{b}
HFD + (MOR +ATOR)	207.91±3.47^{c}	89.21±1.72^{cd}	112.21±1.88^{bc}	77.86±4.28^{c}	17.84±0.34^{cd}	1.86±0.05^{b}
Control+ MOR	207.21±1.85^{c}	83.61±0.76^{cd}	130.58±1.71^{a}	59.91±2.83^{c}	16.72±0.15^{cd}	1.59±0.03^{b}
Control+ ATOR	209.40±8.34^{c}	85.00±1.30^{cd}	127.08±1.86^{ab}	65.32±9.06^{c}	17.00±0.26^{cd}	1.65±0.07^{b}
Control + (MOR	207.67±2.89^{c}	78.91±1.32^{d}	135.87±1.69^{a}	56.02±3.75^{c}	15.78±0.26^{d}	1.53±0.03^{b}

- Values are Expressed as Arithmetic Mean ± Standard Error.
- Number of Rats (5) in Each Group.
- A significant difference is shown by different vertical letters at the probability level ($P \geq 0.05$).

The Effectiveness of The Blood Serum's Liver Enzymes

The results of our research, as shown in Table (2), demonstrated a noteworthy rise (P≥0.05) in the activity of the enzyme alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) in the group of animals in which hyperlipidemia was induced in contrast to the group of healthy controls. While groups of animals induced with hyperlipidemia that were dosed with moringa leaf extract only, ATOR drug only, and moringa leaf extract + ATOR drug showed A major reduce in the activity of ALT, AST, and ALP in contrast to the control group in which hyperlipidemia was induced, while healthy groups dosed with moringa leaf extract showed A major reduce in the activity of ALT, AST, and ALP. Only the ATOR drug and the moringa leaf extract + the ATOR drug did not show negative effects compared to the healthy control group.

Table (2) Effect of Moringa Extract and Atorvastatin on The Focus of Liver Enzymes in The Blood Serum of Male Albino Rats in Which Hyperlipidemia was Induced.

Parameters / Groups	ALT (IU/L)	AST (IU/L)	ALP (IU/ml)
Control	46.60±2.58^{b}	110.80±2.85^{ab}	348.80±12.48^{c}
HFD	61.80±2.01^{a}	126.80±1.16^{a}	836.20±30.40^{a}
HFD + MOR	48.60±2.27^{b}	113.00±4.30^{ab}	702.80±18.55^{b}
HFD + ATOR	61.60±3.46^{a}	104.00±6.96^{ab}	713.80±27.23^{b}
HFD + (MOR +ATOR)	47.40±1.43^{b}	96.80±9.01^{b}	632.60±20.07^{b}
Control+ MOR	42.60±2.48^{b}	92.40±3.12^{b}	380.20±52.03^{c}
Control+ ATOR	41.00±2.74^{bc}	93.00±5.68^{b}	400.00±53.83^{c}
Control + (MOR +ATOR)	34.80±1.66^{c}	112.20±20.47^{ab}	351.00±16.39^{c}

- Values are Expressed as Arithmetic Mean ± Standard Error.
- Number of Rats (5) in Each Group.
- A significant difference is shown by different vertical letters at the probability level (P≥0.05).

Blood Serum Oxidative Stress Level

The results of our study, as shown in Table (3), indicated that, compared to the healthy group, the animals in the hyperlipidemia-induced group had significantly higher (P≥0.05) MDA and lower (P≥0.05) glutathione (GSH) concentrations. In contrast to the control group in which hyperlipidemia was induced, groups of animals dosed with moringa leaf extract only, ATOR drug only, and moringa leaf extract + ATOR drug showed a notable decline in the focus of MDA and a notable rise in the focus of glutathione (GSH). In contrast to the group of healthy, the groups of rats administered with moringa leaf extract alone, ATOR drug alone, and moringa leaf extract + ATOR drug demonstrated favorable effects on the oxidative stress balance.

Table (3) Effect of Moringa Extract and Atorvastatin on The Focus of MDA and GSH in The Blood Serum of Male Albino Rats in Which Hyperlipidemia was Induced.

Parameters / Groups	MDA(µmol/L)	GSH (µmol/L)
Control	29.55±2.39^{b}	11.29±0.28^{ab}
HFD	62.88±6.69^{a}	9.59±0.26^{c}
HFD + MOR	26.98±1.36^{b}	11.24±0.39^{ab}
HFD + ATOR	27.43±0.45^{b}	10.82±0.17^{b}
HFD + (MOR +ATOR)	25.96±1.47^{b}	11.84±0.30^{a}
Control+ MOR	35.45±2.31^{b}	11.39±0.40^{ab}
Control+ ATOR	31.00±2.49^{b}	11.17±0.20^{ab}

Control + (MOR +ATOR)	28.26±2.64[b]	12.00±0.26[a]

- Values are Expressed as Arithmetic Mean ± Standard Error.
- Number of Rats (5) in Each Group.
- A significant difference is shown by different vertical letters at the probability level (P≥0.05).

Histological study

Aorta

The present study's findings demonstrated that the aortic artery's layers, known as the tunica intima (TI) and tunica media (TM), which are made up of smooth muscle fibers (SMF) and elastic sheets (ES), as well as the tunica adventitia (TA), appeared normally in the healthy control group, as shown in (Figure 1A) and (Table 4).

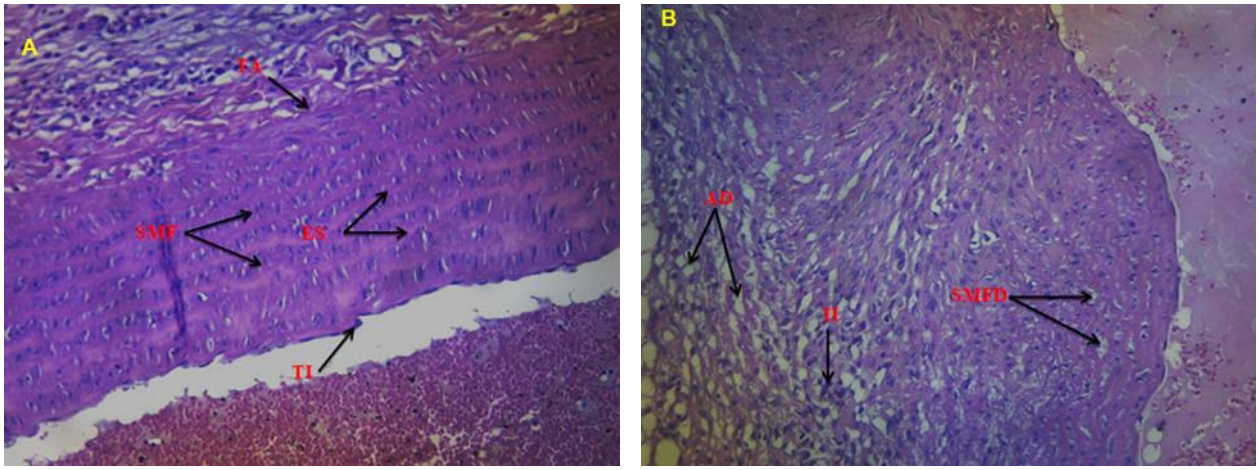
Many histological abnormalities, such as Elastic Sheets Detachment (ESD) within the tunica media at a high rate (+++) and Inflammatory Infiltration (II) within the tunica media and adventitia at a rate, were observed in the infected control group, where hyperlipidemia was produced. Blood Colloid (BC) within the lumen of the aorta at a moderate pace, Smooth Muscle Fibers Degeneration (SMFD) within the tunica media at a moderate rate (++), and Adventitia Degeneration (AD) at a high rate (+++). high(++) in addition to a high percentage(++) increase in the aorta thickening (AT) thickness, as shown in (Figure 1B,C) and (Table 4).

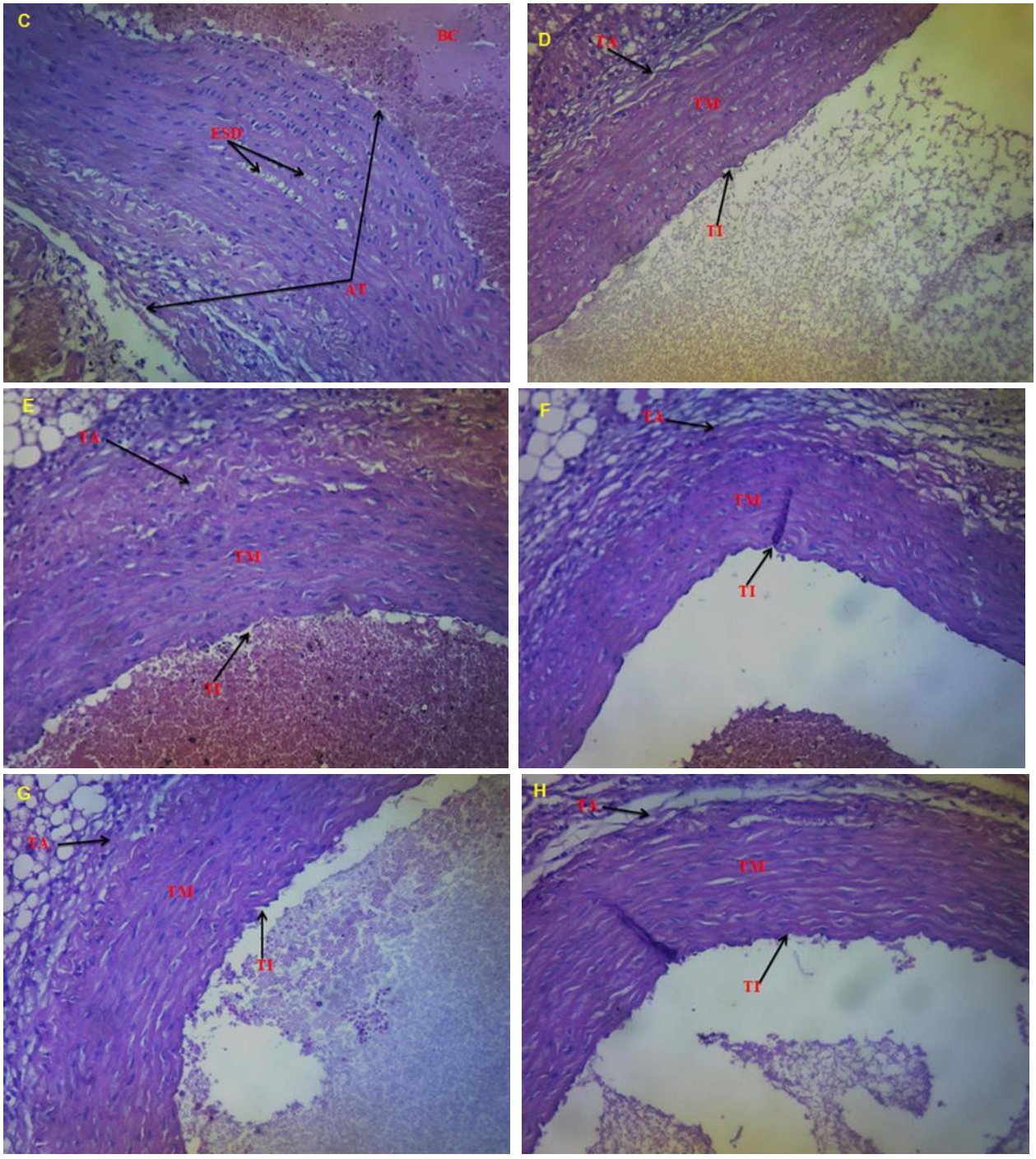
A moderate percentage (++) of the elastic sheet separation (ESD) within the tunica media and the infiltration of inflammatory cells (II) within the tunica media and adventitia were observed in the infected control group that induced hyperlipidemia and was dosed with the hydroalcoholic extract of moringa leaves only. Within the tunica medium, there was no blood colloid (BC), a small percentage (+), a moderate percentage (++) of adventitia degeneration (AD), a rare percentage (Trace) of smooth muscle fiber degeneration (SMFD), and no other abnormalities. The aorta thickening (AT) inside the aortic lumen appeared normal, as shown in (Figure 1D) and (Table 4.)

It was noted that the Elastic Sheets Detachment (ESD) within the tunica media decreased to a moderate percentage (++) and the inflammatory cell infiltration (II) within the tunica media and adventitia to a moderate percentage in the infected control group, where hyperlipidemia was induced and the drug atorvastatin alone was administered. Blood colloid (BC) declines inside the aortic lumen, and adventitia degeneration (AD) to a considerable proportion (++), smooth muscle fiber degeneration (SMFD) within the tunica media to a modest percentage (+). As shown in Figure 1E and Table 4, aorta thickness (AT) should be measured to a low percentage (+) and an average percentage (++).

Regarding the infected control group that was caused by hyperlipidemia and was given atorvastatin in addition to a hydroalcoholic extract of moringa leaves, there was no blood colloid (BC) seen inside the artery lumen, a decrease in Elastic Sheets Detachment (ESD) within the tunica media, and an infiltration of inflammatory cells (II) and adventitia to Rare (Trace) and Adventitia Degeneration (AD) to a small percentage (+). Smooth Muscle Fibers Degeneration (SMFD) within the tunica media to a rare percentage (Trace). Aorta Thickening (AT), as shown in Table 4 and Figure 1F, was normal.

The normal shape of the layers of the aorta—the tunica endothelium, the tunica muscularis media, and the tunica muscularis—was observed in the healthy groups dosed with exclusively the hydroalcoholic extract of moringa leaves, the drug atorvastatin only, and (the moringa leaves hydroalcoholic extract + the drug atorvastatin). Not a major histological changes were noted in these groups when contrasted to the healthy group. Figures 1G, H, and I and Table 4 show the adventitia and normal thickness of the aorta, respectively.

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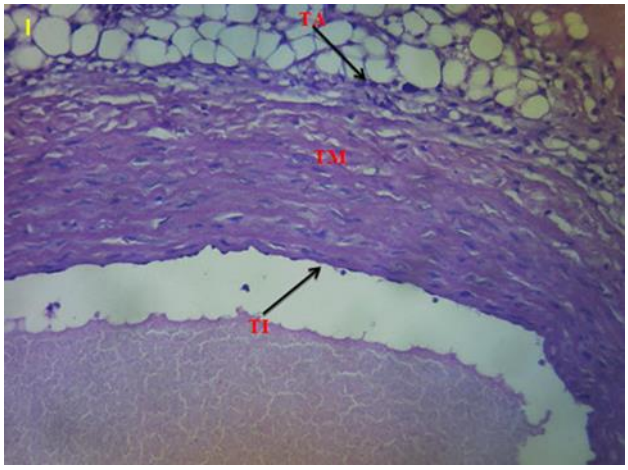


(Figure 1) A. Aortic section of the healthy group, B, C. D. Aortic section of the infected group, D. Aorta section of the infected group dosed with hydroalcoholic moringa leaves extract only, E. Aorta section of the infected group dosed with atorvastatin only, and F. Aortic section of the infected group dosed with (hydroalcoholic moringa leaves extract + atorvastatin) G, H, and I. Aortic sections of the healthy group dosed with hydroalcoholic moringa leaves extract only and the drug atorvastatin only and (hydroalcoholic moringa leaves extract + the drug atorvastatin).H&E 400X.

Table (4) Effect of Moringa Extract and Atorvastatin on Histological Disorders of The Aorta Induced by Hyperlipidemia in Male Albino Rats.

Groups \ Parameters	Elastic Sheets Detachment(ESD)	Inflammatory Infiltration(II)	Adventitia Degeneration(AD)	Smooth Muscle Fibers Degeneration (SMFD)	Blood Colloid(BC)	Aorta Thickening(AT)
Control	Nil	Nil	Nil	Nil	Nil	Nil
HFD	+++	++	+++	++	+++	+++
HFD + MOR	++	+	++	Trace	Nil	Nil
HFD + ATOR	++	++	++	+	+	++
HFD + (MOR +ATOR)	Trace	Trace	+	Trace	Nil	Nil
Control+ MOR	Nil	Nil	Nil	Nil	Nil	Nil
Control+ ATOR	Nil	Nil	Nil	Nil	Nil	Nil
Control + (MOR +ATOR)	Nil	Nil	Nil	Nil	Nil	Nil

Liver

The central vein (CV) in the healthy control group had a typical shape and distinct borders, according to the study's findings. Additionally, it demonstrated that the hepatic platelets were in their proper positions, the hepatocytes (HC) had normal appearances of the cell membrane, cytoplasm, and nuclei, and the sinusoids (S) were clear, normal in size and shape, and clear in relation to the Kupffer Cells (KC), as shown in (Figure 2A) and (Table 5).

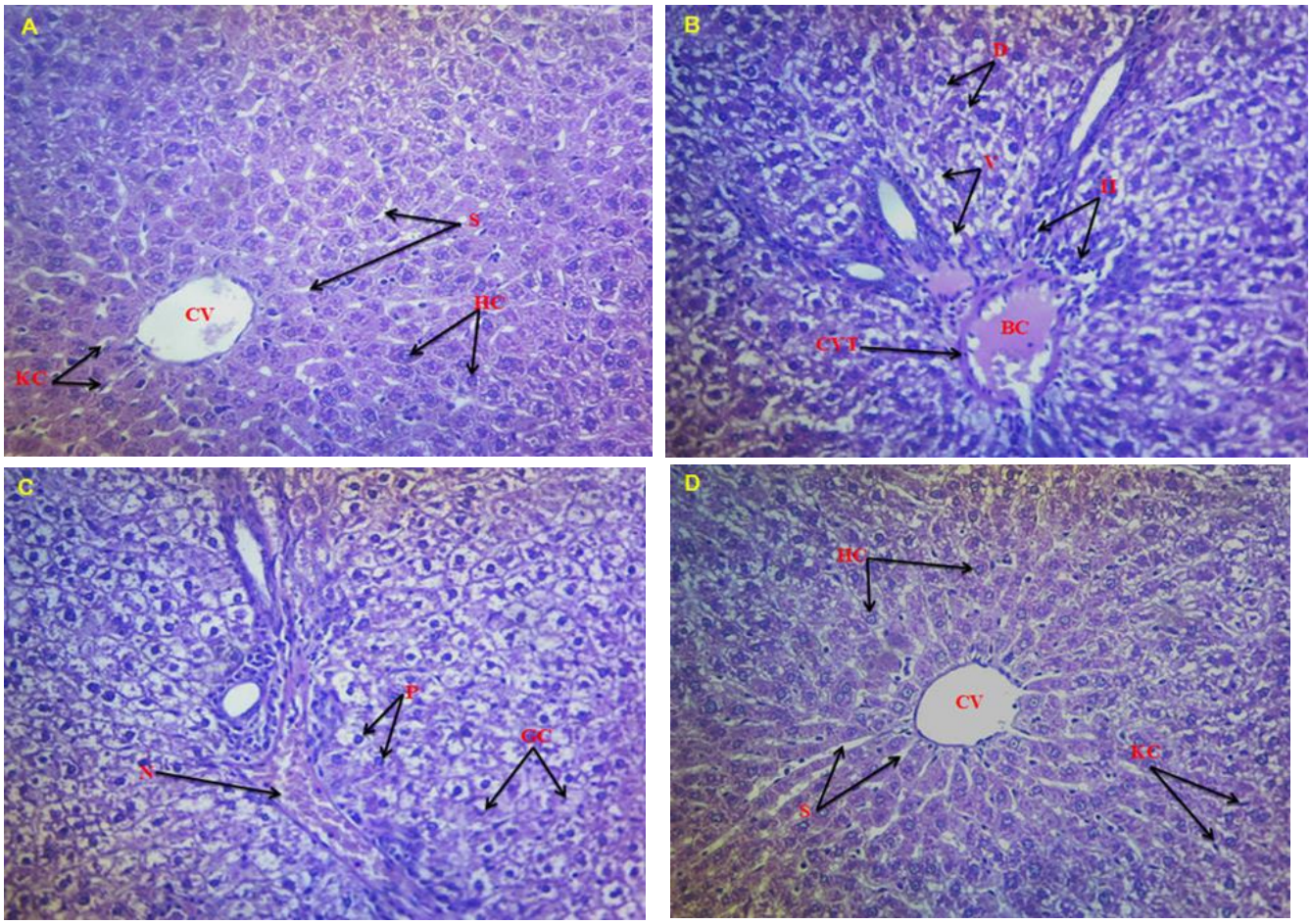
Regarding the group where hyperlipidemia was generated, numerous histological alterations were found, such as a high rate of Central Vein Thickening (CVT) and Blood Colloid (BC) within the central vein lumen (+++). Moderately high rate (+++) of inflammatory cell infiltration (II), moderate rate (++) of congestion (Con) in the blood vessel, degeneration (D) in hepatocytes, and moderate rate (V) of vacuolation (V) inside the liver stroma As shown in (Figure 2B,C) and (Table 5), the nuclei thicken with pyknosis (P) at a high rate (+++) and the emergence of ghost cells (GC) at a moderate rate (++) .

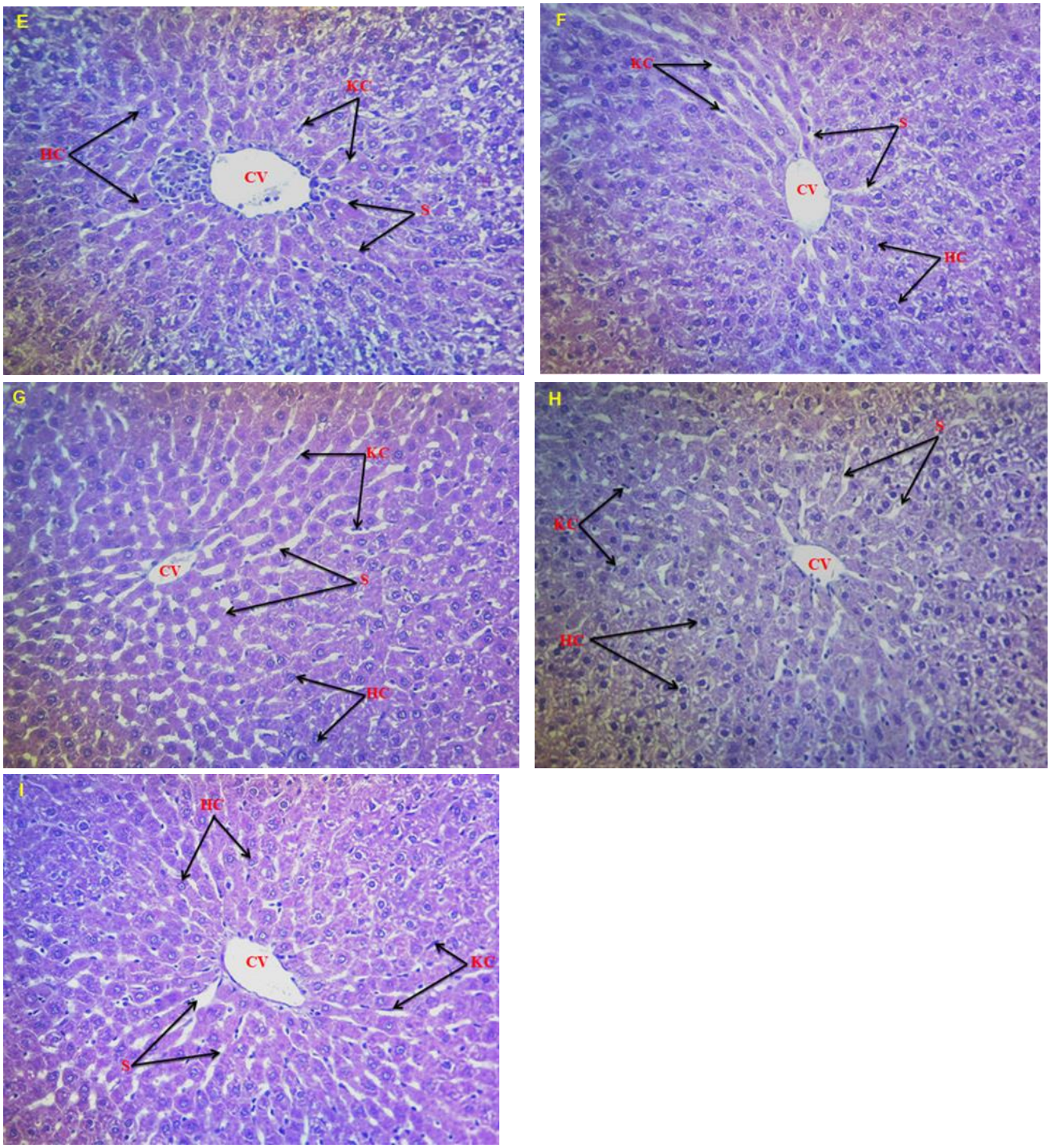
The blood colloid (BC) within the central vein lumen decreased to a moderate percentage (++) and the central vein thickening (CVT) to a moderate percentage (++). Vacuolation (V) within the liver stroma to a small percentage (+), degeneration (D) in hepatic cells, inflammatory cell infiltration (II) to a moderate percentage (++), and congestion (Con) in the blood vessel to a percentage were also observed in the infected control group that produced hyperlipidemia and was dosed with the hydroalcoholic extract of moringa leaves only. As shown in (Figure 2D) and (Table 5), there are few (+), nuclei thicken (P) to a tiny proportion (+), and ghost cells (GC) appear to a rare percentage (trace).

There were several histological alterations in the group that received atorvastatin alone after hyperlipidemia was established. There was an observation of Central Vein Thickening (CVT) and a drop in Blood Colloid (BC) to a moderate percentage (++) within the central vein lumen. As seen in (Figure 2E) and (Table 5), there are several percentages that can be found: a moderate percentage (++), a small percentage (+) of vacuolation (V) within the liver stroma, a medium percentage (++) of degeneration (D) in hepatocytes, and a moderate percentage (++) of inflammatory infiltration (II). There are also moderate percentages of congestion (Con) in blood vessels, thickening of the nuclei (P) at a moderate percentage (++), and the appearance of ghost cells (GC) at a moderate percentage (++).

There were several histological alterations in the group that received atorvastatin with a hydroalcoholic extract of moringa leaves after hyperlipidemia was established. Blood Colloid (BC) in the central vein lumen decreased to a negligible amount (+), and the vein thickened. (CVT) to a rare rate (Trace), the nuclei thickened (Pyknosis) to a rare rate (Trace), the vacuolation (V) within the liver stroma to a rare rate (Trace), the degeneration (D) in hepatocytes to a rare rate (Trace), and the Inflammatory Infiltration (II) to a small rate (+ Congestion (Con) did not appear in the blood vessel (Nil), as shown in (Figure 2F) and (Table 5).

The normal shape of the sinusoids, hepatic cells, and central vein (CV) was noted in the healthy groups dosed with atorvastatin, hydroalcoholic extract of moringa leaves, and (the hydroalcoholic extract of moringa leaves + the drug atorvastatin). No significant histological changes were observed when compared to the control group. Normal forms of blood cells (S) and Kupffer cells (KC) are shown in (Figure 2G,H,I) and (Table 5).





(Figure 2) A. Liver section of healthy group, B,C. Liver sections of the infected group, D. Liver sections of the infected group dosed with hydroalcoholic moringa leaves extract only and E. Liver sections of the infected group dosed with atorvastatin only and F. Liver section of the infected group dosed with (hydroalcoholic moringa leaves extract + atorvastatin) G, H, and I. Liver sections of a healthy group dosed with hydroalcoholic moringa leaves extract only and the drug atorvastatin only and (hydroalcoholic moringa leaves extract + the drug atorvastatin).H&E 400X.

Table (5) Effect of Moringa Extract and Atorvastatin on Liver Histological Disorders Caused by Hyperlipidemia in Male Albino Rats.

Groups \ Parameters	Blood Colloid(BC)	Vacuolation(V)	Degeneration(D)	Inflammatory Infiltration(II)	Congestion (Con)	Pyknosis(P)	Ghost Cells (GC)
Control	Nil	Nil	Nil	Nil	Nil	Nil	Nil
HFD	+++	++	+++	+++	++	+++	++
HFD + MOR	++	+	++	++	+	+	Trace
HFD + ATOR	++	+	++	++	++	++	++
HFD + (MOR +ATOR)	+	Trace	Trace	+	Nil	Trace	Nil
Control+ MOR	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Control+ ATOR	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Control + (MOR +ATOR)	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Discussion

Our study's findings are consistent with that of [10], which demonstrated how cholesterol-containing diets might alter rats' histology and physiology. In comparison to the hyperlipidemia group, the study revealed a substantial drop in the concentration of HDL-C in blood serum and A major rise in focus of LDL-C, total cholesterol, and triglycerides. Because of the liver's elevated cholesterol levels, a large amount of VLDL-C, which contain both LDL-C and cholesterol ester in the plasma, will be formed. Lipoprotein receptors will also be inhibited and become inactive. There will be negative consequences, such as the onset of atherosclerosis. Regarding the impact of leaf extract from Moringa oleifera on the lipid profile in blood serum, this is consistent with research findings [11] wherein the polyphenols in the plant demonstrated anti-obesity and anti-hyperlipidemia properties, as well as a reduction in the risk of cardiovascular disease in rats. According to [12] the antioxidants found in moringa help decrease cholesterol levels because they can lower cholesterol through inhibiting formation in addition to causing it to be broken down; hence those whose diets contain a lot of fat take advantage of them. Moringa leaves contain phytochemical compounds that stimulate intestinal and liver cells to produce high-density lipoproteins, in addition to flavonoids that effectively prevent LDL-C from being oxidized and subsequently prevent its accumulation and deposition inside the arteries and veins [13,14]. Moringa extracts have antioxidants; of which one is vitamin C. These antioxidants influence the liver cells' receptors for LDL-C thereby helping reduce or prevent LDL oxidation process [5]. Atorvastatin works because it stops cholesterol from being produced by regulating the growth of LDL-C receptors on liver cell surfaces. This process causes low-density lipoproteins to be eliminated from the bloodstream. Statins are One of the medications that lowers cholesterol levels through a particular method is this one, which inhibits the enzyme HMG-CoA reductase both selectively and competitively. Since the enzyme functions to prevent HMG-CoA reductase from converting too much into mevalonic acid, which is thought to be a precursor of sterols, including cholesterol, it is thought that the enzyme acts as a catalyst, setting the pace of the reaction. Initially, when this enzyme is blocked, the amount of cholesterol in the liver will decrease. The first steps in compensatory mechanisms involve lowering LDL-C and activating the greatest number of HMG-CoA reductase receptors [15,16].

As per findings from investigations conducted by our research, the rats who belong to a group of animals known as hyperlipidemia showed some remarkable differences when it comes to having increased liver enzymes levels in their bodies which potentially lead them into having a higher concentration of such enzymes which is believed to have been brought about by an attack of oxygen within an excessive amount lipid that accumulates itself upon hepatocytes whose outcome may be manifested as non – alcoholic cirrhosis over time when left uncontrolled because these cells have become damaged – irreversibly due initially even some simple conditions like steatosis (an abnormal condition characterized specifically about large amounts) , A liver becomes full of fats; plus other diseases such as diabetes (diabetes mellitus) or atherosclerosis [17]. One of the main reasons that liver enzymes rise is because free radicals are produced in the body resulting in lipid peroxides that damage cell membranes. When this happens, cell permeability changes leading to cell death with consequent changes in its membrane potential as equilibrium shift causes them leak into the circulating blood where they eventually cause tissue injury as well as necrosis [18]. As for moringa leaf extract, it works to raise the level of liver enzymes because it contains antioxidants such as flavonoids, also known as the active syndrome, as it contains levels of vitamins A and C. Not only this but also other vitamins A, E and C present in the moringa leaves [19,20]. It also contains plant sterols, which protect the liver by lowering blood sugar and cholesterol levels and preventing the accumulation of fat and the progression of cirrhosis. It also protects the liver from oxidative stress, which damages liver cells [21]. The drug atorvastatin helped to protect

the liver, and the liver enzyme levels were within normal ranges, proving that the procedure was effective. The drug atorvastatin was used as a preventive strategy and had no side effects because it lowers blood fat levels, especially cholesterol levels. It not only functions as an antioxidant and gets rid of free radicals, but it also prevents hyperlipidemia from occurring [22].

The rats in the high-fats group had higher levels of malonideoxidealdehyde (MDA) and lower levels of GSH in serum. It is consistent with [23] where there was increase in MDA concentrations along with reduction GSH and CAT glutathione concentrations. The rats in the induced hyperlipidemia group, in comparison to the healthy control group. It can be prised on how the function of lowering MDA concentrations by moringa leaf extract works. It is also worth noting that moringa has active ingredients such as flavonoids and vitamins for example vitamin A that might serve as antioxident that neutralizes free radicals hence lower lipid peroxidation process from which this plant is derived from. Besides, it curtails triglycerides [24]. When it is taken Atorvastatin helpful in lowering the level of fats in blood as a result of it working as a compound anti-oxidant thereby preventing lipid peroxides formation hence preventing stress caused by oxidation [22]. Similarly, because there is a direct correlation between rising fat levels and MDA, atorvastatin lowers fat levels and hence lowers MDA levels. Additionally, by raising HDL levels, which have an inverse relationship with MDA, the medication prevents oxidative stress [25].

The present study's findings, which corroborate those of a study [10] that examined the effects of male rat hyperlipidemia on the aorta and revealed numerous alterations, indicated that only the group in which hyperlipidemia was induced experienced tissue lesions in the aortic areas. Histological observations revealed increased aortic wall thickness along with high rates of atherosclerotic plaque formation and cholesterol crystal deposition within the tunica endothelium, as well as modest rates of inflammatory cell infiltration in the wall layers . The role of a high-fat diet, which caused an imbalance and an increase in the percentage of fat concentrations, is the reason for the appearance of tissue imbalances and the rise in the thickness of the aortic wall, which was indicated in our current research . Consequently, the excess fat causes heart attacks and the deposition of fat in the arteries that develops into atherosclerosis [18,26]. Regarding the Moringa oleifera leaf extract, our findings are consistent with the research [27], which shown that the extract improved the risk index for atherosclerosis and high fat. This is because moringa contains potent compounds that lower blood fat levels, particularly cholesterol, and guard against the negative effects of high fat and cardiovascular disease. As such, it is anti-inflammatory, shields the aorta from the risk of atherosclerosis, and lessens oxidative stress brought on by the possibility of free radicals. which, because of the antioxidants it contains—plant sterols, fatty acids, vitamins, and flavonoids, which are thought to be the most significant substance—causes significant tissue damage [28]. According to [29], atorvastatin's ability to lower oxidative stress and increase antioxidant concentrations is what protects the aorta from the risk of hyperlipidemia.

The study [23] demonstrated numerous histological alterations in the liver, including fibrosis of the liver, thickening of the central vein wall, and a high rate of inflammatory cell infiltration with sclerosis. The results of the current investigation demonstrated that hyperlipidemia caused numerous histological alterations in the liver in this group. There was a modest rate of hepatic cell degeneration and a significant prevalence of hemolysis and hepatic artery involvement. Due to this, TC, TG, LDL-C, and VLDL-C skyrocketed as HDL-C plummeted resulting from the kind of food was rich in fat and cholestero consumed by rats [30]. Higher fat levels were found to increase liver enzymes by damaging liver cells also releasing free radicals and increase oxidative stress that decreases the activity of antioxidant enzymes hence revealing the impact of excess fat on the liver of rats via histological changes [17] . The rolemay be highly attributed with the presence of phenolic compounds from moringa extract for tissue disoredr normalization in that it contains important elements that help decrease pressure on to living being's cells by reducing levels of too much oxidation ntioxidants to lower inflammation and protect against diseases human beings could use medicinal plants Moringa leaves contain a significant amount of flavonoids among which quercetin and kamferol are the most important ones. Being a secondary metabolite, these substances are made in the course of plant metabolism [24]. Our findings regarding the action of atorvastatin are consistent with [31] who studied that hyperlipidemia was induced in rabbits by adding 1% cholesterol to the diet. The role of this atorvastatin is in reducing lipid levels and normalizing histological disorders, in contrast to the hyperlipidemia group.

Conclusion

The results of the current study showed that excess fat leads to imbalances in the levels of lipids, liver enzymes, and oxidation balance in blood serum, in addition to histological disorders in the aorta and liver in male rats. When using the hydroalcoholic extract of moringa leaves and the drug atorvastatin to alleviate the negative effects resulting from hyperlipidemia, positive effects were shown in normalizing physiological and Histological disorders, and the effect of the hydroalcoholic extract of moringa leaves and the drug atorvastatin together outweighed the rest of the treatments.

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