

Studying The Effect Of Hawthorn (*Crataegus Pinnatifida*) And Bay (*Laurus Nobilis*) Leaves Mixture On Body Weight In Obese Rats

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Abstract

Obesity is a complex combination of genetic and environmental factors associated with a significant increase in morbidity and mortality rate. Nowadays, usage of herbs for the management of obesity or controlling body weight interesting. Therefore, the present study was set to investigate the effectiveness of the mixture of hawthorn and bay leaves in controlling body weight in obesity induced by high-fat and calories diet (HFCD) in rats. The experiment was conducted in two stages, each of 4 weeks; in the first stage (induction of obesity) rats were divided into two main groups, normal group (7 rats) fed on the basal diet, and the second main group (28 rats) fed on the HFCD. In the second stage, obese rats were divided into 4 groups (each of 7 obese rats); a positive control group (group 2) was fed on HFCD, group 3, 4 and 5 were fed on supplemented HFCD with the mixture of hawthorn and bay leaves in proportions of 2.5, 5 and 10%, respectively. Feeding obese rats on supplemented HFCD with the leaves mixture of hawthorn and bay results in significant ($P < 0.05$) reduction in body weight gain, relative weight gain, visceral fat weight and adiposity index; and serum levels of insulin Leptin hormone, TC, TG, TL, LDL-c, VLDL-c and MDA and activities of AST, ALT, ALP enzymes in comparison to positive control group. The results also showed a significant ($P < 0.05$) improvement in the serum levels of HDL-c and insulin and activities of antioxidant enzymes (GPx, GSH and SOD), compared to that of the positive control rats. Microscopically, results showed gradual improvement in histopathological structural of both heart and aorta sections with an increase in the proportion of the mixture of hawthorn and bay leaves in treated obese rats, compared to that of the untreated obese rats. Finally, the mixture of dried hawthorn and bay leaves shows powerful potential as natural lowering worker of weight and blood lipids levels. There is need of further study to find out how both herbs works and use of them as anti-obesity agent.

Keywords: Obesity; Overweight; Hart Diseases; Leptin Hormone; Medical Herbs; Hawthorn Leaves; Bay leaves

Introduction:

Obesity is a medical disorder and attends too much body fat (**Pi-Sunyer, 2002**). In generally, obesity is defined as the abnormal accumulation of fats in adipose tissue to the range that the health state of human may be impaired (**Aronne and Segal, 2002**). Nowadays, obesity is on the elevation globally reason being increasing consumption of unhealthy foods and lower levels of physical activity (**Swinburn et al., 2011**). According to the degree of obesity, duration, and distribution of the excess adipose tissue, obesity can progressively cause exacerbate a variety of comorbidities, including type 2 diabetes, cardiovascular diseases, hypertension, dyslipidemia and several forms of cancer (**Kyrou et al., 2020**).

Many medications have been used to manage obesity over the years. However, most of the anti-obesity drugs that were approved and marketed have been withdrawn due to serious adverse effects (**Connolly 1997**). Therefore, there is

a genuine need to explore a new natural materials curing obesity. Hawthorn (*Crataegus* sp.) and *Laurus nobilis* L. (Lauraceae) from the promising substances in the treatment of obesity.

Hawthorn *Crataegus oxyacantha* L. belongs to the Rosaceae family of spiny shrubs and known as the Hawthorn species and is medicinally famous in European Pharmacopeia, having been used for a long time in nation medicine for the treatment of different diseases as diarrhea, asthma, and insomnia (**Benabderrahmane et al., 2021**), angina pectoris, hypertension, and arrhythmia. It has been also proposed as an alternative anxiolytic, antihyperlipidemic, immunomodulatory, antihyperglycemic, and antimutagenic medicine (**Orhan, 2018**).

Laurus nobilis L. (Lauraceae) is native shrub that is cultivated in the Mediterranean area and some of Asian and Europe countries (**Stefanova et al., 2020**). *Laurus* leaves are known as bay laurel, noble laurel and sweet laurel or sweet bay and it is used as a spice or a decorative plant (**Vassileva and Darlenski, 2020**). The *laurus* leaves have a wide range of the beneficial biological properties including anti-fungal and improves blood lipids profile (**Aljamal, 2011**), anti-inflammatory (**Patrakar et al., 2012**), antimicrobial (**El et al., 2014**), improves liver function (**Gasparyan et al., 2015**), antioxidant properties (**Muñiz-Márquez, et al., 2014**) and a carminative (**Stefanova et al., 2020**). In addition it is used in the Iranian folk medicine the in the treatment of epilepsy, neuralgia, and Parkinsonism (**Caputo et al., 2017**). The present study was set to investigate the effectiveness of the mixture of hawthorn and bay leaves in controlling body weight in obesity induced by high- fat and calories diet (HFCD) in obese rats.

2. Materials and Methods:

2.1. Hawthorn and Bay Leaves: Dried hawthorn and bay leaves were purchased from the local herbalist shops in Cairo, Egypt and classified in the Herbarium, Botany Department, Faculty of Sciences, Cairo University, Giza, Egypt. Both leaves of hawthorn and bay were cleaned, sorted and washed from dust and remove all invalid parts and dried in a hot air oven at 105°C for 3 hrs. A grinder mill and sieves were used to obtain a powder particle size of less than 0.2mm of all leaves. All milled dried leaves of hawthorn and bay were being mixture at a 1-1 ratio and package until used.

2.2. Rats and Diet: Thirty-Five of male adult rats (Sprague Dawley Strain), weighing about 170 ± 5 g were obtained from the laboratory animal colony, Helwan, Egypt. Basal diet constituents were purchased from El-Gomhorya Company for Pharmaceutical and Chemical, Cairo, Egypt. The normal basal diet (AIN-93M) consisting of protein (14%), corn oil (5%), minerals mixture (3.5%), vitamins mixture (1%), fiber (5%), sucrose (10%), choline chloride (0.25%) and corn starch was being thoroughly mixed and formulated according to **Reeves et al., (1993)**. High-fat and calories diet (HFCD) was prepared as described by **Bhatt et al., (2006)**. In briefly, basal diet was modified and supplied with 59% calories from fat, 21% calories from carbohydrate and 20% calories from protein.

2.3. Experimental Design and Assembly of Rats: All rats were housed at a room temperature of 25 ± 2 °C, relative humidity of 50–55% and light/dark cycles (12/12) in animal house of the Faculty of Home Economics, Cairo, Egypt for one week for acclimatization. After acclimatization period, the experiment was conducted in two stages, each of 4 weeks. In the first stage (induction of obesity) rats were divided into two main groups, normal group (7 rats) fed on the normal basal diet only, and the second main group (28 rats) fed on the HFCD for another four weeks to induce obesity and hyperlipidemia. In the second stage, obese rats were divided into 4 groups (each of 7 obese rats); a positive control group (group 2) was fed on HFCD only, group 3, 4 and 5 were fed on the supplemented HFCD with the mixture of hawthorn and bay leaves in proportions of 2.5, 5 and 10%, respectively.

At the end of the second stage of experiment period, animals were fasted for 12-hr., except of water and then rats were sacrificed. Blood samples were collected from the posterior vena cava into dry clean centrifuge tubes. Blood samples were left at room temperature to clot, and then centrifuged for 15 minutes at 4000 rpm for serum separation. Serum samples were carefully aspirated using a needle and transfers into dry clean test tubes and frozen at -20°C for biochemical analysis. Heart and aorta from all animals were removed immediately, washed with saline solution, dried and immersed in buffered formalin 10% for histopathology examination.

2.4. Estimation of Food Intake, Body Weight Gain and Relative Weight gain: Food intake (FI) was calculated every day during the second stage of experimental. The changes in body weight were determined by weighing the animals on a balance scale prior the second stage of experiment (IBW) and at the end of experiment period (FBW). The biological value of diets was assessed by the determination of its effect on body weight gain (BWG) and percent change of body weight gain were calculated using the following formula:

$$\text{BWG} = \text{Final Body Weight} - \text{Initial Body Weight}$$

$$\% \text{ change of body weight gain} = \text{BWG}/\text{IBW} \times 100$$

2.5. Determination of Visceral Fat Weight and Adiposity index:

Visceral fat weight and adiposity index was determined as described by **Taylor, and Phillips, (1996)** using the following formula:

$$\text{Fat pad weights} = \text{epididymis fat} + \text{retroperitoneal fat} + \text{visceral}$$

$$\text{Adiposity index \%} = \text{total pad fat weights}/ \text{Final body weight} \times 100$$

2.6. Biochemical Assay:

All chemicals and Kits for biochemical analysis were purchased from the Gamma Trade Company for Pharmaceutical and Chemicals, Dokki, Egypt.

2.6.1. Estimation of Serum Levels of TC, TG, TL, HDL-c, LDL-c and VLDL-c. Serum levels of total cholesterol (TC), triglycerides (TG), total lipid (TL), high density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c) and very low density lipoprotein cholesterol were estimated using commercial reagent kits (Biomed diagnostic, Egypt) as described by **Hostmark et al ., (1991), Vassault et al ., (1986), Zollner and kirsch, (1962) and Young, (2001)**, respectively. Low density lipoprotein cholesterol concentration was calculated by using formula of **Friedwald et al. (1972)**. Very low density lipoprotein cholesterol (VLDL-C) was calculated using the following equation:

$$\text{VLDL-c (mg/ dL)} = \text{TG}/5$$

2.6.2. Estimation of Serum Insulin and Leptin Levels: Serum concentrations of insulin were estimated by using a specific antibody radioimmunoassay (RIA) kits according to the described methods by **Yallow and Bauman (1983)**. Serum level of leptin hormone was determined using Enzyme-linked immunosorbent assays (ELISA) as described by **Xiong et al., (2005)**.

2.6.3. Estimation of Liver Functions: Serum activities of AST and ALT enzymes were estimated colorimetric using kits instruction (Diamond Co, Hannover, Germany) as described by **Young, (2001)**. Serum activity of ALP enzyme was determined according to the methods of **Roy, (1970)**.

2.6.4. Estimation of Oxidative Stress Markers: Malondialdehyde (MDA) was assayed quantitatively in serum using the MDA assay kit by a spectrophotometric method (ABCAM, UK). The MDA in the sample reacts with thiobarbituric acid (TBA) to generate a MDA-TBA adduct. The MDA-TBA adduct is quantified colorimetrically (OD = 532 nm). This assay detects MDA levels as low as 1 nmol/well colorimetric ally **Ohkawa and Yagi, (1979)**.

2.6.5. Estimation of Antioxidant Activity: Serum activity of GSH enzyme was determined according to the described method by **Beutler et al. (1963)**. Serum activities of GPx and SOD enzymes were determined using the pyrogallol autoxidation method as described by **Marklund and Marklund (1974)**.

2.7. Histopathological Examination: Heart and aorta of all the scarified rats were cleaned, dried and immersed in 10% formalin solution. Then, sections of both heart and aorta were trimmed, washed and dehydrated in ascending grades of

alcohol. Specimens was being then cleared in xylol, embedded in paraffin, sectioned at 4-6 microns' thickness, and stained with Hematoxylin and Eosin stain for examination as described by (Carleton, 1979).

2.8. Statistical analysis: Data was evaluated statistically using computerized SPSS package program (SPSS 22.00 software for Windows) by one-way analysis of variance (ANOVA). The obtained data was expressed as Mean \pm SD and the significant difference among means was estimated at $p < 0.05$.

3- Results

3.1. Effect of the mixture leaves of both hawthorn and bay on food intake (FI), body weight gain (BWG) and relative weight gain (RWG) in obese rats:

The current results in Table 1 revealed that untreated obese rats (positive rats) have a significant ($P < 0.05$) decrease in FI compared to that of the normal rats. In contrast, HFCD fortified with the 2.5 and 5% of the mixture leaves of both hawthorn and bay caused no significant changes in FI, while level 10% significantly decreased FI, compared to that of the high-fat diet alone in obese rats.

Regarding to changes in body weight, the tabulated results shows that feeding obese rats on HFCD have significant ($P < 0.05$) increase in FBW, BWG and RWG, compared to that of the fed rats on normal basal diet. Incorporated the HFCD with the mixture leaves of both hawthorn and bay at the different three levels (2.5, 5 and 10%) caused significantly reduction ($P < 0.05$) in FBW, BWG and RWG, compared to HFCD only. The reduction in BWG and RWG was significantly ameliorated with increasing levels of the mixture leaves of both hawthorn and bay.

3.2. Effect of the mixture leaves of both hawthorn and bay on visceral fat weight and adiposity index in obese rats.

Table 2 represents the effect results of the mixture leaves of both hawthorn and bay on visceral fat weight (VFW) and adiposity index (AI) on obese rats. It was showed that rats fed on HFCD only (positive rats) have significant ($P < 0.05$) increase in VFW (g) and AI, compared to that of the fed rats on normal basal diet (normal rats). While, feeding obese rats on HFCD fortified with the three different levels (2.5, 5 and 10%) of the leaves mixture of both hawthorn and bay have significant ($P < 0.05$) decrease in VFW (g) and AI, compared to that obese rats feeding on HFCD only.

Table (1): Effect of the mixture leaves of both hawthorn and bay on FI, BWG and RWG in obese rats.

Parameters Groups		FI (g)	IBW (g)	FBW (g)	BWG (g)	RWG (%)
Normal rats		23.35 \pm 1.11 ^a	250.29 \pm 1.60 ^b	313.00 \pm 1.91 ^e	62.71 \pm 2.92 ^c	25.06 \pm 1.30 ^c
Positive rats		19.14 \pm 0.89 ^b	302.43 \pm 1.90 ^a	392.71 \pm 1.60 ^a	89.57 \pm 3.91 ^a	29.81 \pm 0.92 ^a
Obese rats fed on HFCD+ mixture of HL and BL at levels of :	2.5%	19.35 \pm 0.95 ^b	302.57 \pm 1.99 ^a	385.29 \pm 1.11 ^b	82.71 \pm 2.43 ^b	27.33 \pm 0.95 ^b
	5%	18.35 \pm 1.25 ^b	302.71 \pm 1.50 ^a	358.29 \pm 1.38 ^c	55.14 \pm 2.54 ^d	18.36 \pm 0.78 ^d
	10%	14.00 \pm 1.00 ^c	302.00 \pm 1.82 ^a	329.00 \pm 1.15 ^d	26.43 \pm 2.64 ^e	8.89 \pm 0.96 ^e

Values expressed as means \pm SD;

Means with different letters in each column are significantly differs at $p < 0.05$.

FI= Food Intake; **IBW=** Initial body weight; **FBW:** Final Body Weight, **RWG=** Relative Weight Gain; **HFCD=** High Fat and Calories Diet; **HL=** Hawthorn Leave; **BL=** Bay Leave.

Table (2): Effect of the mixture leaves of both hawthorn and bay on visceral fat weight and adiposity index in obese rats

Parameters		VFW (g)	AI
Groups			
Normal rats		7.29±0.49 ^c	2.30±0.13 ^c
Positive rats		12.00±0.82 ^a	3.05±0.21 ^a
Obese rats fed on HFCD + mixture of HL and BL at levels of :	2.5%	10.00±0.82 ^b	2.57±0.18 ^b
	5%	9.43±0.53 ^b	2.63±0.16 ^b
	10%	8.00±0.82 ^c	2.48±0.22 ^{bc}

Values expressed as means ± SD;

Means with different letters in each column are significantly differs at $p < 0.05$.

VFW= Visceral fat Weight; **AI**= Adiposity Index; **HFCD**= High Fat and Calories Diet; **HL**= Hawthorn Leave; **BL**=Bay Leave.

3.3. Effect of the mixture leaves of both hawthorn and bay on the serum levels of TC, TG, TL, HDL-c, LDL-c and VLDL-c in obese rats

In the case of serum lipid profile, the parameters of serum TC, TG, TL, HDL-c, LDL-c and VLDL-c levels were used to check the effect of the mixture leaves of both hawthorn and bay on obese rats. The results in Table 3 shows that obese rats fed on HFCD have significant ($P < 0.05$) increase in the serum concentrations of TC, TG, TL, LDL-c and VLDL-c levels, and decrease in HDL-c level, compared to that of the normal rats fed on normal basal diet. In contrast, the addition of the three different levels (2.5, 5 and 10%) of the mixture leaves of both hawthorn and bay to the HFCD caused significant amendments in the serum levels of the above parameters, as compared to that caused by the high-fat and calories diet alone in obese rats. The rate of improvement in the serum levels of above parameters was more evident with increasing the levels of the mixture leaves of both hawthorn and bay on.

Table (3): Effect of the mixture leaves of both hawthorn and bay on lipid profiles in obese rats.

Parameters		TC (mg/dl)	TG (mg/dl)	TL (mg/dl)	HDL-c (mg/dl)	LDL-c (mg/dl)	VLDL-c (mg/dl)
Groups							
Normal rats		113.86±3.48 ^e	88.0±1.15 ^e	403.71±4.82 ^e	45.85±1.57 ^a	59.40±2.19 ^e	17.36±0.29 ^e
Positive rats		256.43±4.72 ^a	226.29±1.38 ^a	643.29±6.62 ^a	28.85±1.57 ^d	173.87±2.07 ^a	45.16±0.13 ^a
Obese rats fed on HFCD + mixture of HL and BL at levels of :	2.5%	181.1±4.88 ^b	173.71±0.76 ^b	575.0±39.37 ^b	36.14±2.67 ^c	128.14±1.86 ^b	34.62 ±0.18 ^b
	5%	168.57±3.77 ^c	116.86±1.57 ^c	508.0±11.8 ^c	39.57±2.82 ^b	84.85±2.96 ^c	23.37±0.31 ^c
	10%	134.14±3.53 ^d	102.29±1.25 ^d	440.71±13.97 ^d	46.0±2.94 ^a	67.57±2.93 ^d	21.05±1.83 ^d

Values expressed as means ± SD;

Means with different letters in each column are significantly differs at $p < 0.05$.

HFCD= High Fat and Calories Diet; **HL**= Hawthorn Leave; **BL**=Bay Leave

TC= Total cholesterol; **TG** =Triglyceride; **TL**= Total Lipid; **HDL-c** = High Density Lipoproteins Cholesterol; **LDL-c**= Low Density Lipoproteins Cholesterol; **VLDL-c**= Very Low Density Lipoproteins Cholesterol

3.4. Effect of the mixture leaves of both hawthorn and bay on the serum levels of insulin and Leptin hormones in obese rats.

The presented data in Table 4 revealed that HFCD significantly ($P < 0.05$) increased in serum levels of insulin and Leptin hormone in obese rats, compared to that induced by normal basal diet in normal rats. However, the supplemented HFCD with the different levels of the mixture leaves of both hawthorn and bay significantly ($P < 0.05$) decreased serum level of insulin and of Leptin hormone levels, compared to that induced by the HFCD only in obese rats.

Table (4): Effect of the mixture leaves of both hawthorn and bay on the serum levels of insulin and Leptin hormones in obese rats

Parameters		Insulin (mg/dl)	Leptin (ng/ml)
Normal rats		3.04±0.05 ^c	4.08±0.21 ^d
Positive rats		3.18±0.02 ^a	10.78±0.31 ^a
Obese rats fed on HFCD + mixture of HL and BL at levels of :	2.5%	3.15±0.07 ^{ab}	8.21±0.26 ^b
	5%	3.14±0.07 ^{ab}	5.87±0.32 ^c
	10%	3.11±0.06 ^b	5.65±0.19 ^c

Values expressed as means ± SD;

Means with different letters in each column are significantly differs at p< 0.05.

HFCD= High Fat and Calories Diet; **HL**= Hawthorn Leave; **BL**=Bay Leave

3.5. Effect of the mixture leaves of both hawthorn and bay on the serum activities of AST, ALT and ALP enzymes in obese rats.

The results in Table 5 shows the effect of the mixture leaves of both hawthorn and bay on the serum activities of AST, ALT and ALP enzymes in obese rats. It revealed that HFCD caused significant increases in the serum activities of AST, ALT and ALP enzymes in obese rats, compared to that caused by normal basal diet in normal rats. In contrast, treated obese rats with the mixture leaves of both hawthorn and bay at the three different levels (2.5, 5, and 10%) have significant decreases (P<0.05) in the serum activities of AST, ALT and ALP enzymes as compared to that of untreated obese rats (positive rats). In addition, higher level of the mixture leaves of both hawthorn and bay (10%) significantly lowered serum activities of AST, ALT, and ALP as compared to that of the other two levels (2.5 and 5%, respectively).

3.6. Effect of the mixture leaves of both hawthorn and bay on the serum levels of MDA and activities of antioxidant enzymes in obese rats.

The results of the effect of the three different levels of the mixture leaves of both hawthorn and bay on the serum level of malondialdehyde (MDA) and the activities of reduced glutathione (GSH), glutathione peroxidase (GPx) and superoxide dismutase (SOD) enzymes in the experimental obese rats are recorded in Table 6. Results showed that untreated obese rats have significant increase at p<0.05 in serum level of MDA, compared with those of the normal rats. Feeding obese rats on complement HFCD with the three different levels of the mixture leaves of both hawthorn and bay have significant decrease at p<0.05 in serum levels of MDA, compared with that of the untreated obese rats fed on HFCD only. It was noted that the rate of amelioration in the levels of antioxidant enzymes was better with increasing the proportion of the mixture leaves of both hawthorn and bay.

Table (5): Effect of the mixture leaves of both hawthorn and bay on the serum activities of AST, ALT and ALP enzymes in obese rats.

Parameters		AST (µ/L)	ALT (µ/L)	ALP (µ/L)
Normal rats		25.14±3.48 ^c	32.71±2.36 ^d	55.31±1.39 ^d
Positive rats		49.42±3.73 ^a	69.14±3.33 ^a	74.1±1.28 ^a
Obese rats fed on HFCD + mixture of HL and BL at levels of :	2.5%	33.85±2.96 ^b	48.0±2.38 ^b	65.42±1.39 ^b
	5%	33.28±0.95 ^b	41.0±1.82 ^c	60.64±2.68 ^c
	10%	27.71±2.05 ^c	32.71±2.28 ^d	55.85±0.74 ^d

Values expressed as means ± SD;

Means with different letters in each column are significantly differs at p< 0.05.

HFCD= High Fat and Calories Diet; **HL**= Hawthorn Leave; **BL**=Bay Leave
AST= Aspartate transaminase; **ALT**= Alanine transaminase; **ALP**= Alkaline phosphatase

Table (6): Effect of the mixture leaves of both hawthorn and bay on the serum levels of MDA and activities of antioxidant enzymes in obese rats.

Parameters		MDA (nmol/ml)	GSH (mmol/l)	GPx (nmol/dl)	SOD (ng/ml)
Normal rats		90.85±1.86 ^e	5.22±0.42 ^b	38.31±0.74 ^b	884.41±12.62 ^b
Positive rats		239.0±1.41 ^a	2.15±0.19 ^e	16.44±0.82 ^e	460.71±1.97 ^e
Obese rats fed on HFCD + mixture of HL and BL at levels of:	2.5%	145.43±1.27 ^b	2.83±0.32 ^d	19.92±1.01 ^d	554.86±5.14 ^d
	5%	114.0±2.16 ^c	3.71±0.31 ^c	32.0±1.11 ^c	766.14±5.78 ^c
	10%	93.85±1.21 ^d	5.61±0.39 ^a	42.21±1.43 ^a	913.57±8.05 ^a

Values expressed as means ± SD;

Means with different letters in each column are significantly differs at p< 0.05.

HFCD= High Fat and Calories Diet; **HL**= Hawthorn Leave; **BL**=Bay Leave

MDA= Malondialdehyde; **GSH**= Reduced Glutathione; **GPx**= Glutathione Peroxidase; **SOD**= Superoxide Dismutase

3.7. Histopathological Examination: Microscopically, heart sections from the normal control group showing the normal histological structure of branching and anastomosing longitudinal muscle fibers, acidophilic sarcoplasm, and central oval vesicular nuclei as shown in **(Photo 1)**. Meanwhile, examine heart sections of untreated obese rats (positive control rats), showed striation of cardiac muscle and vast distances between cardiomyocytes **(Photo 2)**, intrafibrillary bleeding (hemorrhage), dilated and congested blood arteries, and inflammatory cellular infiltration **(Photo 3)**. As shown in **(Photo 4)**, there were focal areas of dysfunction and myocyte cytolysis and some sections of cytoplasm that hyper acidophilic and Pyknotic nuclei. Cardiomyocytes sections from treated obese rats with 2.5% of the mixture leaves of hawthorn and bay revealed disorganized and mononuclear cells infiltrated in several places **(Photo 5)**, as well as there was dilated, congested blood vessels and intrafibrillary bleeding **(Photo 6)**. The Cardiomyocytes morphology of treated obese-hyperlipidemic rats with 5% of the mixture leaves of both hawthorn and bay revealed intact structure with central oval vesicular nucleim and disintegrated nuclei and small cytoplasmic vacuoles with a few myocytes as shown in **(Photo 7)**. Closely, heart sections from treated obese-hyperlipidemic rats with 10% of the mixture leaves of both hawthorn and bay revealed contiguous and regular longitudinal heart muscle fibers, central oval nuclei and no widening gaps between myocytes, as well as a small number of clogged blood vessels. In addition, there was no mononuclear cellular invasion or spots of bleeding visible as shown in **(Photo 8)**.

With regard to the histology examination of aorta, the investigation showed that the normal control group have no histological changes in endothelial cells in the tunica intima (TI) **(Photo 9)**. Aorta sections of untreated obese rats (positive control group) revealed that endothelial desquamation (the discharge of endothelial cells from the basal membrane) and irregular elastin fibers structure that describe the injury. In addition to, multifocal deterioration, smooth muscle cell displacement, vacuolation in tunica medium cells, edematous of the tunica adventitia (TD), and enlarged in both the tunica media and adventitia as shown in **(Photo 10)**. In addition, there was no improvement in the aorta sections of the treated obese rats with the lowest level of the mixture leaves of hawthorn and bay (2.5%), as well as endothelial desquamation and vacuolation as shown in **(Photo 11)**. In the treated obese rats with 5% of the leaves mixture of hawthorn and bay, the endothelial cells lining the tunica intima were consistent and the majority of the smooth muscle cells in the tunica media orientated horizontally to the aortic canal. In their tunica media, well-formed elastic fibers were organized in a lamellar manner and the diameter tunica medium reduced **(Photo 12)**. As shown in **(Photo 13)**, the aorta sections of treated obese rats with 10% of the leaves mixture of hawthorn and bay revealed that, the intimae were thin

and lacking edema, the endothelial cells were mostly intact, and did not desquamate, and the smooth muscle cells allocated in an ordered arrangement, and the tunica medium and adventitia diameters were normal.

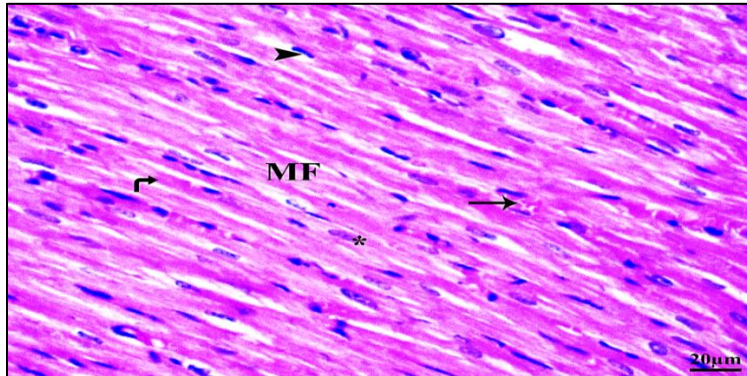


Photo 1: Heart section from the normal rats showing normal cardiac myocytes structure of branching and anastomosing longitudinal muscle fibers, acidophilic sarcoplasm, and central oval vesicular nuclei (H & E x200)

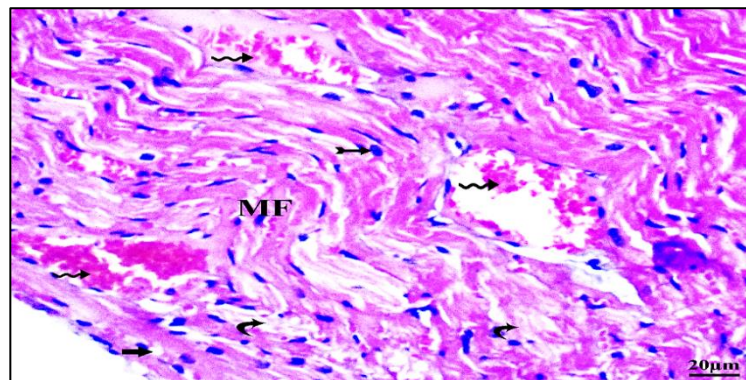


Photo 2: Heart section from untreated obese rats (positive control group) showing striation of cardiac muscle and misrepresented and vast distances between cardiomyocytes have increased noticeably (H & E x 200)

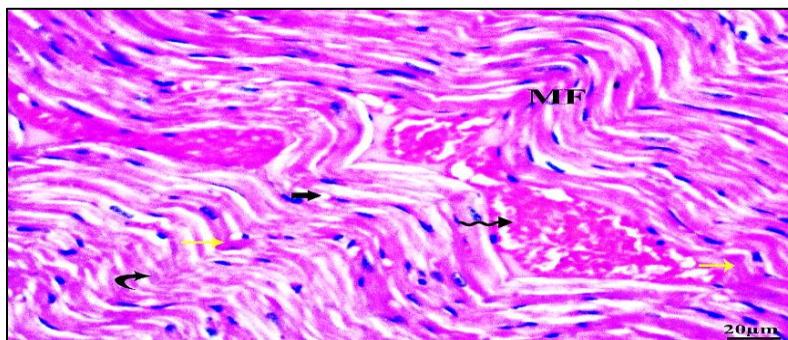


Photo 3: Heart section from untreated obese rats (positive control group) showing intra-fibrillary bleeding (hemorrhage), dilated and congested blood arteries, and inflammatory cellular infiltration (H & E x 200)

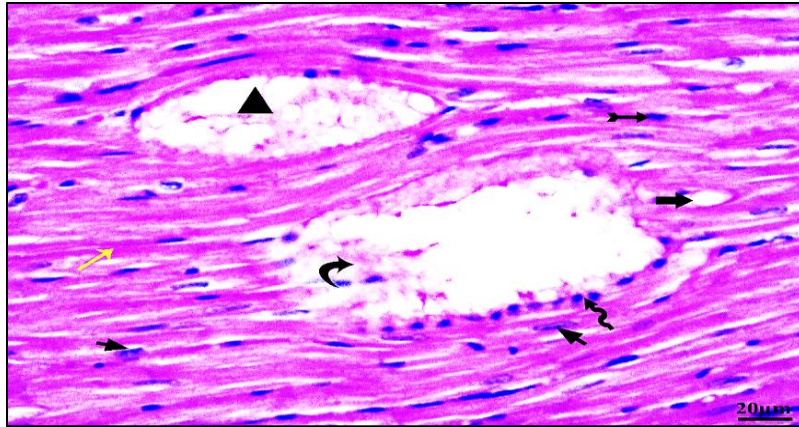


Photo 4: Heart sections from untreated obese rats (positive control group) showing focal areas of dysfunction and myocyte cytolysis and cytoplasm that is hyperacidophilic and Pyknotic nuclei (H & E x 200)

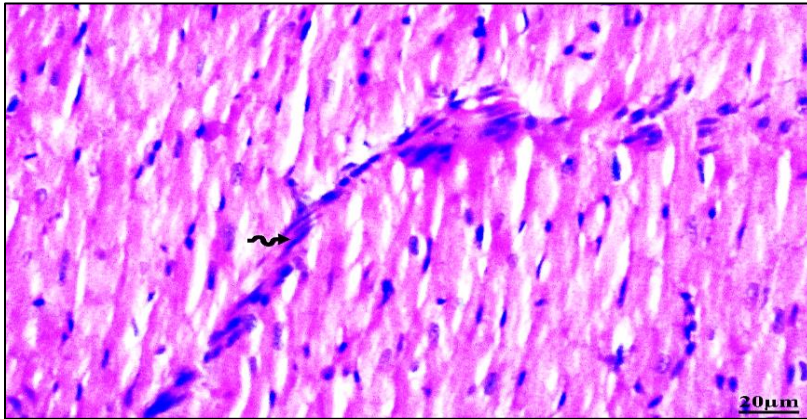


Photo 5: Heart section from treated obese rats with 2.5% of the mixture leaves of hawthorn and bay showing disorganized and mononuclear cells infiltrated several places (H & E x 200)

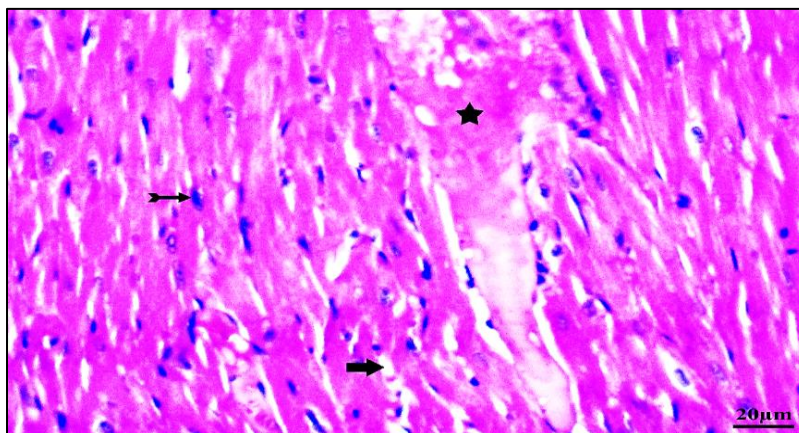


Photo 6: Heart section from treated obese rats with 2.5% the mixture leaves of hawthorn and bay showing dilated and congested blood vessels, as well as intrafibrillar bleeding (H & Ex 200)

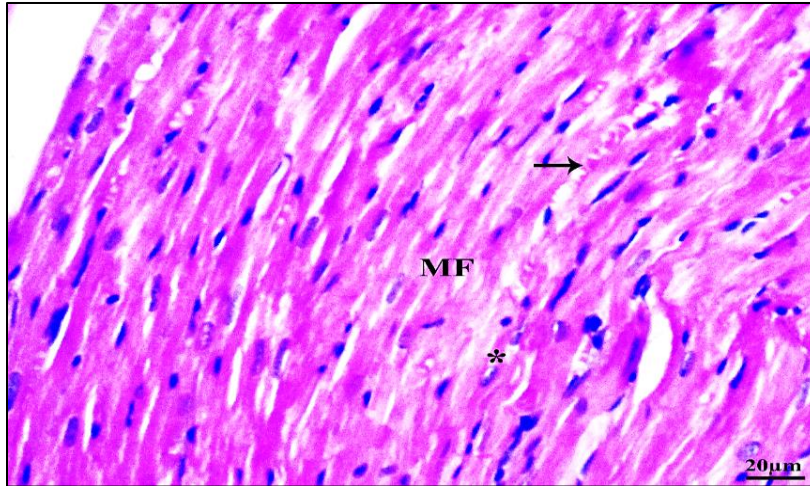


Photo 7: Heart section from treated obese rats with 5% the mixture leaves of hawthorn and bay showing intact structure with central oval vesicular nucleim and a disintegrated nuclei and small cytoplasmic vacuoles in a few myocytes (H & E x 200)

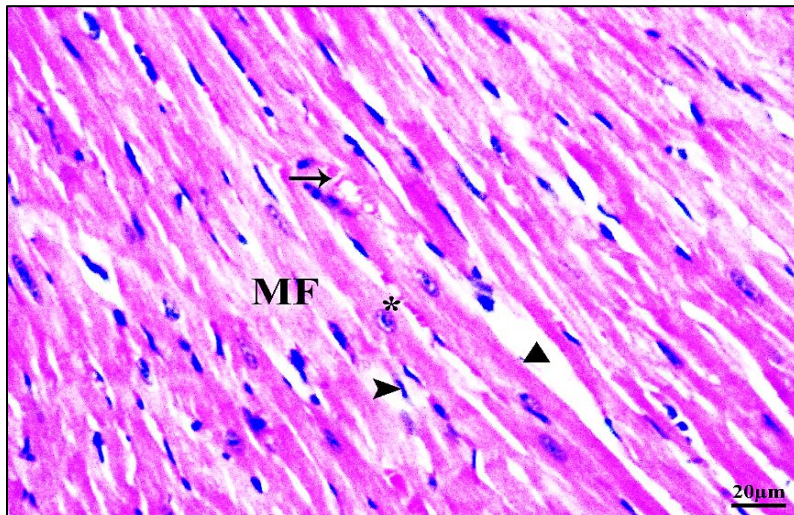


Photo 8: Heart section from treated obese rats with 10% the mixture leaves of hawthorn and bay showing contiguous and regular longitudinal heart muscle fibers, central oval nuclei and no widening gaps between myocytes, a small number of clogged blood vessels and no mononuclear cellular invasion or spots of bleeding visible (H & E x 200)

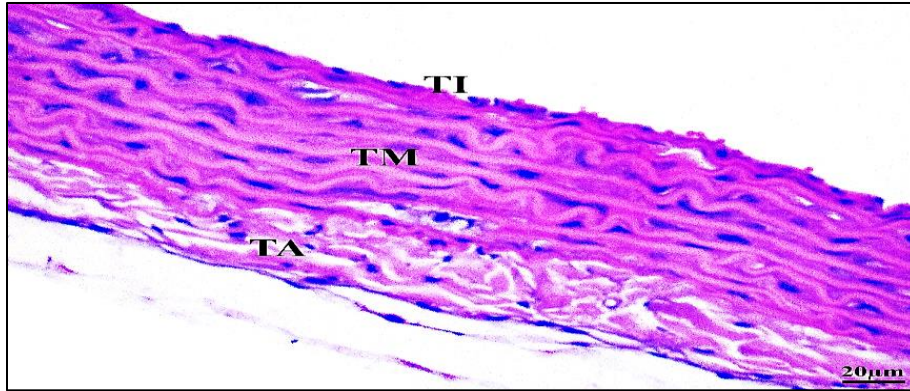


Photo 9: Aorta section from the normal rats showing normal histological structure (H & E x 200)

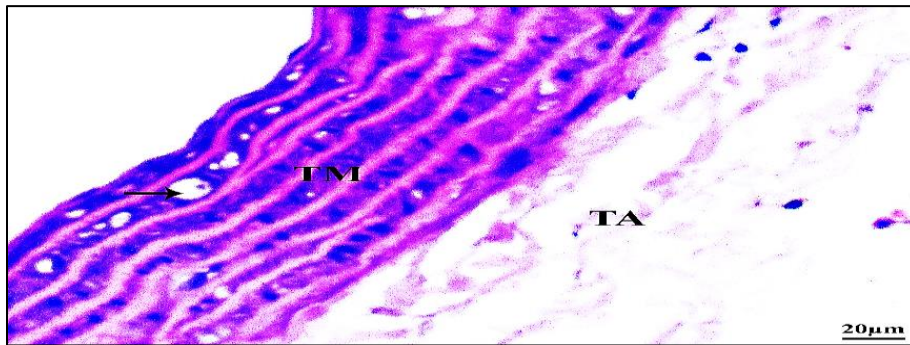


Photo 10: Aorta section of untreated obese rats (positive control group) showing discharge of endothelial cells from the basal membrane, irregular elastin fibers structure, multifocal deterioration, smooth muscle cell displacement, vacuolation in tunica medium cells, oedematous of the tunica adventitia and enlarged in both the tunica media and adventitia (H & E x 200).

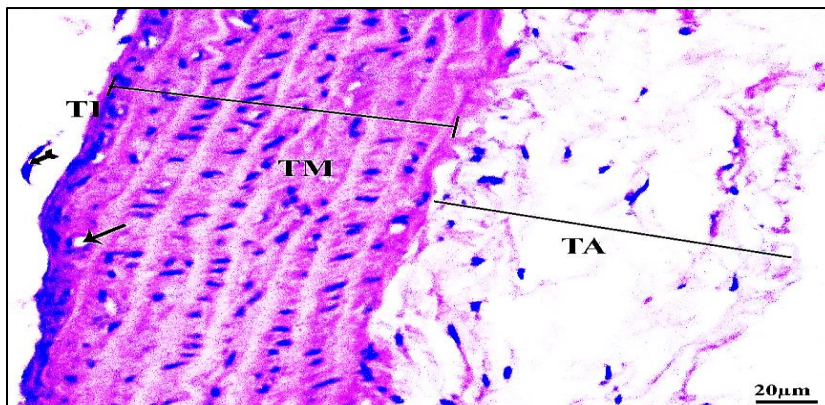


Photo 11: Aorta section from the treated obese rats with 2.5% of the mixture leaves of hawthorn and bay showing endothelial desquamation (bifid arrow) and vacuolation (arrow) in tunica medium and intima cells (H & E x 200).

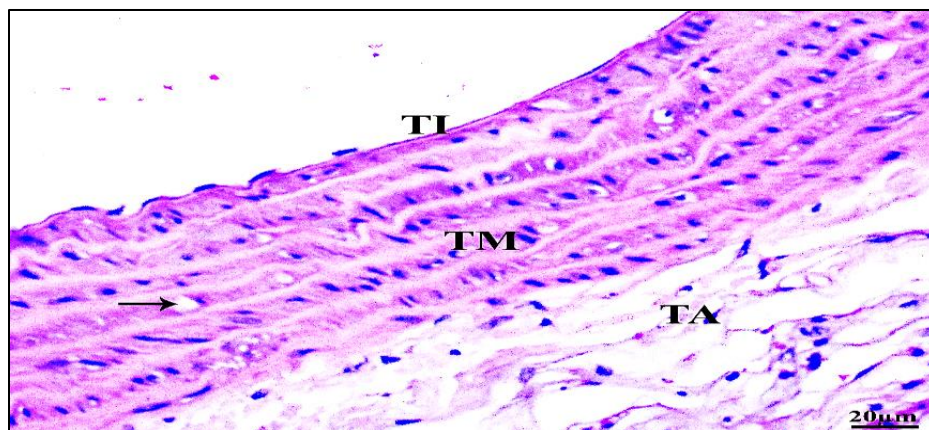


Photo 12: Aorta section from the treated obese rats with 5% of the mixture leaves of hawthorn and bay showing consistent in the endothelial cells lining the tunica intima, the majority of the smooth muscle cells in the tunica media orientated horizontally to the aortic canal formed elastic fibers in a lamellar manner (H & E x 200).

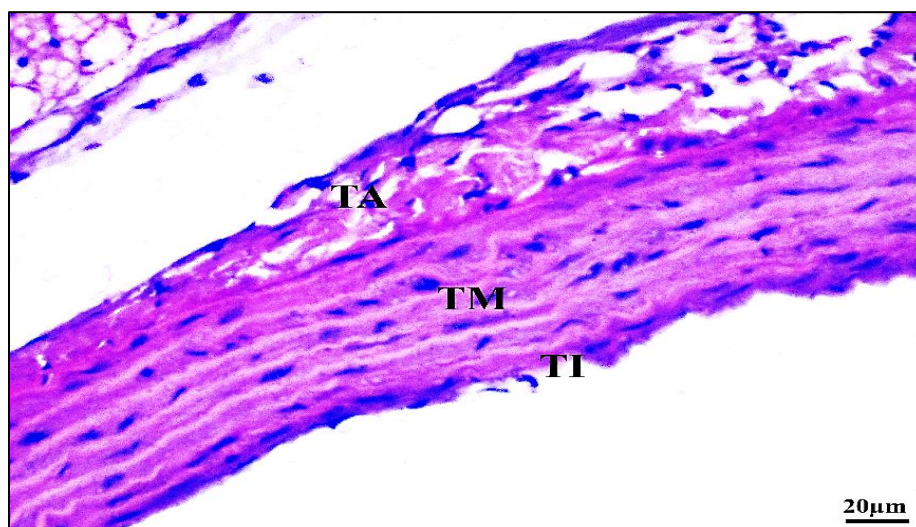


Photo 13: Aorta section from the treated obese rats with 10% of the mixture leaves of hawthorn and bay showing normal endothelial cells with smooth muscle cells. The tunica medium and adventitia diameters were normal (H & E x 200)

4. Discussion

The existing study was conducted to find out the effectiveness of the mixture of hawthorn and bay leaves in controlling body weight in obesity induced by high-fat and calories diet (HFCD) in obese rats. HFCD has been deemed the most folk pattern among researchers to induce obesity in rats. Therefore, the present study was used HFCD to caused obesity in normal male rats before starting the study.

The obtained data revealed that untreated obese rats fed on HFCD alone had significant increased ($P < 0.05$) in FBW, BWG and RWG and decreased ($P < 0.05$) in FI, compared to that of the normal rats fed on basal diet alone. This noticing provides that the increases in body weight is independent on the amount of food consumed by the rats. The present results were accordance with (Rezq, 2017) who recorded that rats fed on HFCD had a significant increase in body weight and there is no significant difference in the food intake, as compared to normal rats fed on the normal basal diet.

Additionally, **Ogungbemi et al., (2017)** reported that a high-fat diet caused significant increase in FBW and FER with significant decrease in FI, compared to the rats fed on normal diets. Also, **Abdulrahman et al., (2020)** showed significantly higher in FBW of rats fed on an HFD compared to that of fed rats on a normal basal diet. In addition, obesity is characterized by increased adipose tissue mass that results from both increased fat cell number and increases fat cell size (**Lafontan and Langin, 2009**). Adipogenesis is a part of adipocyte differentiation process from preadipocyte precursors into mature adipocytes with the formation and enlargement of intracellular lipid droplets (**Ali et al., 2013**). This process is associated with the development of obesity. Excess energy intake and reduced energy expenditure results in abnormal excessive growth of white adipose tissue (WAT), which can lead to the development of obesity in rats (**Jo et al., 2009**). These results were confirmed by the significant ($P < 0.05$) increase in visceral fat weight (VFW) and adiposity Index (AI), compared to that of the fed rats on normal basal diet (normal rats) in the current present study. Complementary high fat and calories diet with the different levels of the mixture leaves of both hawthorn and bay caused reduction in FI, and significantly reduction in FBW, BWG, REW, VFW and AI in treated obese rats, compared to that of untreated obese rats. These reductions were more pronounced with increasing levels of leaves mixture. This result was in accordance with the results reported from **Kuo et al., (2009)** who revealed that hawthorn has significant weight lowering effect and reducing size of white fat cells in treated hamsters. Also, **Al Shammari, (2020)** who reported that the hawthorn leaves powder at levels of 2.5 and 5% decreased significantly weight gain and feed intake in obese rats. **Salim et al., (2021)** showed that bay leaves were progressive improvement in body weight of rabbits and caused no significant effect on FI. The observed improvements in body weight as well as lower visceral fat and AI may be due to the effects of naturally-occurring polyphenols (flavonoids) and oligomeric proanthocyanidins in hawthorn (*Crateagusoxyacantha*) (**Mladěnka et al., 2010**). In addition to **Tao et al., (2011)** reported that hawthorn was shown to exert impressive metabolic and anti-obesity benefits by acting on a family of receptors called Peroxisome Proliferators-Activated Receptors (PPARs) by inhibitor effect for triglycerides and glucose absorption in vivo. Also, epidemiologic studies support that dietary fiber (plant leaves) intake strongly prevents obesity and is inversely associated with body fat and body mass index at all levels of fat intake (**Cruz-Bravo et al., 2001**). High-fiber foods have much less energy density compared with high-fat diet and can displace energy. Eating equal weight of high-fiber food increases satiety. The bulking and viscosity properties of dietary fiber are mainly responsible for the influencing satiety (**Slavin, 2005**).

Dyslipidemia is another important lineament in the manner of development of obesity which characterized by hyperlipidemia, hypertriglyceridemia with increased level of LDL-c and VLDL-c. Hypercholesterolemia is one of the risk factors for the emergence of atherosclerosis, which is an inflammatory disorder in artery walls characterized by the formation of atheroma (**Newby et al., 2014**). In the present study, HFCD exposure resulted in a significant increase in serum TL, TG, TC, LDL-c and VLDL-c levels and decreased serum HDL-c level. In addition, striation of cardiac muscle and vast distances between cardiomyocytes, intrafibrillary bleeding (hemorrhage), dilated and congested blood arteries, and inflammatory cellular infiltration. In addition, there were focal areas of dysfunction and myocyte cytolysis and some sections of cytoplasm that hyper acidophilic and Pyknotic nuclei. As well as, aorta sections of untreated obese rats (positive control group) revealed that endothelial desquamation and irregular elastin fibers structure that describe the injury. In addition to, multifocal deterioration, smooth muscle cell displacement, vacuolation in tunica media cells, edematous of the tunica adventitia, and enlarged in both the tunica media and adventitia. The present results were in accordance with **Rezq and El-Khamisy, (2011)** who showed that high-fat diet results in dyslipidaemic changes by increase serum TG, VLDL, TC and LDL-c and decrease serum HDL-c levels. Additionally, **Puskas et al., (2004)** demonstrated that intracellular lipid accumulation in Cardiomyocytes is in response to cholesterol diet. Excess cholesterol in the bloodstream can form plaque in artery walls. The cholesterol or plaque build-up causes the arteries to become thicker, harder and less flexible, slowing down and sometimes blocking blood flow to the heart and results in a heart attack. When there is too much LDL-c in the blood, it is deposited inside the blood vessels, where it can build up to hard deposits and cause atherosclerosis (**Puskas et al., 2004**). Combination of HFCD with the three different levels of both HL and BL induced significant attenuation in serum TL, TG, TC, LDL-c and VLDL-c levels and increased serum HDL-c levels in treated obese rats. The increase in serum level of HDL-c was found to be in a dose-dependent manner of the leaves mixture. The obtained results agreed with **Agustina et al., (2015)** and **Eman and Naglaa, (2017)** who found that both hawthorn and bay leaves possess antihyperlipidemic and cardioprotective potential. Also, **Aljamal (2010)** revealed that bay leaves are one of the plants that can be used to decrease the cholesterol level in animal blood.

Asadi et al., (2014) and Bahmani et al., (2014) reported that some medicinal plants such as bay leaves may lower hyperlipidemia, inhibiting atherosclerosis and vascular endothelium injury. **AL-Samarrai et al., (2017) and Palazzo et al., (2020)** indicated that oral bay leaves administration and its isolated flavonoids and glycosides reduced TC, LDL-c, VLDL-c and TG compared to control in obese female rabbits. So, **Sutrisna et al., (2018)** revealed that bay leaves contain secondary metabolites, such as saponin, terpenoid, flavonoid, polyphenol, alkaloid, and essential oil which have hypolipidemic effect. On the otherwise, **Hong et al., (2009)** who demonstrated that consumption of hawthorn reduces blood lipid and cholesterol levels. Additionally, hawthorn exhibited a substantial lipid lowering effectiveness in hyperlipidemic albino rats (**Kausar et al., 2011**). **Ali, (2020)** showed that feeding on a high-fat diet increase Tc, TG, LDL-c, and VLDL-c, but decreases HDL-c, while, HFD+ hawthorn leaves significant decreased lipid profile. **Zhang et al., (2001)** reported these compounds purified from hawthorn demonstrated varying effects on the oxidation of human low-density lipoprotein (LDL) and α -tocopherol activity. Besides, there may be some interactions among phenolic compounds, which can affect their bioactivities with antagonistic or synergistic effects. Also, **Wang et al., (2018)** revealed that the hawthorn leaf has been prescribed in herbal formulae to treat various diseases, such as hyperlipidemia, atherosclerosis and dyspepsia. Identified chemical constituents in the hawthorn leaf, including flavonoids, triterpenoids, steroids, lignans, organic acids and nitrogen-containing compounds, among which, flavonoids are the most abundant chemical components (**Wu et al., 2014**). Hawthorn leaf flavonoids have demonstrated a potential effect in lipid regulation, regulate serum TC and TG (**Wang et al., 2018**). In addition, **Liang et al., (2010)** reported that the hawthorn leaves flavone could intervention effectively reduce the content of TC and TG in serum and liver. Moreover, the content of lipoprotein lipase (LPL) in muscle tissue increased while the LPL in adipose tissue decreased, the accumulation of fat in adipose tissue was inhibited. In addition, some polyphenols can reduce the fat accumulation through the regulation of proteins that are related to adipocyte differentiation.

Insulin resistance in humans can be linked to lifestyle and can be notice more as a cause of lipid deposition in a caloric excess (**Unger and Scherer, 2010**). Insulin resistance is associated with a number of metabolic disorders such as obesity, hyperlipidemia, and hypertension. High-fat diet intakes were shown to contribute to syndromes such as hyperlipidemia, glucose intolerance, hypertension, and atherosclerosis (**Sumiyoshi et al., 2006**). Numerous evidences indicated that in experimental animals, high-fat diets resulted in disturbance in glucose metabolism and impaired glucose tolerance (**Vessby, 2000**). The present results showed a significant increase in serum insulin level in rats fed on HFCD, compared to that fed on normal basal diet. This result was agreed with **Kusunoki et al., (2000)** who showed hyperglycemia, dyslipidemia and hypeinsulinemia in rodents fed a high-fat diet. **Srinivasan et al., (2004)** revealed that the feeding on high-fat diet for a period of 30 days increased levels of serum insulin and insulin resistance. Some previous studies revealed that hypeinsulinemia and insulin resistance are common features of obesity in experimental animals (**Amin and Nagy, 2009**).

Adipocytes secrete a variety of peptide hormones called adipocytokines such as Leptin, adiponectin, visfatin, resistin, tumor necrosis factor- α and interleukin-6, which play a role in energy regulation (**Garg, 2006**). Leptin is a common protein produced by the adipose tissue and highly correlates with body fat, suggesting that obese persons are insensitive to endogenous leptin production. It is a key fat-derived regulator of food intake and energy expenditure and its secretion levels are usually positively correlated with the extent of the triglyceride stores in adipocytes (**Staiger and Haring, 2005**). In the present study, result showed that serum Leptin hormone level increased significantly in the HFCD control group compared with the normal control group. The present experimental diet consisted of more fat and this might have accounted for the elevated levels of Leptin, consistent with literature reports (**Handjieva-Darlenska and Boyadjieva, 2009**). **Saravanan et al., (2014)** showed that rats fed on high fat-diet had high serum leptin hormone level when compared with those fed on normal basal diet.

In contrast, supplemented HFCD with the three different levels of the mixture leaves of both hawthorn and bay significantly ($P < 0.05$) decreased serum levels of insulin and leptin hormone, compared to that induced by the HFCD only in obese rats. The present study confirms the findings of **Majeed, (2020)**, who founded that there is a reduction in fasting blood glucose levels, an increase in fasting insulin levels. The extract of bay leaf is distinguished by the presence of antioxidants that help to lower glucose levels. The hormone leptin critically regulates body weight and metabolism at central level in the brain (**Elena et al., 2017**), and disruption of Leptin/Leptin receptor (LEPR) signaling results in morbid obesity and severe metabolic disease (**Zhang and Chua, 2018 & Zhou and Rui, 2013**). One of the peripheral

functions of Leptin is a regulatory role in the interplay between energy metabolism and the immune system, which is, in part, responsible for the inflammatory state associated to obesity (Pérez et al., 2017). Accumulating evidence also suggests that flavonoids have therapeutic effects on obesity by controlling adipogenesis, adipokine secretion, food intake, and energy expenditure. Bay leaf contains many types of flavonoids (Abu-Dahab et al., 2014). Flavonoids might down regulate the synergistic interaction between insulin and leptin signaling in the inflammatory processes (Araújo et al., 2015). Particularly, considering the anorectic activity of Leptin, propolis has potential to attenuate feeding and subsequently prevent obesity (Washio et al., 2015). Bay leaves resulted in a significant drop in glucose and HbA1C levels (Shnewer Mahdi Al-Turfi et al., 2022).

Since the high effectiveness of liver enzymes (ALT, AST) in the blood is the best indicator of liver damage, their high levels in the blood can be used to predict inflammatory changes in the liver (Singh and Sharma, 2011). Hepatic enzymes AST and ALT are the most specific intracellular enzymes that are associated with cell leakage and serve as a marker of hepatocellular injury with greater grades of hepatic steatosis and fibrosis in several studies. The elevation in the hepatic enzymes may be attributed to an increase in the production of free radicals that initiate lipid peroxidation of membrane leading to loss of integrity of cell membranes and damage of hepatic cells. The metabolic processes resulting from a high-fat diet (HFD) can cause oxidative stress in mitochondria and the endoplasmic reticulum, as well as induce de novo lipogenesis and inflammation in liver cells (Yang et al., 2019). The present study showed significant elevation in serum activities of AST, ALT and ALP enzymes in untreated obese rats. The obtained results were in agreement with Al Shammari, (2020) who founded that HFD caused significant increase in serum ALT, AST and ALP enzymes as compared to negative control group. Recently, Huang et al., (2022) reported the high fat diet significantly elevated the levels of TG, TC, LDL-c, AST, ALT and lowered HDL-c in male mice (Huang et al., 2022).

In contrast, treated obese rats with the mixture leaves of both hawthorn and bay at the three different levels have significant decreases in the serum activities of AST, ALT and ALP enzymes as compared to that of untreated obese rats. The obtained result was in agreement with the previous by Casamassima et al., (2017) founded a decrease in the activities of ALT and AST in New Zealand white-growing rabbits as a result of feeding on dried leaves of bay leaves-contained meals. Also, the present results were in line with Al Chalabi et al., (2020) who reported that the bay leaf extract resulted in decreased in serum ALT, and AST. Al-Chalabi et al., (2020) mentioned that reduction of the ALT, AST, and ALP activities in the diabetic group given bay leaves alcoholic extract compared to the normal control group, and this was attributed to the antioxidant compounds in the extract. In addition, Al Chalabi et al., (2020), indicated that there was a reduction in fasting blood glucose levels, an increase in fasting insulin levels, as well as a significant decrease in ALT, AST, alkaline phosphatase, blood urea, and serum creatinine levels after treatment with 200 mg kg B.W alcoholic extract of bay leaves for 30 days. Hawthorn leaves supplementation significantly lowered body weight, liver weight, liver/body weight ratio, improved serum parameters and liver dysfunction and markedly decreased hepatic lipid accumulation in HFD-fed rats (Li et al., 2015). Housein et al., (2017) recorded elevated in fasting serum triglyceride and cholesterol levels in hypertriglyceridemia diet, while consumption of hawthorn markedly and significantly suppressed these elevations in triglyceride and cholesterol well as the liver enzymes such as ALP, SGOT and SGPT. Additionally Al Shammari, (2020) reported that hawthorn leaves extract decreased significantly the serum activities of AST, ALT and ALP enzymes, compared to that of rats fed on HFD. This is more likely attributed to the existence and joint activity of the phytochemicals of flavonoid and nonflavonoid origins, such as terpenes and terpenoids, which have antioxidant properties (Yahyaa et al., 2015). In addition, bay laurel (*Laurus nobilis* L.) leaf powder had a high content of minerals that can motivate many enzymatic systems in the liver and consolidate metabolism (Weber et al., 2012). The hawthorn leaf has been reported to contain flavonoids, flavone-C-glycosides, catechins, amines, triterpene saponins, and oligomeric procyanidins, among which, flavonoids are the main bioactive compounds (Liu and Yu, 2006). that can prevent lipid metabolic dysfunction, and ameliorating hepatic steatosis in rats fed HFD.

The present study provides a perfect correlation between serum lipid peroxidation products as indicator by MDA and the activity of antioxidant enzymes, which play an important role in the antioxidant system. It showed that fed rats on HFCD induced significant increase of serum MDA level, and decrease serum GSH level and activities of GPx and SOD enzymes, compared to that fed on normal basal diet. The decrease in serum activity of antioxidant enzymes, as seen in serum of obese rats, can lead to the excessive availability of superoxide and peroxy radicals, which in turn generate hydroxyl radicals, resulting in the initiation and propagation of more lipid peroxidation products. High-fat diets result in

the release of free fatty acids by the action of lipoprotein lipase with increase serum triglycerides and cause lipotoxicity, which results in insulin receptor dysfunction. The release of excessive free fatty acids provokes lipotoxicity, as lipids and their metabolites create oxidative stress (Zhang et al., 2007). The present result was agreed with Amirkhizi et al., (2007) who showed that increase the production of reactive oxygen species as well as reduced antioxidant defense mechanisms have been suggested to play a role in both humans and animal models of obesity. Further, lipid alterations have been considered as contributory factors to oxidative stress in obesity (Leopold and Loscalzo, 2008). Hypertriglyceridemia results in obese rats participate in the alteration of oxidant-antioxidant balance, suggesting increase the bioavailability of free fatty acids and lipid peroxidation Amirkhizi et al., (2007). Hyperlipidemia induces oxidative stress and increase lipid peroxidation (Moussa, 2008). Recently, Denisenko and Novgorodtseva (2013) showed that fed animals on high fat diet inhibits activity of blood antioxidant enzymes and elevate lipid peroxidation (MDA). The prooxidative effects have been documented as it decreases the activity of antioxidant enzymes such as SOD, CAT, and GPX and increased the concentration of malondialdehyde (MDA), which is the main marker of lipids peroxidation (Capatina et al., 2020). MDA is the product of oxidative degradation, and it reflects the level of lipid peroxidation. CAT; GSH and GPx act as free radical scavengers to decompose H₂O₂ (Qin et al., 2019).

The present study provides a perfect correlation between serum lipid peroxidation products as indicator by MDA and activities of some antioxidant enzymes which play an important role in the antioxidant system. It showed that fed rats on HFCD have a significant increase in serum level of MDA and decrease in serum activities of GSH and GPx and SOD enzymes, compared to that fed rats on normal basal diet. High-fat diets result in the release of free fatty acids by the action of lipoprotein lipase with increase serum triglycerides and cause lipotoxicity, which results in insulin receptor dysfunction. The release of excessive free fatty acids provokes lipotoxicity, as lipids and their metabolites create oxidative stress (Zhang et al., 2007). The present result was agreed with Amirkhizi et al. (2007) who showed increased in the production of reactive oxygen species with reduced in antioxidant defense mechanisms in obese animal models. Further, lipid alterations have been considered as contributory factors to oxidative stress in obesity (Leopold and Loscalzo, 2008). Additionally, Denisenko and Novgorodtseva, (2013) showed that fed animals on high fat diet inhibits activity of blood antioxidant enzymes and elevate lipid peroxidation (MDA). Also Rezaq, (2017) reported that fed rats for 4 weeks on high-fat diet decreased significantly serum activities of GSH, GPx, SOD and CAT enzymes, and increased serum MDA level, compared to that fed on basal diet.

In contrast, the present study documented that the mixture leaves of both hawthorn and bay have significant effect in decreasing level of MDA and increasing activities of antioxidant enzymes GSH, GPx and SOD in obese rats fed on HFCD, compared to that of untreated obese rats. Therefore, the obtained results demonstrated the ability of eliminating free radicals and increases the activity of antioxidant enzymes and is protective against oxidative stress. The current results were confirmed and agreed with the different previous studies that demonstrated the antioxidant effects of bay and hawthorn leaves. Ham et al., (2010) reported that spirafolide from the bay leaf (*L. nobilis*) prevented dopamine-induced apoptosis by decreasing reactive oxygen species production in human neuroblastoma SH-SY5Y cells. Additionally, Turkez et al., (2013) demonstrated that laurus leaves extract has a preventive role against oxidative damages aluminum phosphide-induced DNA in vitro study. Recently, Hanaa et al., (2020) indicated that the antioxidant activity of laurus leaves extract has a defensive role against the oxidative damage caused by lead in a rat's brain. As demonstrated by a substantial increase in the activities of SOD, CAT and GSH, with a decrease in protein carbonyl and MDA levels. Additionally, Qin et al., (2019) revealed that hawthorn leaves flavonoids increase significantly antioxidant enzyme activity and reduce MDA level in selenite-induced cataract. These data are in same direction with those obtained by Nsimba et al., (2008) who revealed that natural anti-oxidants have an important action in scale down free radicals and oxidative reactions in tissue and membrane levels. Recently, Al Shammari (2020) showed that hawthorn leaves powder and extract significantly increased GST, catalase, SOD and decrease NO compared to positive rats fed HFD. Thus both of hawthorn (*Crataegus Pinnatifida*) and bay (*Laurus Nobilis*) leaves have the ability to normalize the elevated lipid peroxidation and improved susceptibility to oxidative stress associated with depletion of antioxidants in obese rats. The antioxidant properties of both plants might be attributed to its content of phenolic and flavonoid compounds. Preliminary phytochemical studies of hawthorn identified of more than 150 bioactive molecules, including phenolic acids (ferulic, gallic, p-coumaric, syringic, chlorogenic, caffeic), quercetin, pyrocatechin, phlorodizin, terpenoids, lignans, steroids, organic acids (fumaric, tartaric, succinic, citric, malic), and sugars (maltose, sucrose, glucose, fructose) (Orhan, 2018).

Phytochemical composition of bay leaves shows many types of flavonoids and glycosides, such as kaempferol, quercetin, apigenin, luteolin, quercetin 3-O- α -L-rhamnopyranoside, kaempferol-3-O- β -glucopyranoside, quercetin-3'-O- β -glucopyranoside, quercetin-3-O- β -galactoside, isorhamnetin-3-O- β -glucopyranoside, isorhamnetin-3-O- β -galactopyranoside, quercetin-3-O-rutinoside, kaempferol-3-O-rutinoside, isorhamnetin-3-O-rutinoside and isorhamnetin (**Abu-Dahab et al.,2014**). Flavonoids are natural antioxidant polyphenol compounds can reduce cholesterol and triglyceride levels in the blood, protect from arterial damage, and reduce the amount of cholesterol deposited on the surface of the arterial endothelium. Research in rat showed that flavonoids can reduce lipid peroxidation (**Ratty, and Das,1998**). Also, it is known that flavonoids and proanthocyanidins can decrease the inflammatory processes by increasing the activity of enzymes that control the oxidation of the cell membrane (**Rauf et al., 2019**).

Conclusion:

the mixture of dried hawthorn and bay leaves shows powerful potential as natural lowering worker of weight and blood lipids levels and ameliorate of liver functions and antioxidant defense system. There is need of further study to find out how both herbs works and use of them as anti-obesity agent.

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