Egypt. J. of Nutrition and Health Vol.18 No.1 January (2023)

Effect of lemongrass powder on hyperlipidemia compared to Orlistat using experimental animals

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Abstract

This study was designed to investigate the effect of lemongrass powder and Orlistat on hyperlipidemia in rats fed on a high fat diet. Twenty four normal male albino rats of Sprague Dawley Strain weighing (150±10g), were used in this study and split into 4 equal groups; each group contained 6 rats.One group was conserved as a control negative group (G1), while (G2) were fed on high fat diet, (G3)were fed on high fat diet plus7.5 % lemongrass powder and (G4) fed on high fat diet plus Orlistat (60 mg /Kg body weight). At the end of the experiment, glucose levels, total protein (Albumin and globulin), serum liver functions, and serum lipids were assessed. The results indicated that tests plants improved glucose levels, liver functions, and lipid profile. According to these results, moderate amounts of lemongrass in our diets could be tried for improvement of hyperlipidemic humans.

Keywords:Hyperlipidemia levels, lipid profile, lemongrass, andOrlistat.

Introduction

Hyperlipidemia, implying to a metabolic disorder, is a prevalent disease in modern society along with a harmful diet and less physical activity has been included as the direct risk factor leading to cardiovascular diseases (CVD). Its identification is often based on the abnormal distortion of one or several plasma lipids, composed of increased triglycerides (TG), total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-c) and depressedhigh-density lipoprotein cholesterol (HDL-c) ***Nie and Luo, (2021)***.Hyperlipidemia and obesity are common and cause more health problems throughout the world. Hyperlipidemia is a status that incorporates different genetic and gained disorders that depict elevated lipid levels within the human body. Hyperlipidemia is highly popular, all over the world chiefly in the Western hemisphere ***Doostiet al., (2022).***

Lipids typically comprise cholesterol levels, lipoproteins, chylomicrons, very low-density lipoprotein cholesterol (VLDL-c), LDL-c, and HDL-c ***Hill and Bordoni, (2022)***.Hyperlipidemia is considered if low-density lipoprotein (LDL), total cholesterol, triglyceride levels, or lipoprotein levels are greater than the 90^{th} percentile in comparison to the prevalent population, or an HDL level is less than the 10^{th} percentile when compared to the common population. Hyperlipidemia subdivides into two broad classifications: primary (familial) or secondary (acquired) hyperlipidemia. Primary hyperlipidemia derives from an increase of genetic disorders that a patient may inherit through birth, while secondary hyperlipidemia usually originates from an alternate essential etiology, such as harmful diet, medications

(amiodarone, glucocorticoids), hypothyroidism, un inhibited diabetes, and/or a poor lifestyle routine***(Singh, 2022).***

Hyperlipidemia, in special elevated LDL (hypercholesterolemia), is one of the most predominant risk factors contributing to the evolution of atherosclerosis and consequential vascular disease. It is simply defined as raised concentrations of lipids or fats inside the blood ***(AL-Ezzy and Hameed, 2021)***.The central cause of hyperlipidemia contains changes in lifestyle behaviors in which risk factor is mainly poor diet i.e. with a fat intake larger than 40% of total calories, saturated fat intake larger than 10% of total calories; and cholesterol intake greater than 300 mg/day ***(Li et al.,2021)***. The atypical cholesterol levels are the result of harmful lifestyle including taking high-fat diet and other existence factors like being overweight, smoking, heavy alcohol use and lack of exercise. Other factors include diabetes, kidney disease, pregnancy, and an underactive thyroid gland ***(Gill and Hegele, 2022)***.

Other diseases that may elevate cholesterol levels include polycystic ovarian syndrome and kidney disease. The higher levels of female hormones like estrogen, have been famous to increase or change cholesterol levels. In totaling, drugs like diuretics, beta-blockers and medicines used to delight depression have also been reported to rear cholesterol levels ***(Saraogi et al., 2022)***. Another adapting factor in the improvement and progress of hyperlipidemia are age and gender. It has been shown that cholesterol levels growth as the person gets older. Heredity has also been a changing factor for the progression of hyperlipidemia as it has been eminent that the genes partly determine the amount of cholesterol body marks***(Ashorobi and Liao, 2021).***

Orlistat is a tetrahydrolipstatin, which constrains both pancreatic and gastric lipase enzymes in the gut and avoids the absorption of dietary fats in the intestine. Therefore, it is generally used as an anti-obesity medication to control and manage body weight in obese patients wide-reaching ***(Rajan et al., 2021)***.Orlistat items selectively near gastrointestinal lipase by avoiding the hydrolysis of consumed dietary fat into absorbable free fatty acids and glycerol ***(Othman et al., 2021)***. For this goal, Orlistat has demonstrated its efficiency in decreasing obesity factors such as BMI, lipid profile, white adipocyte size, and increase fecal fat excretion in animal replicas, as well as the complications of obesity such as metabolic syndrome and endothelial dysfunction in human. Considering its easy obtainability, and significant effect on reducing weight ***(Abdel-Baky and Abdel-Rahman, 2021).***

Orlistat for subjects via preventing of gastric and pancreatic lipase, an enzyme that is vital for the digestion of the long chain triglycerides, which at a three daily dose of 120 ml reduces fat absorption by 30% and has been verified to be useful in easing both weight loss and weight conservation ***Katimbwaet al., (2022)***.Nevertheless, it is not known if Orlistat has any impact on the clinical results of other diseases and it is long term safety is quiet to be determined ***Jin et al., (2021)***.Orlistat covalently drags to the serine remains of active sites of lipases and inactivates them. The inactivation of lipases avoids the hydrolysis of triglycerides, and thus free fatty acids are not absorbed. The major action of Orlistat is local lipase hang-up within the gut. Systemic absorption is not compulsory for the activity of Orlistat, it inhibits dietary fat absorption by approximately 30% ***(Braeckmans et al.,2022).***

Lemongrass, generally known as citronella grass is a member of the *Poaceae* family and belongs to the genus *cymbopogon*. The genus *cymbopogon* constitutes of around 140 species that show widespread growth across the semi-temperate and steamy regions of Asian, American and

African continents. Australia and Europe are home to only a few types of lemongrass ***(Németh et al., 2021)***. Lemongrass is known by numerous other colloquial names throughout the world. The members of the *cymbopogon* genus produce volatile oils and therefore are also known as aromatic grasses. A strong lemon fragrance, a predominant feature of this grass, is owed to the high citral content of its oil***(da Silva et al., 2021)***. The suggestion of the oil enables its use in soaps, detergents, etc. As a good source of citral, it finds an application in the perfumery as well as food productions. It is also the starting material for the manufacture of ionone's, which produce vitamin-A ***(Shendurseet al., 2021).***

Lemongrass contains several bioactive compounds that teach medicinal value to it. Considerable evidence is available for its ethnopharma-cological applications***(Gomes et al., 2021)***.Lemongrass keeps antioxidants that render protective measures against responsive species. Citral was shown to modulate oxidative stress differently in cancer cells and to induce the endoplasmic reticulum stress using thus an antiproliferative action***(Mukarramet al., 2021).***

Law and Lo, (2021*)** showed that lemongrass has hypoglycemic possessions and did not exert oxidative destruction to the heart and the various hormonal profiles as well as its relative safety and possible use for weight gain. ***(Silva and Bárbara, 2022*)** showed that lemongrass (*Cymbopogon citratus*) elicited reduction on vascular smooth muscle. The ease of vascular smooth muscle through prostacyclin (PGI2) since inhibition of its synthesis by indomethacin resulted in a contraction of hypertensive rat models develop low blood pressure ***(Law and Lo, 2021). The properties of *Cymbopogon citratus*, being antioxidant and anti-inflammatory**,** prevent the damage of blood vessels as it increased the level of nitric oxide to support its vasodilation ***(Qiu et al., 2022).***

The aim of this study was for investigating the effect of lemongrass (*Cymbopogon citratus*) powder on hyperlipidemia compared to Orlistat using experimental animals.

Materials and Methods

Materials:

Plant samples: lemongrass (*Cymbopogon citratus*) powder was purchased from local market,Tanta city,Egypt.

Orlistat:purchased from sigma pharmaceutical industries, Egypt (SAE), as capsule contains 60 mg.

Diet: the basic diet was as indicated by **(*Reeves et al., 1993*)**as follows: corn oil (10%), protein (10%), vitamin mixture (1%), mineral mixture (4%), cellulose (5%), methionine (0.3%), choline chloride (0.2%), and corn starch (69.5%). The utilized vitamins and salt mixtures components were formulated according to ***(Campbell, 1963)*** and **(*Hegsted et al., 1941)***, respectively.

High fat diet: was organized from fine ingredients per 100g according to***(Li et al., 2019).*** The diet had the following composition: Fat 15% (beef tallow), sucrose 15%, milk powder 5%, egg powder 5% ,3% corn oil, 2% NaCl and Standard diet 55%.

Animals:twenty four normal male albino rats 5 weeks old of *Sprague Dawley* Strain weighing (150±10g) were obtained from serum and Vaccine Center, Cairo, Egypt.

Methods:

Experimental design: rats were housed discretely in stainless steel containers at around 55% of relative humidity and a temperature of 25±2ºC with unrestricted access to both water and food. After the adaptation dated***(AIN, 1993)***, rats were separated into 4 groups, 6 rats each; groups receiving certain diet for 28 days as follows:

G1 (-Ve) group: was fed on basal diet as a negative control group.

G2 (+Ve) group: was fed on high fat diet as a positive control group.

G3:was fed on high fat diet + 7.5 % lemongrass powder.

G4:was fed on high fat diet + Orlistat (60 mg/ Kg of body weight).

The dose of Orlistat (60 mg/kg/day) was applied according to ***(Fan et al., 2021)***. The dose of lemongrass (7.5% of diet) was applied according to ***(Majewskaetal., 2019)***.

Biological evaluation:

Body weight gain%, feed intake, feed efficiency ratio (FER), and relative organs weight were calculated at the end of the experiment according to ***Chapman et al., (1959).***

Chemical analysis:

After sacrifice of rats, blood samples were composed from hepatic portal vein of each rat in dried clean centrifuge tubes. Serum was carefully separated by centrifugation of blood samples at 3500 round per minute (rpm) for 15 minutes at room temperature, transferred into dry clean eppendorf tubes, then kept frozen at - 20˚C for later determinations.

Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were determined according to ***Tietz and Berger, (1976) and Henary, (1974)***respectively, serum *alkaline phosphatase* (ALP) was determined according to the colorimetric method of ***Belfield and Goldberg, (1971),***and albumin (Alb) according to ***Drupt, (1974).***

Total protein (TP)was determined according to ***Sonnenwirth and Jarett, (1980)***. Globulin (Glb) was calculated according to ***Busher, (1990)*** using the following equation:

Globulin=total protein – albumin

Total bilirubin was determined in the serum according to ***Doumas et al., (1973)***.Serum total cholesterol (TC) was determined in the serum according to the method described by ***Thomas, (1992).*** Triglycerides (TG) were determined in the serum according to the method described by ***Fossati and Prencipe, (1982).*** HDL-c was determined in the serum according to the method described by ***Gordon et al., (1977).*** Serum LDL-c and VLDL-c were calculated according to ***Lee and Niemann (1996)***.Blood glucose (BG)was determined using glucose enzymatic kit according to ***Siestet al., (1981)***. Atherogenic index (AI) was calculated according to the formula of ***KiKuchietal., (1998)***.

Organ sampling:

Liver was removed from rats by careful dissection, washed in saline solution (0.9%), then drying using filter paper and independently weighed. A specimen from liver was kept at (-20 °C).The relative organs

weight was calculated as following:

Relative organs weight (ROW)% =Organ weight (g)/ Total body weight (g) × 100

Histopathological examination:

The liver of the scarified rats was reserved and immersed in 10% buffered neutral formalin solution. The fixed specimens were then trimmed, washed and dehydrated in ascending grades of alcohol. Then remove alcohol by xylol, embedded in paraffin, sectioned at 4-6 microns thickness and stained with hematoxylin and eosin as described by ***Bancroft and Gamble, (2008).***

Statistical analysis:

Data were analyzed using one-way classification, analysis of change (ANOVA). The differences between means were tested for significance using Duncan and least significant difference (LSD) tests at p<0.05. The results were expressed as Mean±SE ***(Monizet al.,1998).***

Results and Discussion

Impact of lemongrass(*Cymbopogon citratus*)powderand Orlistat on serum glucose in rats:

It was obvious that high fat diet induced a substantial rise (P≤0.05) in the concentrations of serum glucose in comparison to the normal control group. Hence serum glucose for control (+Ve) was higher than control G1 (-Ve) and all the other groups. The table showed that serum glucose in all groups had lower values compared to control G2 (+Ve), with the fact that G3 was highly significant different (P<0.001) compared to control G2 (+Ve), and G4 was significantly different (P<0.01) compared to control G2 (+Ve); this means that G3 gave the better result,these results are in agreement with ***Ademuyiwa et al., (2015)*** who stated that administration of lemongrass powder for 30 days produced a steady decrease in blood glucose levels of diabetics' rats. According to ***Garba et al., (2020)*** they reported that Cymbopogon citratus plants has hypoglycemic property in customary and hyperglycemic mice. ***Zhao et al., (2016)*** reported that hypoglycemic activity of lemongrass is due to interaction of numerous bioactive chemical compounds (Secondary metabolites) or several compounds in isolation. ***Ewenighiet al., (2013)*** reported significant reduction in glucose levels of alloxan-tempted diabetic rats treated with lemongrass powder after weeks of treatment. It is thought that this reduction in glucose level may be due to the effect of essential active elements, a substance similar to insulin, which confers hypoglycemic ability on the lemongrass; and demonstrated that lemongrass reinstated glucose levels to normal in four weeks of treatment in rats.

Table (1)

Impact of lemongrass (*Cymbopogon citratus*) powderand Orlistat on serum glucose in rats

Groups	Serum glucose (mg/dl)
	Mean ± SE
G1 (-Ve)	88.00 ± 5.5^{d}
G2 (+Ve)	327.63 ± 27.1^{a}
G3	125.30 ± 3.1^{c}
G4	219.81 ± 3.9^{b}

a=*p < 0 .05; **b=****p < 0.01and **c=***** P < 0.001*

Impact of lemongrass (*Cymbopogon citratus*) powder and Orlistat on atherogenic index in rats:

Group 3 and group 4 are the ones where rats were given high fat diet plus 7.5% lemongrass powder and high fat diet plus60 mg/Kg of body weight of Orlistat respectively. All groups

hadatherogenic index lower than the control G2 (+Ve), but G3 displayed highest significant difference (P<0.001) compared to the control G2 (+Ve), while G4 showed significant differences (P<0.01) compared to the control G2 (+Ve).

Table (2)

Impact of lemongrass (*Cymbopogon citratus*) powder and Orlistat on atherogenic index in rats

Groups	Atherogenic index (TG/ HDL-c)
	Mean ± SE
G1 (-Ve)	1.09 ± 0.06[d]
G2 (+Ve)	5.53 ± 0.14[a]
G3	2.10 ± 0.05[c]
G4	2.50 ± 0.06[b]

a=*p < 0 .05; **b=****p < 0.01and **c=**** P < 0.001*

Impact of lemongrass (*Cymbopogon citratus*) powder and Orlistat on FI,FERand BWG%in rats:

Results in table (3) indicated that total feed intake in the normal rats G1 was 483.46±22.7, while in the positive group G2 was 334.13±8.3. It's clear that total feed intake for the control G1 (-Ve) was higher than the control G2 (+Ve). Other groups G3 and G4 were 336.00±9.00 and 286.53±6.5, respectively; were lower than the control G2 (+Ve). G4 showed a high significant difference (P<0.001) compared to the control G2 (+Ve). The results revealed that the mean value of feed efficiency ratio (FER), and body weight gain% in the rats in the group G2 (+Ve) was significantly higher compared to the G1 (-Ve) group. At the same time, all treated groups recorded a significant decrease compared with the control group G2 (+Ve). ***Shaimaa et al., (2016)*** reported that the protecting groups rats fed on lemongrass levels at (10, 20 and 30%) diets showed significant higher FI and BWG%, while in this study we used 7.5 lemongrass powder only. This supported by ***Alagawanyet al., (2021)*** who indicated that the significant increase in the rate of live body weight and the total weight increase by cure of lemongrass powder compared to the(control) treatment due to the role of the active substances such as flavonoids, linalool and phenols as stimulants of the digestive system and educating digestion. This result in agreement with ***Ewenighi et al., (2013)*** who rated that, four weeks of management with the lemongrass powder elicits significant reductions in body weight.

Table (3)

Impactof lemongrass (Cymbopogon citratus) powder and Orlistat on FI, FER and BWG% in rats

Groups	FI (g)	FER	BWG%
	Mean ± SE	Mean ± SE	Mean ± SE
G1 (-Ve)	483.46±22.7[a]	0.15±0.01[b]	0.35± 0.01[b]
G2 (+Ve)	334.13±8.3[b]	0.24±0.01[a]	0.41±0.02[a]
G3	336.00±9.00[b]	0.09±0.02[c]	0.14±0.02[c]
G4	286.53±6.5[c]	0.10±0.003[c]	0.12±0.01[c]

a=*p < 0 .05; **b=****p < 0.01and **c=**** P < 0.001*

Impact of lemongrass (*Cymbopogon citratus*) powder and Orlistat on lipids profile in rats:

Table (4) showed that the positive control group recorded a significant increase in the mean value of total cholesterol (TC) and triglycerides (TG) compared with the negative control group, while

the treatment groups showed a significant decrease of (TC) and (TG) compared with the positive control group. The best results were found in group fed on high fat diet plus 7.5 % lemongrass powder**.** ***Ewenighi et al., (2013)*** showed that treatment with *C. citrates* powder over the course of several weeks significantly reduced TG and TC in diabetic rats. In a study performed by ***Agbafor and Akubugwo, (2007)*** showed the antihypercholesterolemic possible of the powder of *C. citratus*. The cholesterol-lowering potential of the powder may also be ascribed to the modification of the intestinal cholesterol uptake, increased conversion of cholesterol to bile acids, and increased excretion of the formed bile acids, produced by the powder of lemongrass.

Table (4)

Impact of lemongrass (Cymbopogon citratus) powder and Orlistat on lipids profile in rats

Groups	TC (mg/dl)	TG (mg/dl)
	Mean ± SE	Mean ± SE
G1 (-Ve)	90.20±3.37^{d}	65.06±4.80^{c}
G2 (+Ve)	262.46±6.25^{a}	205.36±3.82^{a}
G3	123.86±2.57^{c}	105.50±3.98^{b}
G4	136.80±4.21^{b}	117.93±4.27^{b}

a=*p < 0 .05;* ***b=****p < 0.01 and* ***c=*** *P < 0.001*

Impact of lemongrass (*Cymbopogon citratus*) powder and Orlistat on(HDL-c), (LDL-c) and VLDL-c:

Concerning HDL-c in G1 (-Ve) group was 58.96±3.23, while G2 (+Ve) group was (37.06±1.60). HDL-c for control G2 (+Ve) was lower than control G1 (-Ve), and others groups 50.07±2.39 and 47.70±2.34, respectively; but G3 and G4 showed higher significant P<0.01 value compared to control G2 (+Ve). However, LDL-c in G1 (-Ve) group was 18.22±0.74, while G2 (+Ve) group was 184.32±7.52. LDL-c for control G2 (+Ve) was higher than control G1 (-Ve), and others groups 52.70±2.93 and 72.18±5.75, respectively; G3 and G4 had higher values compared tothe control G2 (+Ve). With reference to VLDL-c in G1 (-Ve) group was 13.01±0.96, while G2 (+Ve) group was 41.07±0.76. VLDL-c among control G2 (+Ve) was higher than control (-Ve), and others groups 21.10±0.79 and 23.58±0.85, respectively; all groups had lower values as compared to the control G2 (+Ve), Where G3 and G4had high difference significant P<0.01 compared to control G2 (+Ve)***. Emeka and Funmilayo, (2011)*** indicated that the level of the LDL-cin powder of lemongrass decreased when compared with the control group and the level of the HDL-c in the treated groups. Thus blood serum cholesterol level was found to be lower in this study. It is known that high blood cholesterol levels and hyperlipidemia can be the consequence and frequently related with diabetes.It was reported that powder of lemongrass to non-diabetic, hyperlipidemic and diabetic animals showed antihyperlipidemic action ***Ademuyiwa et al., (2015).***

Table (5)

Impact of lemongrass (Cymbopogon citratus) powder and Orlistat on (HDL-c), (LDL-c) and VLDL-c

Groups	HDL-c(mg/dl)	LDL-c(mg/dl)	VLDL-c(mg/dl)
	Mean ± SE	Mean ± SE	Mean ± SE
G1 (-Ve)	58.96±3.23[a]	18.22±0.74[d]	13.01±0.96[c]
G2 (+Ve)	37.06±1.60[c]	184.32±7.52[a]	41.07±0.76[a]
G3	50.07±2.39[b]	52.70±2.93[c]	21.10±0.79[b]
G4	47.70±2.34[b]	72.18±5.75[b]	23.58±0.85[b]

a=*p < 0 .05; **b=****p < 0.01 and **c=**** P < 0.001*

Impact of lemongrass (*Cymbopogon citratus*) powder and Orlistat on (AST), (ALT) and (ALP) in rats:

Mean values of AST, ALT and ALP (Table 6) in the G2 (+Ve) control group showed significant increase compared with the G1 (-Ve) control group. All treated groups recorded a significant decrease in all liver enzymes as compared to control (+Ve). Best results in AST, ALT and ALP were found in rats fed on high fat diet plus 7.5 % lemongrass powder***.(Genser et al.,2008)*** indicated that, there is a significant decrease in serum ALT, AST and ALP by adding lemongrass powder therapy is an indication of founding of plasma membrane as well as repair in hepatic tissue. This effect shows that return to normal with the healing of hepatocytes may be due to their qualitative phytochemical analysis which shows the occurrence of flavonoids in lemongrass.

Table (6)

Impactof lemongrass (Cymbopogon citratus) powder and Orlistat on (AST), (ALT) and (ALP) in rats

Groups	AST (U/L)	ALT(U/L)	ALP (U/L)
	Mean ± SE	Mean ± SE	Mean ± SE
G1 (-Ve)	26.08±2.65[d]	20.84±2.58[c]	54.06±2.56[d]
G2 (+Ve)	230.80±4.25[a]	197.73±7.27[a]	320.46±4.12[a]
G3	87.73±2.62[c]	86.80±4.01[b]	156.40±3.00[c]
G4	97.46±0.66[b]	87.00±5.57[b]	179.96±3.02[b]

a=*p < 0 .05; **b=****p < 0.01 and **c=**** P < 0.001*

Impact of lemongrass (*Cymbopogon citratus*) powder and Orlistat on TP,(Alb) and (Glb) in rats:

Table (7) revealed that the mean value of TP, Alb and Glb in the G2 (+Ve) control group was significantly increased as compared with normal group G1 (-Ve).While all treated groups recorded significant decrease compared to control G2 (+Ve). Lowest level of total protein, albumin and globulin recorded by treated group fed on high fat diet plus 7.5 % lemongrass powder.

Table (7)

Impactof lemongrass (Cymbopogon citratus) powder and Orlistat on (TP),(Alb) and (Glb) in rats

Groups	TP(g/dl)	Alb(g/dl)	Glb(mg/dl)
	Mean ± SE	Mean ± SE	Mean ± SE
G1 (-Ve)	7.40±0.32^{c}	4.20±0.34^{b}	2.96±0.17^{b}
G2 (+Ve)	10.07±0.34^{a}	6.76±0.26^{a}	4.73±0.45^{a}
G3	8.20±0.15^{b}	4.47±0.37^{b}	3.16±0.18^{b}
G4	8.43±0.20^{b}	4.63±0.40^{b}	3.43±0.23^{b}

a*=p < 0 .05; ***b*=****p < 0.01 and ***c*=***** P < 0.001*

Impact of lemongrass (*Cymbopogon citratus*) powder and Orlistat on relative liver weight% in rats:

Positive control group showed increase in relative liver weight as compared with negative group. Relative liver weight decreased significantly in all treated groups as compared to positive control. The best results were found in groups fed on high fat diet plus 7.5 % lemongrass powder,while those who were fed on high fat diet plus 60 mg/Kg of body weight of Orlistat showed also significant decrease, when compared with positive control group as shown in (Table 8).According to a study completed by ***Genser et al., (2008)*** who observed that the liver weight were decreased by *C. citrats* powder treatment in diabetic dyslipidemic rats,perhaps because the powder inhibited either cholesterol admission in the liver tissues or hepatic HMG CoA reductase activity.

Table (8)

Impact of lemongrass (Cymbopogon citratus) powder and Orlistat on relative liver weight% in rats

Groups	Relative liver weight%
	Mean ± SE
G1 (-Ve)	2.44±0.03^{c}
G2 (+Ve)	3.73±0.08^{a}
G3	2.89±0.06^{b}
G4	2.23±0.01^{d}

a*=p < 0 .05; ***b*=****p < 0.01 and ***c*=***** P < 0.001*

HISTOPATHOLOGY OF LIVER

Photo (1):

Section in liver negative control group (G1)(fed on basal diet) showed average sized central veins (red arrows) surrounded by cords of hepatocytes (blue arrows) separated by blood sinusoids (black arrow) [H&E x 100].

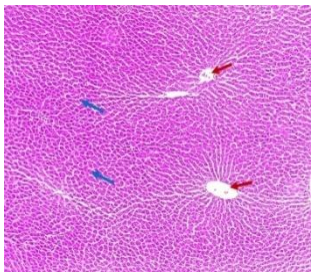


Photo (2):

Section in liver negative control group(G1) (fed on basal diet)showed portal tract (portal venule, hepatic arteriole and bile ductule) (red arrow) surrounded by cords of hepatocytes (blue arrows) [H&E x 100].

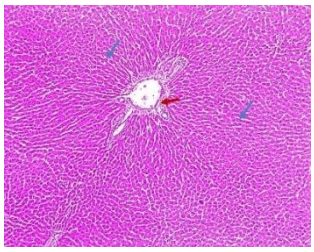


Photo (3):

Section in liver positive control group (G2) (fed on high fat diet) showed dilated congested central vein (red arrow), surrounded by cords of hepatocytes showing focal spotty necrosis (blue arrows) and marked lobar inflammation (black arrows) [H&E x 100].

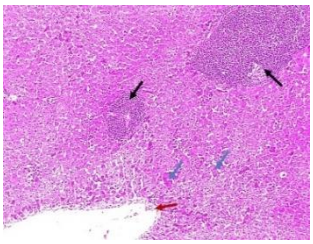


Photo (4):

Section in liver positive control group (G2) (fed on high fat diet) showed portal tract inflammation showing chronic inflammatory cellular infiltrate (black arrows) with portal fibrosis [fibrosis between two portal tracts] (red arrows) surrounded by degenerated cords of hepatocytes (blue arrow) [H&E x 100].

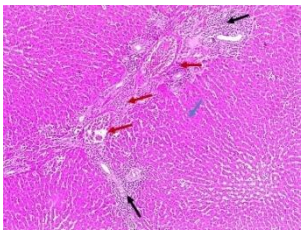


Photo (5):

Section in liver group (3) was fed on high fat diet + 7.5 % lemongrass powder showed moderate dilated portal venule (black arrow) surrounded by moderate portal inflammation (red arrows) and average sized cords of hepatocytes with no degeneration or necrosis (blue arrows) [H&E x 200].

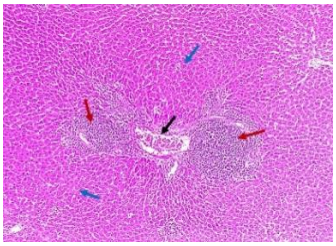
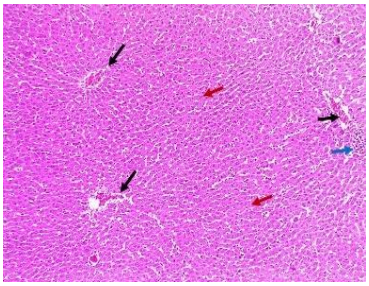


Photo (6):

Section in liver group (4) was fed on high fat diet + Orlistat (60 mg /Kg of body weight) showed slight dilated central veins (black arrows) surrounded by cords of average sized hepatocytes (red arrows) with focal lobar inflammation (blue arrow) [H&E x 200].



Conclusion

Lemongrass (*Cymbopogon citratus*) powder had an ameliorative effect on hyperglycemia and hyperlipidemia via improving body weight gain, tumbling food and liquid intake and improves liver function. It may be potential therapeutic means for atherogenic cardiovascular diseases.Lemongrass is a steamy herb used in cooking that has a lemony aroma and flavor. This type of herb is generally sold fresh from super market, but it can be used dehydrated or in powder form. Lemongrass is normally used in many dishes common in Asian and other cuisines. We can also use this herb in many cups from soups to desserts.

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تأثيرمسحوق حشيشة الليمون على ارتفاع مستوى دهون الدم مقارنة بالأورليستات باستخدام حيوانات التجارب

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الملخص العربى

أجريت هذه الدراسة لمعرفة تأثيرمسحوق حشيشة الليمون والأورليستات على فرط دهون الدم في الفئران التي تتغذى على نظام غذائي عالى الدهون. تم استخدام أربعة وعشرين من ذكورالجرذان البيضاء من سلالة Dawley Sprague وزن (150±10 جم) في هذه الدراسة وتم تقسيمها إلى 4 مجموعات متساوية،كل مجموعة تحتوي على 6 فئران. تم الحفاظ على مجموعة واحدة كمجموعة ضابطة سلبية (-Ve) (G1) ،بينما تم تغذية (G2) على نظام غذائي عالي الدهون كمجموعة ضابطة موجبة (+Ve)(G3) تم تغذيتهاعلى نظام غذائي عالي الدهون بالإضافة إلى 7.5 ٪ من مسحوق حشيشة الليمون (G4) تم تغذيتها على نظام غذائي عالي الدهون بالإضافة إلى(60ملجم أورليستات/ كجم من وزن الجسم). في نهاية التجربة تم تقييم مستويات الجلوكوزوالبروتين الكلي (الألبومينوالجلوبيولين) ووظائف الكبد في الدم ودهون الدم. أشارت النتائج إلى أن اختبارات النباتات حسنَّت مستويات الجلوكوزو وظائف الكبدونسبة الدهون. وفقًا لهذه النتائج،يمكن تجربة كميات معتدلة من عشبة الليمون في وجباتنا الغذائية لتحسين حالة الأشخاص المصابين بفرط دهون الدم.

الكلمات المفتاحية : فرط دهون الدم، مستويات الدهون، حشيشة الليمون،الأورليستات.