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Study of Chemical, Nutritional and Therapeutic Biological Effects of Garden Cress seeds (*LepidiumSativum*) on Experimental Rats.

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Abstract:-
The main objective of this study was to investigate the effect of *LepidiumSativum* powder (LSP) at concentration 2.5%, 5% and 10% in diet on CCL4-induced hepatotoxicity rats, gentamicin-induced nephrotoxicity rats and knowledge the organoleptic evaluation for bread and apple juice when supplement it.Forty-five adult male healthy albino rats (Sprague-Dawley strain)were divided into(9)groups.Weight of rats for all groups was nearly equal and each group contains 5 rats. Group(1)control negative group in which normal rats were fed on basal diet and tap water. Group (2) hepatic control positive group in which hepatotoxicity rats which were injected by CCL4 were fed on basal diet and tap water. Group(3),(4)and(5)hepatic rats were fed on basal diet containing 2.5%, 5% and 10% LSP respectively. Group(6)nephritic control positive group in which nephrotoxicity rats which were injected by gentamicin were fed on basal diet and tap water. Group(7),(8)and(9)nephritic rats were fed on basal diet containing 2.5%, 5% and 10% LSP respectively. At the end of period of the experiment 28 day, rats were fasted 12 hours of diet and 2 hours of water, blood samples were collected from the retro orbital method by means of a micro capillary glass todetermine biochemical parameters as follows: aspartate aminotransaminase(AST or GOT),alanine aminotransferase (ALT or GPT), alkaline phosphatase (ALP), AST/ALT ratio,gamma-glutamyltransferase (GGT), total protein (Tp), albumin (Alb), globulin (Glo), Alb /Glo ratio, total bilirubin (T.Bil), direct bilirubin(D.Bil), indirect bilirubin (Ind.Bil), urea, uric acid, creatinine, sodium (Na), potassium (K), calcium (Ca), phosphorus (P), glutathione peroxidase

(GPX), superoxide dismutase (SOD), catalase (CAT) ,glutathione S-transferases (GSTs),total antioxidant capacity (TAC) ,malondialdehyde (MDA),high density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c), very low-density lipoprotein cholesterol(VLDL-c), atherogenic index (AI), HDL-c/TC ratio and glucose. Biological parameters body weightgain(BWG%),feed intake(FI) ,feed efficiency ratio(FER)and internal organs were calculated at the end of experiment. Liver and kidney of all animals were carefully surgically removed to histopathological examination. The results were obtained from all hepatic and nephritic LSP treated groups revealed dramatically decreased in level of AST, ALT, ALP, GGT, urea, uric acid, creatinine, Glo, T.Bil, D.Bil, Ind.Bil, MDA, LDL-c, VLDL-c, AI and glucose, beside greatly increasing in levels of BWG, FI, FER, Tp, Alb, GPX, SOD, CAT, GSTs, TAC, HDL-c and HDL-c/TC ratio. Regarding levels of K and P decreased while levels of Na and Ca increased in nephritic LSP treated groups. Markedly improvement was appeared in histologically examination of liver and kidney in all hepatic and nephritic LSP treated groups. The best results in all LSP treated groups of hepatic, nephritic, bread and apple juice were recorded in10% LSP.

Conclusion:-This study proved that *LepidiumSativum* has great effectiveness in treating liver and kidney diseases and protecting against complications associated with them also it contains many phytochemical compounds that play an important and effective role in metabolic processes and performance important biological functions during the life cycle.

Key words:- *LepidiumSativum*-hepatotoxicity-nephrotoxicity-liver function- kidney function major minerals-antioxidant and oxidant enzymes-lipid profile-glucose-histopathology examination -organoleptic evaluation.

Introduction:-

Garden cress (*Lepidiumsativum*) is an annual herbaceous from family Cruciferae and edible plant that is botanically related to mustard and watercress,is from the important medicinal plants where it is used in popular medical treatments in the Kingdom of Saudi Arabia, Sudan, Egypt, some other Arab countries and South west Asia . Grows in Egypt by three species: *L. latifolium, L.sativum*and *L. aucheri*, of

which the most common one is *L. sativum*, the leaves of garden cress are used in salad while the seeds are used in different medicinal applications as tonic for the immune system, in treating dysentery, anemia, diarrhea, migraine antidiabetic**(Eddouks and Maghrani, 2008),** anti-asthmatic, diuretic**(Eddouks*et al.*, 2002),** hypotensive **(Maghrani*et al.*, 2005),**antioxidant, anti-carcinogenic **(Zhang &Talalay, 1994 and Kassie*et al.*, 2003),** anti-mutagenic activities, hypolipidemicactivity, antibacterial, antifungal,anti-inflammatory **(Aburjai*et al.*, 2001)**, well for healing broken bones in the human skeleton besides that seeds have protective and curative effect against nephrotoxicity and fatty liver in albino rats.

Also a number of recent studies noted of the traditional uses of *L. sativum* seed in control of many of the clinical problems was due to the presence of active therapeutic compounds in it as isoflavonoid,5,6-dimethoxy-2',3'-methylenedioxy-7-C-β-D-gluco-pyranosy lisoflavone,7-hydroxy-4',5,6-trimethoxyisoflavone and 7-hydroxy-5,6-dimethoxy-2',3'-methylenedioxyisoflavone addition to the most effective ingredient isothiocyanates, glucosinolates and this compounds responsible to protect DNA from damage caused by free radical where protect cells of liver and kidney against various toxins **Sakran*et al.*,(2014),** moreover presence another antioxidant phytochemicals compounds as alkaloids, tannin, flavonoids, phenols, riboflavin, thiamine, niacin, α-tocopherols, β-carotenes, β-sitosterol, ascorbic, linolenic, oleic, palmitic, stearic, and amino acids like glutamine, cysteine, and glycine,**Gaafar*et al.*,(2013) and Jain *et al.*,(2016)**besides calcium, magnesium, iron and zinc.Where they are play an important role in many metabolic processes and performance important biological functions throughout the life cycle **Gokavi*et al.*,(2004);Yadav*et al.*,(2010) andAgarwal&Sharma,(2013).**

The liver is the largest internal organ in the body, is essential in keeping the body functioning properly. It removes or neutralizes poisons from the blood, produces immune agents to control infection and removes germs and bacteria from the blood. It makes proteins that regulate blood clotting and produces bile to help absorb fats and fat-soluble vitamins **(Schuppan and Nezam, 2008)**.Hepatotoxicity or liver damage is caused by hepatotoxins which may source from chemicals, dietary supplements, pharmaceutical drugs and medicinal plants.The global burden of hepatotoxicity affects over fifty million people

worldwide**(Bruha *et al*.,2012)**.Drug-induced hepatotoxicity is one of the most common causes of drug withdrawal from the market. Metabolic syndrome (Diabetes, hypertension, hyperlipidemia and obesity), insulin resistance, alcohol consumption and oxidative stress also cause liver damage **(Defronzo and Ferrannini, 1991).**

The kidney is an essential organ required by the body to perform several important functions including the maintenance of homeostasis,regulation of the extracellular environment, such as detoxification and excretion of toxic metabolites and drugs **(Ferguson *et al*., 2008)**. Therefore, the kidney can be considered as a major target organ for exogenous toxicants. Nephrotoxicity is a kidney-specific feature in which excretion does not go smoothly owing to toxic chemicals or drugs **(Galley,2000 and Finn&Porter,2003).** Approximately 20% of nephrotoxicity is induced by drugs, but medication of the elderly increases the incidence of nephrotoxicity up to 66% as the average life span increases. Chemotherapy or anticancermedicine has been of limited use due to nephrotoxicity**(Kohli*et al*., 2000; Naughton, 2008 and Nagai & Takano,2010).**

Aim of the study:-

The objective of this study was to investigate the effect of *LepidiumSativum* powder (LSP) at concentration 2.5%, 5% and 10% in diet on CCL4-induced hepatotoxicity rats, gentamicin-induced nephrotoxicity rats and knowledge the organoleptic evaluation for biscuit and apple juice when supplement it.

Materials and Methods:-

Materials:-

The used plant:

LepidiumSativum (Garden cress) seed was obtained from the local market of Shibin-El kom City -Menofia governorate - Egypt.

Experimental animals:

Forty-five 45 (Sprague-Dawleystrain) adult male healthy albino rats weighting (145±5) g were used in this study, were obtained from Research Institute of Ophthalmology, Animal House Department, Giza, Egypt.

Chemicals:

Carbon tetra chloride(CCL4)and Gentamicin (aminoglycosides antibiotics) were obtained from El-Gomhoryia Company for chemicals and medical Eequipments Cairo-Egypt.

Technological materials:

Bread:

100g fluor, 2g salt, 3g sagar, 3g active dry baker's yeast, 5g shortening, 60ml warm water and LSP(2.5%, 5% and 10%)on account the quantity of wheat flour**(Greene&Bovell, 2004 and Mansour, 2006)**.

Apple juice:

1000 ml water, 1000g apple , 140g sugar, 2 tablespoons of lemon juice and LSP(2.5%, 5% and 10%) **(FAO, 1995)**.

Methods:-

Chemical analysis of *LepidiumSativum*powder:

LepidiumSativum powder was subjected to chemical analysis in order to determine content: (moisture, protein, fat, ash and crude fiber)accordingto **A.O.A.C.method,(2000).**Total carbohydrates were determined by difference as mentioned by **Abd El-Latif, (1990).**

Basal diet composition of tested rats:

The basal diet in the experiment consisted of corn starch (67.6%), casein (11.9%), corn oil (10%), salt mixture (4%), vitamin mixture (1%), barn (5%), methionine (0.3%) and choline chloride (0.2%) according to **AIN, (1993).**

Induction of liver intoxication in rats:

Chronic liver damage was induced in normal healthy male albino rats by intro-peritoneal injection of carbon tetrachloride (CCL4) in paraffin oil (50%v/v2ml/kg/body weight) subcutaneous injection twice a week for two weeks **(Turkdogan*et al*., 2003).**

Induction of kidney intoxication in rats:

Kidney toxic was induced in normal healthy male albino rats by intro-peritoneal injection of gentamicin (aminoglycosides antibiotics), (10 mg /kg/day for 10 days) subcutaneous injection once daily for 10 days **(Farombi and Ekor, 2006).**

Experimental design and animal groups:

Forty-five (45) (Sprague-Dawley strain) adult male healthy albino rats weighting (145±5)g were used in this study. Rats were housed individually in wire cages under hygienic conditions, good ventilation

system in laboratory and were fed on basal diet for 7 consecutive days as adaptation period.The rats were divided into 9 groups and each group contains five 5 rats.Weight of rats for all groups was nearly equal and period of the experiment was 28 day. The nine groups of rats were as follows:-

Group(1): Negative control group in which normal rats were fed on basal diet.

Group(2): Hepatic control positive group(hepatotoxicity rats) were fed on basal diet.

Group(3): Hepatotoxicity rats werefed on basal diet containing 2.5% *LepidiumSativum*powder.

Group(4): Hepatotoxicity rats werefed on basal diet containing 5% *LepidiumSativum*powder.

Group(5): Hepatotoxicity rats werefed on basal diet containing 10% *LepidiumSativum*powder.

Group(6): Nephritic control positive group (nephrotoxicity rats) were fed on basal diet.

Group(7): Nephrotoxicity rats werefed on basal diet containing 2.5% *LepidiumSativum*powder.

Group(8): Nephrotoxicity rats werefed on basal diet containing 5% *LepidiumSativum*powder.

Group(9): Nephrotoxicity rats werefed on basal diet containing 10% *LepidiumSativum*powder.

Blood Sampling and Organs Collection:

From all the previously mentioned groups blood samples were collected after 12 hours fasting for diet and 2 hours for water at the end the experiment. Blood samples were collected into a dry clean centrifuge tubes and were left to clot at room temperature for 30 minutes then were centrifuged for 10 minutes at 3000 round per minute (r.p.m) to separate the serum. Serum was carefully aspirated and transferred into a dry clean Eppendorf tubes and kept frozen at (-20°C) until the time of chemical analysis**Schemer,(1967)**.All serum samples were analyzed for determination of the following parameters:liver enzymes, serum bilirubin fractions, serum protein fractions, kidney function, minerals major, antioxidant and oxidant enzymatic, lipids profile and serum glucose.The organs (liver, spleen, kidney, heart and Lung) of each rat were removed surgically and washed in saline solution dried by filter

paper and weighed separately and saved in formalin solution 10% for histopathological examination according to methods explained by **Drury and Wallington,(1980).**

Biological evaluation:

During the experimental period (28day), the consumed feeding was recorded every day, body weight gain (BWG%),feed efficiency ratio (FER) and relative weight of organs were calculated according to **Chapman *et al*.,(1959)** using the following equations:-

$$\text{Body weight gain (BWG\%)} = \frac{\text{(Final weight-Initial weight)}}{\text{Initial weight}} \text{ X } 100$$

$$\text{Feed efficiency ratio (FER)} = \frac{\text{Gain in body weight(g)}}{\text{Feed intake(g)/28}}$$

$$\text{Relative weight of organ} = \frac{\text{Organ weight(g)}}{\text{Final weight(g)}} \text{ X } 100$$

Biochemical analysis of serum:

All serum samples were analyzed for determination of the following parameters:

Aspartate aminotransaminase(AST or GOT) and alanine aminotransferase(ALT or GPT) were measured by method according to described by**Henry,(1974) and Yound,(1975)**,respectively.Also alkaline phosphatase (ALP), AST/ALT ratio, serum gamma-glutamyltransferase (GGT) and total protein (Tp) were carried out according to the method of **IFCC, (1983);Gowenlock*et al*.,(1988) and spencer &price,(1977),** respectively.Albumin (Alb), globulin (Glb), albumin/globulin ratio (Alb/Glb ratio)were obtained by **Srivastava*et al*., (2002) and Charry& Sharma,(2004),** respectively.Direct bilirubin (D.Bil), indirect bilirubin (Ind.Bil) and total bilirubin (T.Bil) were obtained by **Srivastava*et al*.,(2002); Charry& Sharma, (2004) andDoumas*et al*.,(1973)** ,respectively. Urea, uric acid and creatinine were determined to method of **patton& crouch,(1977), Baraham&Trinder,(1972) and Henry ,(1974)**, respectively.Sodium (Na), potassium (K), calcium (Ca) and phosphorus (P) were described by **Nicoli,(2003)**.Glutathione peroxidase (GPX), superoxide dismutase (SOD), catalase (CAT), glutathione s-transferases (GSTs), total antioxidant capacity (TAC) and

malondialdehyde (MDA) weremeasured by method of**Zhao,(2001);Sun *et al*.,(1988);Diego,(2011);Hegsted*et al*.,(1941); Koracevic,(2001); Satoh,(1978)and Ohkawa*et al*.,(1979)** respectively.

Histopathological Examination:

Specimens of the internal organs (liver and kidneys) were taken immediately after sacrificing rats (all groups) and were immersed in 10% neutral buffered formalin and were dehydrated in ascending concentration of ethanol (70, 80, 90%), then the fixed specimens were trimmed and dehydrated in ascending grades of alcohol, cleared in xylene and embedded in paraffin sectioned (4-6 Mm thickness), stained with hematoxylin and eosin and examined microscopically **Drury & Wallington, (1980) and Bancroft *et al.*,(1996).**

Preparation of bread:

Bread was prepared by mixing with different levels of LSP (2.5%, 5% and10%) straight dough method was used**(Greene&Bovell, 2004 and Mansour, 2006)**.

Preparation of applejuice:

1000 ml water, 1000g apple , 140g sugar and 2 tablespoons of lemon juice, addition to LSP(2.5%, 5% and 10%) **(FAO, 1995)**.

Statistical Analysis:-

The data were statistically analyzed using a computerized Costat program by oneway ANOVA. The results are presented as Mean ± SD, differences between treatments at ($P \leq 0.05$) were considered significant **(S.A.S, 1985).**

Results and Discussion:-

Chemical composition of *Lepidiumsativum* powder:

Table (1): Chemical composition of *LepidiumSativum*powder g/100g dry weight basis.

Constituent	*LepidiumSativum*powder
Moisture	6.73
Crude protein	21.61
Fat	32.28
Crude fiber	6.75
Ash	4.83
Total carbohydrate	27.80

Biological results of CCL4-induced hepatotoxicity rats:

Results in table (2) showed that BWG %, FI g/28 day and FER of hepatic control (+) group were greatly decreased significantly (P≤0.05) when compared to control (-) group, while hepatic groups fed on diet containing 2.5%,5% and 10% LSP appeared a high gradual increase in BWG%, FI g and FER as compared to control (+) group. The best results were recorded for group5 (hepatic rats fed on diet containing 10%LSP)comparison to control (+) group.The statistical analysis showed significant positive relations between treatments for BWG, FI, & FER by LSP, these results are in agreement with those reported by**(Mali *et al*., 2007)** who found that *L.sativum* contain growth promoter factors and as triterpens, alkaloid, tannin and coumarins, beside it minimized the hemorrhage caused by CCL4 in the liver because of the presence of flavonoids in it are known to be vascular protector,moreover it has hepatoprotection by inhibiting the free radicals mediated damage.

Table (2): Effect of feeding *LepidiumSativum* powder (LSP) 2.5% , 5% and 10% on body weight gain (BWG%), feed intake (FI g/28 day) and feed efficiency ratio (FER) of CCL4-induced hepatotoxicity rats.

Parameters / Group		BWG %		FI (g 28/day)		FER	
		M±SD	%Change of(C+)	M±SD	%Change of(C+)	M±SD	%Change of(C+)
G1Control (-)		62.50^{a}±2.120	+ 400.00	364^{a}±2.545	+73.33	0.275^{a}±0.011	+189.47
G2Control (+)		12.50^{e}±0.520	—	210^{e}±1.468	—	0.095^{b}±0.002	—
LepidiumSativum powder (LSP)	G3 2.5%	28.13^{d}±1.200	+ 125.04	238^{d}±1.664	+ 13.31	0.189^{a}±0.008	+98.95
	G45%	40.63^{c}±1.600	+ 225.04	280^{c}±2.110	+ 33.33	0.232^{a}±0.011	+ 144.21
	G510%	56.25^{b}±2.200	+ 350.00	350^{b}±1.958	+66.67	0.257^{a}±0.090	+170.53
LSD		3.0009		3.6099		0.0746	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Data in table (3) indicated that all mean values of relative weight of organs liver, spleen , kidney, heart and lung of control (+) group were dramatically increased significantly (P≤0.05) when compared to control (-) group, but hepatic groups fed on diet containing 2.5%, 5% and 10% LSP were significantly (P≤0.05) lower as compared to the counterparts values in control (+) group. The best results were noticed of group5 (hepatic rats fed on diet containing 10%LSP) where it recorded insignificant differences in mean values of all relative weight of organs

comparison to control (-) group. These results are matched with the results which reported by **Ezejindu*et al*.,(2013) and Raish*et al*.,(2016)**who explained that the relative organ weights of rats injured with carbon tetrachloride were showed significant differences, where was there high increase in all relative organs weights regardless of total body weight loss, and this increase was not growth but in fact its acute inflammation caused by poisoning of CCL4, but when use treatment with *L. sativum* seeds led to reduction in inflammation and decreased in this overweight of organs is due to the presence important phytochemical properties in it as benzyl isothiocyanate, flavonoids, tannins, triterpens, alkaloids, sterols, glucosinolates and they have role of anti-inflammatory, antioxidant, analgesic activities and hepatoprotective properties.

Table (3): Effect of feeding *LepidiumSativum* powder (LSP) 2.5%, 5% and 10% on relative weight of organs (liver, spleen , kidney, heart and Lung) of CCL4-induced hepatotoxicity rats.

Parameters / Groups		Liver		Spleen		Kidney		Heart		Lung	
		M± SD	%Change of (C+)	M± SD	%Change of (C+)	M± SD	%Change of (C+)	M± SD	%Change of (C+)	M± SD	%Change of (C+)
G1 Control (-)		3.09^{d}±0.130	-50.00	0.23^{e}±0.010	- 66.67	0.63^{d}±0.030	- 48.78	0.29^{d}±0.013	- 73.15	0.44^{e}±0.021	- 63.93
G2 Control(+)		6.18^{a}±0.210	–	0.69^{a}±0.230	–	1.23^{a}±0.051	–	1.08^{a}±0.044	–	1.22^{a}±0.041	–
LepidiumSativum powder (LSP)	G3 2.5%	5.05^{b}±0.230	-18.28	0.44^{b}±0.011	- 36.23	0.96^{b}±0.037	- 21.95	0.48^{b}±0.013	- 55.56	0.91^{b}±0.034	-25.41
	G4 5%	4.24^{c}±0.210	-31.39	0.34^{c}±0.017	- 50.72	0.81^{c}±0.031	- 34.15	0.38^{c}±0.017	- 64.81	0.77^{c}±0.028	- 36.89
	G5 10%	3.40^{d}±0.170	-44.98	0.26^{d}±0.013	- 62.32	0.68^{d}±0.032	- 44.72	0.31^{d} ±0.014	- 71.29	0.52^{d}±0.025	- 57.38
LSD		0.3517		0.0282		0.0673		0.0427		0.0557	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Data in table (4) confirmed that all hepatic rats fed on diet containing 2.5%, 5% and 10% LSP were markedly decreased significantly($P \leq 0.05$) in liver enzymes as compared to hepatic control (+) group, addition to that the best treatment was recorded of group5 (hepatic rats fed on LSP 10% diet) where is due to it had effective in correcting the disorder of liver enzymes and reaching to near the normal level. The hepatoprotective effect of *Lepidiumsativum* seed is due to the presence of alkaloid, coumarin, flavonoids, tannin, triterpenes and high

concentrations of mainly α-linolenic acid which enhance antioxidant activity and reduce free radical production from CCl4 which is considered the basic triggering factor for hepatotoxicity, also extend its bioactivity in ameliorating the hepatic intoxication and oxidative stress including liver injury induced by alcohol liver steatosis, nonalcoholic hepatic disease and parenteral nutrition-associated liver disease by prohibit formation of D-GalN/LPS, LDH and restoring of liver functions to normal levels **(Mignon *et al.*,1999;Nakama *et al.*,2001; Burow*et al.*, 2007; Sharma &Agarwal, 2011;Al-Asmari*et al.*, 2015 and Zamzami*et al.*, 2019).**

Table (4): Effect of feeding *LepidiumSativum* powder (LSP) 2.5%, 5% and 10% on aspartate amino transaminase (AST), alanine aminotransferase (ALT), (AST/ALT ratio), alkaline phosphatase (ALP), and gamma-glutamyltransferase (GGT) of CCL4-induced hepatotoxicity rats.

Parameters / Group		AST(U/L)		ALT(U/L)		ALP(U/L)		AST/ALT(ratio)		GGT(U/L)	
		M±SD	%Change of (C+)	M±SD	%Change of (C+)	M± SD	%Change of (C+)	M± SD	%Change of (C+)	M±SD	%Change of (C+)
G1 Control (-)		100^{e} ±2.520	-44.44	47^{d} ±1.178	-28.79	189^{e} ±2.480	-36.15	2.13^{d} ±0.053	-21.20	3.12^{d} ±0.078	- 47.03
G2 Control (+)		180^{a} ±2.841	–	66^{a} ±1.950	–	296^{a} ±3.133	–	2.73^{a} ±0.078	–	5.89^{a} ±0.422	–
LepidiumSativum powder (LSP)	G32.5%	150^{b} ±2.522	-16.67	60^{b} ±1.752	-9.09	214^{b} ±2.057	-27.70	2.50^{b} ±0.082	-8.42	4.88^{b} ±0.147	- 17.14
	G4 5%	134^{c} ±1.775	-25.56	58^{b} ±1.501	-12.12	208^{c} ±1.200	-29.73	2.31^{c} ±0.057	-15.38	3.96^{c} ±0.099	- 32.77
	G5 10%	111^{d} ±2.150	-38.33	51^{c} ±1.275	-22.73	197^{d} ±1.791	-33.45	2.18^{d} ±0.061	-20.15	3.41^{d} ±0.085	- 42.10
LSD		4.2483		2.8345		4.0553		0.1222		0.3840	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Results in table (5) revealed that there decreases of levels Tp, Alb and Alb/Glb ratio beside significant increases of Glb in hepatic control (+) group comparison to control (-) group. Concerning all hepatic rats fed on diet containing 2.5%, 5% and 10% LSP achieved significant increases in Tp, Alb and Alb/Glb, also significant decreases of Glb .The best results of serum protein fractions were observed in group 5 (hepatic rats fed on LSP 10% diet) where it was the closest to control (-) group.These data are in agreement with those of **Pandit*et al.*,(2012) and Zamzami*et al.*,(2019)** who confirmed hepatoprotective efficacy of *L.sativum* seeds in white male New Zealand rabbits where the results revealed that

concurrent treatment of rabbits injured with CCl4 for 5 and 10 weeks with *L. sativum* seeds led to significantly repaired their liver enzymes such as elevation of total protein and albumin improved with decrease level of globulin.

Table (5): Effect of feeding *LepidiumSativum* powder (LSP) 2.5% , 5% and 10% on total protein (Tp), albumin (Alb), globulin (Glb) and (Alb /Glb ratio) of CCL4-induced hepatotoxicity rats.

Parameters / Group		Tp (g/dl)		Alb (g/dl)		Glb (g/dl)		Alb/Glb ratio	
		M±SD	%Change of (C+)	M±SD	%Change of (C+)	M±SD	%Change of (C+)	M±SD	%Change of (C+)
G1 Control (-)		7.92^{a} ±0.243	+54.38	6.81^{a} ±0.836	+238.80	1.11^{e} ±0.018	-64.42	6.14^{a} ±0.335	+859.37
G2 Control (+)		5.13^{d} ±0.170	—	2.01^{d} ±0.607	—	3.12^{a} ±0.062	—	0.64^{e} ±0.193	—
LepidiumSativum powder (LSP)	G3 2.5%	5.91^{c} ±0.197	+15.20	3.41^{c} ±0.113	+69.65	2.50^{b} ±0.051	-19.87	1.36^{d} ±0.045	+112.50
	G4 5%	6.52^{b} ±0.117	+27.09	4.72^{b} ±0.159	+134.82	1.80^{c} ±0.036	-42.30	2.62^{c} ±0.065	+309.37
	G5 10%	7.75^{a} ±0.152	+51.07	6.43^{a} ±0.106	+219.90	1.32^{d} ±0.026	-57.69	4.87^{b} ±0.093	+660.93
LSD		0.3290		0.8597		0.0760		0.3298	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Data in table (6) reflected that T.Bil, D.Bil and Ind.Bil of hepatic control (+) group were higher than control (-) group, at the same time all hepatic rats fed on diet containing 2.5%,5% and 10% LSP revealed significantly (P≤0.05) decreases in the same values as compared to hepatic control (+) group. The effective treated group for serum bilirubin fractions is group 5 (hepatic rats fed on LSP 10% diet) when compared to hepatic control (+) group.**Mignon *et al*.,(1999); Nakama*et al*.,(2001);Sakran*et al*.,(2014) and Zamzami*et al*.,(2019**) found that *Lepidiumsativum* seeds possess hepatoprotective active effect against damage liver induced CCL4 in rats, where both of 5,6-dimethoxy-2,3-methylenedioxy-7-C-*β*-Dglucopyranosylisoflavone and natural sterols were extracted from *Lepidiumsativum* seeds, and thus this compounds have efficient in correcting the disorder of lipid profile and liver functions through their ability to significantly overcomes on the production of lipid peroxidation and free radicals, on the other hand they works to restore the level of total protein to normal and reducing high levels of globulin, direct and indirect bilirubin.

Table (6): Effect of feeding *LepidiumSativum* powder (LSP) 2.5%, 5% and 10% on total bilirubin (T.Bil), direct bilirubin (D.Bil) and indirect bilirubin (Ind.Bil) of CCL4-induced hepatotoxicity rats.

Parameters / Group		T.Bil (mg/dl)		D.Bil (mg/dl)		Ind.Bil (mg/dl)	
		M ± SD	%Change of (C+)	M±SD	%Change of (C+)	M ± SD	%Change of (C+)
G1Control (-)		0.67^{d}±0.016	-47.65	0.24^{d}±0.005	-58.62	0.43^{d}±0.010	-38.57
G2Control (+)		1.28^{a}±0.042	—	0.58^{a}±0.029	—	0.70^{a}±0.023	—
LepidiumSativum powder (LSP)	G3 2.5%	1.09^{b}±0.027	-14.84	0.47^{b}±0.019	-18.96	0.62^{b}±0.034	-11.42
	G4 5%	0.88^{c}±0.018	-31.25	0.35^{c}±0.014	-39.65	0.53^{c}±0.022	-24.28
	G5 10%	0.71^{d}±0.012	-44.53	0.26^{d}±0.003	-55.17	0.45^{d}±0.013	-35.71
LSD		0.0461		0.0307		0.0401	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Results in table (7) exhibited that activating levels of GPX, SOD and CAT of hepatic control (+) group were dramatically decreased significantly (P≤0.05) as compared to control (-) group. With respect to all hepatic rats fed on diet containing 2.5%,5% and 10% LSP achieved high significantly (P≤0.05) gradual increases in antioxidant levels comparison to hepatic control (+)group. The best treatment was observed for group 5 (hepatic rats fed on LSP 10% diet) where it had the action effect in increasing antioxidant enzymes.The isoflavonoid of *L. sativum* have action ability to reduce the hepatotoxicity induced by paracetamol in male rats by reducing the damage and toxicity effects on liver cells with a significant improvement of total antioxidant capacity, normalizing the levels of liver enzymes GSH, SOD, GPX, CAT and GST compared to paracetamol control group **(Aranda *et al*., 2007).**

Table (7): Effect of feeding *LepidiumSativum* powder (LSP) 2.5%, 5% and 10% on activities of glutathione peroxidase (GPX),

superoxide dismutase (SOD) and catalase (CAT) enzymes of CCL4-induced hepatotoxicity rats.

Parameters / Group		GPX (ng/dl)		SOD (U/L)		CAT(mmoL/L)	
		M± SD	%Change of (C+)	M ±SD	%Change of (C+)	M ± SD	%Change of (C+)
G1Control (-)		82.53^{a}±2.225	+39.17	54.75^{a}±1.985	+52.46	75.74^{a}±2.887	+83.70
G2Control (+)		59.30^{d}±1.126	—	35.91^{e}±0.795	—	41.23^{e}±1.715	—
Lepidiumsativumpowder (LSP)	G3 2.5%	65.15^{c}±1.965	+9.86	40.43^{d}±1.635	+12.58	52.52^{d}±1.094	+27.38
	G4 5%	67.84^{c}±1.291	+14.40	44.55^{c}±1.235	+24.06	60.08^{c}±2.101	+45.71
	G5 10%	73.97^{b}±1.695	+24.73	50.74^{b}±1.032	+41.29	69.59^{b}±2.740	+68.78
LSD		3.1108		2.5516		3.9008	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Results in table (8) illuminated that there great decreases of levels GST and TAC as well high increases of MDA of hepatic control (+) comparison to control (-) group, whereas all hepatic rats fed on diet containing 2.5%, 5% and10% LSP recorded markedly improvement in levels of GST and TAC , at the same time showed dramatically decreased in level MDA. The best treatment was observed for group 5 (hepatic rats fed on LSP 10% diet) when comparison hepatic control (+) group, where was proved its efficient effect in enhancement GST and TAC and reducing MDA.**Sakran*et al*.,(2014); Ali & Rajab,(2019)and Zamzami*et al*.,(2019)** found that both alkaloids, flavonoids and phenolic compounds in *Lepidiumsativum* seeds play an essential important roles in inhibiting both of structural injury through the decay of oxidative stress, DNA disintegration of liver and malondialdehyde (MDA) which are related with liver damage induced by CCl4, furthermore this compounds have antioxidant characteristics such as improved the degree of structural damage, reduced of inflammatory infiltration in hepatic cells, alleviates hepatic impairments, apoptosis and structural injury in liver thus increase total antioxidant capacity (TAC).

Table (8) :Effect of feeding *LepidiumSativum* powder (LSP) 2.5%, 5% and 10% on activities of glutathione S-transferases (GST), total antioxidant capacity (TAC)and malondialdehyde (MDA) enzymes of CCL4-induced hepatotoxicity rats.

Parameters / Group		GST(mmoL/L)		TAC(nmoL/L)		MDA(nmoL/L)	
		M ± SD	%Change of (C+)	M ± SD	%Change of (C+)	M ± SD	%Change of (C+)
G1Control (-)		35.97^{a}±1.798	+66.06	1.93^{a}±0.461	+112.08	16.17^{e}±0.808	-48.51
G2Control (+)		21.66^{d}±1.083	—	0.91^{c}±0.045	—	31.41^{a}±1.770	—
LepidiumSativum powder (LSP)	G3 2.5%	24.41^{c}±1.220	+12.69	1.28^{bc}±0.064	+40.65	28.91^{b}±1.445	-7.95
	G4 5%	28.57^{b}±1.418	+31.90	1.54^{ab}±0.075	+69.23	23.53^{c}±1.176	-25.08
	G5 10%	33.69^{a}±1.584	+55.54	1.85^{a}±0.092	+103.29	19.47^{d}±0.951	-38.01
LSD		2.6255		0.3924		2.3242	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Data in table (9) explained that serum of LDL-c, VLDL-c and AI were pronounced increased significantly (P≤0.05) besides decreased significantly (P≤0.05) of HDL-c andHDL-c/TC ratio of hepatic control (+) group as compared to control (-) group rats. All hepatic rats fed on diet containing 2.5%,5% and 10% LSP revealed dramatically decreases of serum LDL-c, VLDL-c,AIat the same time greatly increases of HDL-c and HDL-c/TC ratio.The best treatment was recorded for group 5 (hepatic rats fed on LSP 10% diet when compared to hepatic control (+) group where it had very efficacy a potent effect. These results are accordance with those of **Halaby *et al*.,(2015) and Shukla*et al*.,(2015)** who proved that *LepidiumSativum*seeds has the role of as hypolipidemic agent as LDL-c and VLDL-c and enhanced of HDL-c due to the existence of flavonoids, glucosinolates, tannins, alkaloids, triterpenes, sterols and benzylisothiocyanate as antioxidant agents where they decrease free radicals formation, have ability to overcome lipid peroxidation and scavenges the superoxide anion to form hydrogen peroxide thus decreases the toxic effect caused by the free radical.

Table (9):Effect of feeding *LepidiumSativum* powder (LSP) 2.5% , 5% and 10% on High density lipoprotein cholesterol (HDL-c), Low density lipoprotein cholesterol (LDL-c), Very low density lipoprotein cholesterol (VLDL-c), Atherogenic Index (AI) and HDL-c/TC ratio of CCL4-induced hepatotoxicity rats.

Parameters / Groups		HDL-c (mg/dl)		LDL-c (mg/dl)		VLDL-c (mg/dl)		AI (ratio)		HDL-c/TC (ratio)	
		M ±SD	% Change of (C+)	M ±SD	% Change of (C+)	M±SD	% Change of (C+)	M±SD	% Change of (C+)	M±SD	% Change of (C+)
G1 Control (-)		59.0^{a} ±1.475	+51.28	28.4^{e} ±0.568	-67.72	18.6^{e} ±0.465	-31.11	0.79^{e} ±0.039	-73.01	55.66^{a} ±2.641	+119.82
G2 Control(+)		39.0^{e} ±0.601	–	88.0^{a} ±1.090	–	27.0^{a} ±0.943	–	2.95^{a} ±0.148	–	25.32^{e} ±1.233	–
LepidiumSativum powder (LSP)	G3 2.5%	45.0^{d} ±0.951	+15.38	65.0^{b} ±1.463	-26.13	25.0^{b} ±0.357	-7.41	2.00^{b} ±0.112	-32.20	33.33^{d} ±1.632	+31.63
	G4 5%	49.0^{c} ±0.237	+25.64	55.8^{c} ±1.116	-36.59	21.2^{c} ±0.592	-21.48	1.57^{c} ±0.079	-46.78	38.88^{c} ±1.944	+53.55
	G5 10%	54.2^{b} ±0.210	+38.97	41.0^{d} ±0.855	-53.41	19.8^{d} ±0.149	-26.67	1.12^{d} ±0.056	-62.03	47.13^{b} ±2.367	+86.14
LSD		1.5311		1.9300		1.0309		0.1732		3.6873	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Biological results of gentamicin-induced nephrotoxicity rats:

Data in table (10) confirmed that there high significantly (P≤0.05) decreases of (BWG %),(FI g/28 day) and (FER) of nephritic control (+) group as compared to control (-) group. While all nephritic rats fed on diet containing 2.5%, 5% and 10% LSP showed widely increases in BWG%, FI and FER comparison to nephritic control (+) group. The best treatment was recorded for group 9 (nephritic rats fed on LSP 10% diet) where it had improvement effect of FER. These results are in agreement with those of **Yadav*et al.*,(2009) and Halaby *et al.*,(2015)**who noticed that the feeding of acute renal failure rats with garden cress seeds powder at 5% & 10% in both of curative and protective groups led to improved body weight gain, feed intake and feed efficiency ratio, due to nutrients this seeds contains as 25% protein (glycine, cysteine and glutamine) 33-54 %carbohydrate, 8%crude fiber and 14-24% lipids, where18-24% of fat which 34% of total fatty acids is alpha linolenic acid and 30.6 % oleic, which give it nutritional advantages in addition good amount of lignans, antioxidants and high concentrations of tocopherols which have a role in help to reduce gastrointestinal toxicity and cause to recover of body weight and normal urinary volume.

Table(10): Effect feeding *LepidiumSativum* powder (LSP) 2.5% , 5% and 10% on body weight gain (BWG%), feed intake (Fig/28 day) and feed efficiency ratio (FER) of gentamicin-induced nephrotoxicity rats.

Parameters / Group		BWG %		FI (g 28/day)		FER	
		M ±SD	%Change of (C+)	M ±SD	%Change of (C+)	M ± SD	%Change of (C+)
G1 Control (-)		62.50^{a}±2.120	+233.33	364^{a}±2.545	+62.50	0.275^{a}±0.011	+106.77
G6 Control (+)		18.75^{e}±0.730	—	224^{e}± 1.851	—	0.133^{c}±0.005	—
LepidiumSativumPowder(LSP)	G7 2.5%	31.25^{d}±1.220	+66.67	249.20^{d}±1.325	+11.25	0.200^{b}±0.009	+50.38
	G8 5%	46.88^{c}±1.340	+150.03	294^{c}±1.739	+31.25	0.255^{a}±0.012	+91.73
	G9 10%	59.38^{b}±2.000	+216.69	358.40^{b}±2.361	+60.00	0.265^{a}±0.013	+99.25
LSD		2.8547		3.6618		0.0189	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Results in table (11) showed of relative weight of organs liver, spleen , kidney, heart and Lung of control (+) group were greatly increased significantly (P≤0.05) as compared to control (-) group, while nephritic groups fed on diet containing 2.5%,5% and 10% LSP revealed improvement and high gradual decreased in BWG%, FI g and FER comparison to control (+) group. The best results were observed of group5 (nephritic rats fed on diet containing 10%LSP) where it recorded insignificant differences in mean values of all relative weight of organs comparison to control (-) group.**Jabeen*et al.*,(2017)** who demonstrated that greatly decreased of all organ weights and begin to return to normal in curative and protective groups in acute renal failure (ARF) of rats were feed with LSP at 5% and 10%where this is due to the presence cardiotonic glycosides, glucosinolates, sothiocynates glycoside, sterols, tannins, and triterpene, beside β-carotene, riboflavin, niacin and ascorbic acid as acute anti-inflammatory, antioxidant, anticancer and boosts up the immune system.

Table (11): Effect of feeding *LepidiumSativum* powder (LSP) 2.5%,5% and 10% on relative weight of organs (liver, spleen, kidney, heart and Lung) of Gentamicin-induced nephrotoxicity rats.

Parameters / Groups		Liver		Spleen		Kidney		Heart		Lung	
		M ± SD	% Change of (C+)	M ± SD	% Change of (C+)	M± SD	% Change of (C+)	M± SD	% Change of (C+)	M± SD	% Change of (C+)
G1 Control (-)		3.09^{d}±0.130	-44.12	0.23^{d}±0.010	-61.02	0.63^{d}±0.030	-73.33	0.29^{d}±0.013	-68.82	0.44^{d}±0.021	-57.28
G2 Control(+)		5.53^{a} ±0.250	—	0.59^{a}±0.019	—	1.35^{a}±0.056	—	0.93^{a}±0.035	—	1.03^{a}±0.051	—
LepidiumSativum powder (LSP)	G7 2.5 %	4.63^{b}±0.230	-16.27	0.39^{b}±0.018	-33.89	0.96^{b}±0.047	-28.89	0.44^{b}±0.022	-52.69	0.81^{b}±0.040	-21.36
	G8 5%	3.92^{c} ±0.180	-29.11	0.30^{c}±0.014	-49.15	0.81^{c}±0.030	-40.00	0.34^{c}±0.016	-63.44	0.66^{c}±0.022	-35.92
	G9 10 %	3.26^{d} ±0.150	-41.05	0.25^{d}±0.120	-57.63	0.68^{d}±0.024	-49.63	0.30^{d}±0.015	-67.74	0.47^{d}±0.013	-54.37
LSD		0.3520		0.0272		0.0714		0.0395		0.0592	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Results in table (12) exhibited that levels of creatinine, urea and uric acid of nephritic control (+) group were markedly increased significantly (P≤0.05) as compared to control (-) group.All nephritic rats fed on diet containing 2.5%, 5% and 10% LSP showed dramatically decreases significant in levels of kidney function comparison to nephritic control(+)group. The best treatment was recorded for group 9 (nephritic rats fed on LSP 10% diet) where it had the active effect in correction kidney function. The feeding of 5% and 10% LSP to rats injured with renal toxicity due oxidative stress by cisplatin led to

improving on renal function where markedly reduced level of urea, uric acid and creatininewhile increase glomerular filtration rate, this is due to that LSP contained flavonoid and polyphenolic compounds which is responsible for its strong antioxidant capacity and decline the risks complications of ARF**Yadav*et al.*, (2010) and Yadav&Srivastav, (2012).**

Table(12):Effect of feeding *LepidiumSativum* powder (LSP) 2.5%, 5% and 10% on creatinine, urea, and uric acid of gentamicin-induced nephrotoxicity rats.

Parameters / Group		Creatinine (mg/dl)		Urea (mg/dl)		Uric acid (mg/dl)	
		M ± SD	% Change of (C+)	M ± SD	% Change of (C+)	M ±SD	% Change of (C+)
G1 Control (-)		0.43^{d}±0.011	-70.75	18.22^{d}±0.712	- 46.01	1.31^{d}±0.057	-62.78
G6 Control (+)		1.47^{a}±0.074	—	33.75^{a}±1.351	—	3.52^{a}±0.176	—
LepidiumSativum Powder(LSP)	G72.5%	1.26^{b}±0.063	-14.29	29.60^{b}±1.172	- 12.29	2.41^{b}±0.121	- 31.53
	G8 5%	0.94^{c}±0.047	-36.05	25.32^{c}±1.012	- 24.97	1.97^{c}±0.098	- 44.03
	G910%	0.48^{d}±0.024	-67.34	18.85^{d}±0.943	- 44.14	1.42^{d}±0.071	- 59.66
LSD		0.0904		1.9286		0.2050	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Data in table (13) indicated that Na and Ca recorded high significant decreases meanwhile K and P revealed high significant increases in nephritic control (+) group as compared to control (-) group.Furthermore all nephritic rats fed on diet containing 2.5%, 5% and 10% LSP achieved markedly increased significantly (P≤0.05) in Na and Ca, besides dramatically decreased significantly (P≤0.05) in K and Pcomparison to nephritic control (+) group.The best results were appeared for group 9 (nephritic rats fed on LSP 10% diet) is due to its efficient in correcting disorder in renal function.**Adam,(1999) and Juma,(2007)**reported that the beneficial properties of LSS induced marked efficiency in fracture healing in rabbits and has effects that enhance the bone. **Maghrani*et al.*, (2005)**observed that the oral

administration of aqueous and methanol extract of LSS in hypertensive rats caused in widely increase of urinary elimination of the excess Na($p<0.01$), K ($p<0.001$)and chlorides($p<0.001$) is due to the presence of polar compounds such as flavonoids and steroids in it.

Table (13): Effect of *LepidiumSativum* Powder (LSP) 2.5%, 5% and 10% on minerals sodium (Na), potassium (K), calcium (Ca) and phosphorus (P) of gentamicin -induced nephrotoxicity rats.

Parameters / Group		Na(mmoL/L)		K (mmoL/L)		Ca (mmoL/L)		P (mmoL/L)	
		M± SD	%Change of (C+)	M± SD	%Change of (C+)	M± SD	%Change of (C+)	M ± SD	%Change of (C+)
G1 Control (-)		140[a] ± 2.330	+10.24	4.22[d] ±0.084	- 44.03	13.56[a] ± 0.271	+90.18	5.71[d] ±0.114	-42.38
G6 Control (+)		127[d] ± 2.821	–	7.54[a] ±0.305	–	7.13[e] ± 0.237	–	9.91[a] ± 0.196	–
LepidiumSativumPowder(LSP)	G7 2.5%	130[cd] ± 3.011	+2.36	6.92[b] ± 0.252	-8.22	8.51[d] ± 0.383	+19.35	9.04[b] ± 0.325	-8.77
	G8 5%	134[bc] ± 2.233	+5.51	5.70[c] ±0.143	-24.40	10.11[c] ± 0.131	+41.79	7.22[c] ± 0.206	-27.14
	G9 10%	138[ab] ±1.971	+8.66	4.40[d] ±0.271	-41.64	12.76[b] ± 0.423	+78.96	5.90[d] ± 0.169	-40.46
LSD		4.5535		0.4128		0.5591		0.3885	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Results in table (14) illuminated that GPX, SOD and CAT of nephritic control (+) group showed high obvious decreases as compared to control (-) group. While all nephritic rats fed on diet containing 2.5%, 5% and10% LSP revealed significant increases in GPX, SOD and CAT comparison to nephritic control (+) group. The best treatment was recorded for group 9 (nephritic rats fed on LSP 10% diet) where it had active effect to repair antioxidant enzymes. These data are in agreement **Behrouzian*et al*., (2014) and Doke&Guha (2014)** who confirmed that when use the ethanolic extract of garden cress seeds against cisplatin induced nephrotoxicity in adult male Wistar rats dramatically increased in glutathione level while decreased lipid peroxidation and reactive oxygen species in protective and curative nephrotoxicity groups.

Table(14): Effect of *LepidiumSativum* Powder (LSP) 2.5%, 5% and 10% on activities of antioxidant glutathione pyroxidase (GPX), superoxide dismutase (SOD) and catalase (CAT) enzymes of gentamicin-induced nephrotoxicity rats.

Parameters / Group		GPX (ng/dl)		SOD (U/L)		CAT(mmoL/L)	
		M ± SD	% Change of (C+)	M ± SD	% Change of (C+)	M ± SD	% Change of (C+)
G1 Control (-)		82.53^{a}±2.225	+61.60	54.75^{a}±1.985	+82.26	75.74^{a}±2.887	+103.00
G6 Control (+)		51.07^{d}±1.955	—	30.04^{d}±1.502	—	37.31^{d}±1.866	—
LepidiumSativum Powder(LSP)	G72.5%	60.72^{c}±2.035	+18.89	42.33^{c}±1.951	+40.91	55.00^{c}±2.570	+47.41
	G8 5%	71.15^{b}±1.551	+39.31	46.47^{b}±2.135	+54.69	62.74^{b}±2.135	+68.15
	G9 10%	79.78^{a}±2.277	+56.21	52.53^{a}±1.641	+74.86	71.95^{a}±2.054	+92.84
LSD		3.6841		3.3795		4.3171	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Data in table (15) confirmed that GST and TAC of nephritic control (+) group revealed very high significant decreases, meanwhile MDA recorded very high significant increases when compared to control (-) group. All nephritic rats fed on diet containing 2.5%,5% and10% LSP caused markedly increases in GST, TAC and recorded very pronounced decreases in MDA as compared to nephritic control(+)group. The best treatment was group 9(nephritic rats fed on LSP 10%)is due it had action effect in improvement antioxidant enzymes. These results are accordance with **Chauhan*et al.*,(2012)** who found that themethanolic extract of LSScontain a noticeable amount of total phenols, polyphenolic, flavonoids and isoflavonoids as natural antioxidants which has a major role in controlling oxidation with potential application to reduce oxidative stress and raised TAC.

Table (15): Effect of *LepidiumSativum* Powder (LSP) 2.5%, 5% and10% on activities of antioxidant glutathione transferase (GST), total antioxidant capacity (TAC) and oxidant enzymatic malondialdehyde (MDA) enzymes of gentamicin -induced nephrotoxicity rats.

Parameters / Group		GST(mmoL/L)		TAC(nmoL/L)		MDA(nmoL/L)	
		M ± SD	% Change of (C+)	M ± SD	% Change of (C+)	M ± SD	% Change of (C+)
G1 Control (-)		35.97^{a}±1.798	+89.92	1.93^{a}±0.461	+127.06	16.17^{d}±0.808	-54.61
G6 Control (+)		18.94^{d}±1.947	—	0.85^{b}±0.042	—	35.63^{a}±1.780	—
*LepidiumSativum*Powder(LSP)	G7 2.5%	22.35^{c}±1.118	+18.00	1.39^{a}±0.095	+63.53	30.21^{b}±1.511	-15.21
	G8 5%	27.12^{b}±1.356	+43.19	1.61^{a}±0.081	+89.41	25.32^{c}±1.266	-28.93
	G9 10%	34.88^{a}±1.744	+84.16	1.89^{a}±0.069	+122.35	18.11^{d}±0.905	-49.54
LSD		2.9507		0.3940		2.3756	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Data in table (16) illustrated that there increased significantly (P≤0.05) of LDL-c, VLDL-c and AI besides decreased significantly (P≤0.05) of HDL-c and HDL-c/TC ratio of nephritic control (+) group comparison to control (-) group rats. Furthermore all nephritic rats fed on diet containing 2.5%, 5% and10% LSP revealed markedly decreases of LDL-c, VLDL-c and AI as well dramatically increases of HDL-c.The best results was appeared for group 5 (nephritic rats fed on LSP 10% diet) where it had a potent effect. These results are consistent with **(Olsson & Yuan,1996; Kirtkar&Basu,2005 and Hamer &Steptoe,2006)**who found that LSS widely reduced risk of fatal ischemic heart disease in heart attacks and mortality from chronic vascular disease, because it is rich in linolenic acid which have decrease platelet aggregation, TC, LDL-c and TG in humans and rats.

Table (16) :Effect of feeding *LepidiumSativum* powder (LSP) 2.5% , 5% and 10% on High density lipoprotein cholesterol (HDL-c), Low density lipoprotein cholesterol (LDL-c), Very low density lipoprotein cholesterol (VLDL-c), Atherogenic index (AI) and HDL-c/TC ratio of Gentamicin-induced nephrotoxicity rats.

Parameters / Groups		HDL-c (mg/dl)		LDL-c(mg/dl)		VLDL-c(mg/dl)		AI (ratio)		HDL-c/TC (ratio)	
		M±SD	% Change of (C+)	M±SD	% Change of (C+)	M±SD	% Change of (C+)	M±SD	% Change of (C+)	M±SD	% Change of (C+)
G1 Control (-)		59.0^{a} ±1.475	+43.90	28.4^{e} ±0.568	-65.19	18.6^{e} ±0.465	-26.77	0.79^{e} ±0.039	-69.50	55.66^{a} ±2.641	+ 100.94
G6Control (+)		41.0^{e} ±0.844	—	81.6^{a} ±1.832	—	25.4^{a} ±0.595	—	2.61^{a} ±0.104	—	27.70^{e} ±1.385	—
LepidiumSativum Powder(LSP)	G7 2.5%	50.0^{d} ±0.625	+21.95	57.8^{b} ±0.963	-29.17	24.2^{b} ±0.245	-4.72	1.64^{b} ±0.066	-37.16	37.87^{d} ±1.893	+36.71
	G8 5%	52.6^{c} ±0.484	+28.29	45.0^{c} ±1.051	-44.85	22.4^{c} ±0.302	-11.81	1.28^{c} ±0.051	-50.96	43.83^{c} ±1.682	+58.23
	G9 10%	56.0^{b} ±0.509	+36.59	35.0^{d} ±0.388	-57.11	20.0^{d} ±0.153	-21.26	0.98^{d} ±0.039	-62.45	50.45^{b} ±2.018	+82.13
LSD		1.5801		1.9697		0.7037		0.1173		3.5815	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Results in table (17) described that level glucose in nephritic control (+) group was very higher than the same level in control (-) group. Were as all nephritic rats fed on diet containing 2.5%, 5% and10% LSP showed very significant decrease in glucose compared to nephritic control (+) group. The best treatment was recorded for group5 (nephritic rats fed on LSP 10% diet) where it had strong action in reducing level glucose. Both **Maier *et al.*, (1998) and Eddouks*et al.*,**

(2002) who confirmed that *Lepidiumsativum* seed has the significant antidiabetic and cytoprotective activity in type I diabetic rats through phytochemicals study in it (flavonoids and glycosides) which have able to act and stimulate pancreaticβ-cells to secrete insulin and enhance glucose metabolism.

Table (17) : Effect of feeding *LepidiumSativum*powder (LSP) 2.5% , 5% and10% on blood glucose of Gentamicin-induced nephrotoxicity rats.

Parameters / Groups		Glucose (mg/dl)	
		M ± SD	% Change of (C+)
G1 Control (-)		97^{e}±2.801	-38.22
G2 Control (+)		157^{a}± 2.774	—
Lepidium Sativum powder (LSP)	G3 2.5%	130^{b}± 1.967	- 17.19
	G4 5%	118^{c}± 2.013	-24.84
	G5 10%	102^{d}± 1.547	- 35.03
LSD		4.1369	

Means in the same column with different letters are significantly different (P ≤ 0.05).

Histopathological changes:

Hepatotoxicity Rats:-

Microscopically,Liver of rats from group 1 control (-) group (normal rats) revealed the normal histological structure of hepatic lobule (Photo.1).In contrary, liver of rats from group 2 control (+) group (hepatic non-treated rats) showed activation of kupffer cells and inflammatory cells infiltration in the portal triad (Photo.2). However, sections from group 3 (hepatic LSP 2.5% treated rats) appeared no changes except activation of kupffer cells (Photo.3). Moreover, liver from group 4 (hepatic LSP 5% treated rats) showed kupffer cells activation (Photo.4). Meanwhile, liver from group 5 (hepatic LSP 10% treated rats) evidenced no histopathological changes (Photo.5).

Nephrotoxicity Rats:-

Microscopically kidneys of rats from group 1 control (-) group (normal rats) revealed the normal histological structure of renal parenchyma (Photo.6).In contrary, kidneys of rats from group 6 control (+) group (nephritic non-treated rats) revealed necrobiosis of epithelial lining renal tubules and vacuolation of endothelial lining glomerular tuft (Photo.7). However, kidneys of rats from group 7 (nephritic LSP 2.5% treated rats) showed vacuolation of epithelial lining renal tubules and endothelial lining glomerular tuft (Photo.8). Kidneys of rats from group 8 (nephritic LSP 5% treated rats) revealed no histopathological changes

except vacuolation of endothelial lining glomerular tuft (Photo. 9). Moreover, vacuolation of endothelial lining glomerular tuft was the only change observed in kidneys from group 9 (nephritic LSP 10% treated rats) (Photo.10).

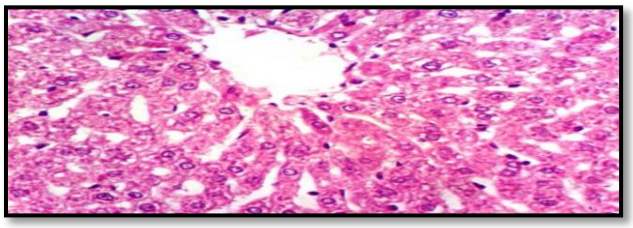

Photo (1): Liver of rat from group 1 control (-) group (normal rats) showing the normal histological structure of hepatic lobule (H & E X400).

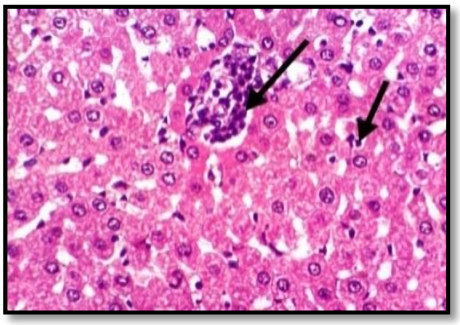

Photo (2): Liver of rat from group 2 control (+) group (hepatic non-treated rats) appeared activation of Kupffer cells and inflammatory cells infiltration in the portal triad (H & E X 400).

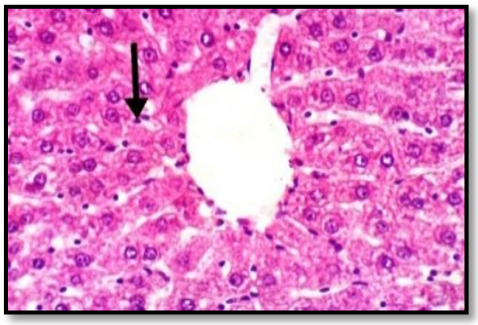

Photo (3): Liver of rat from group 3 (hepatic LSP 2.5% treated rats) it clear effective in most of cells Kupffer (H & E X400).

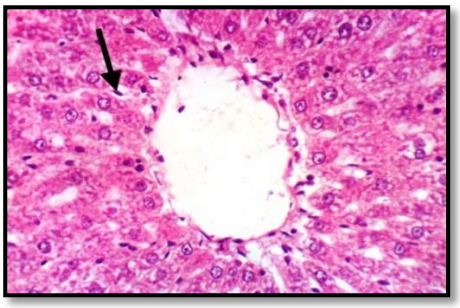

Photo (4): Liver of rat from group 4 (hepatic LSP 5% treated rats) it clarify effective of Kupffer cells (H & E X 400).

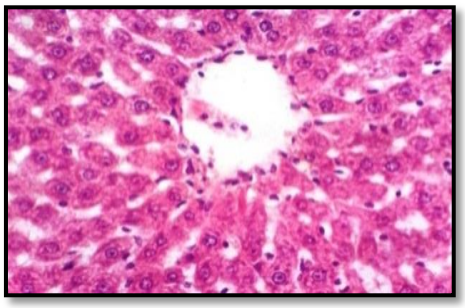

Photo (5): Liver of rat from group 5 (hepatic LSP 10% treated rats) becomeclear normal cells (H&E X 400).

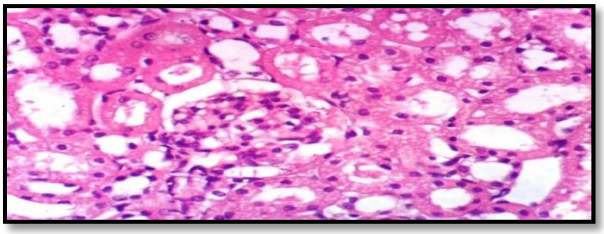

Photo (6): Liver of rat from group 1 control (-) group (normal rats) conspicuous the normal histological structure of hepatic lobule (H & E X 400).

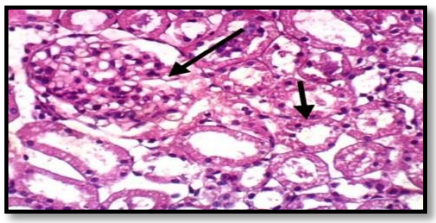

Photo (7): Kidney of rat from group 6 (nephritic non-treated rats) showing necrobiosis of epithelial lining renal tubules and vacuolation of endothelial lining glomerular tuft (H & E X 400).

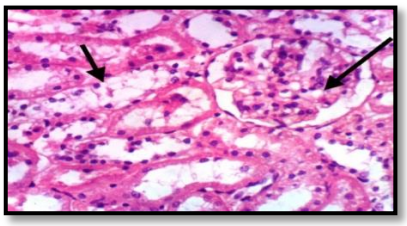

Photo (8): Kidney of rat from group 7(nephritic LSP 2.5%treated rats) evidenced vacuolation of epithelial lining renal tubules and endothelial lining glomerular tuft (H & EX 400

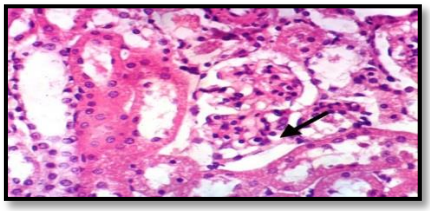

Photo (9): Kidney of rat from group 8 (nephritic LSP 5% treated rats) was obviously vacuolation of endothelial lining of glomerular tuft (H & E X 400).

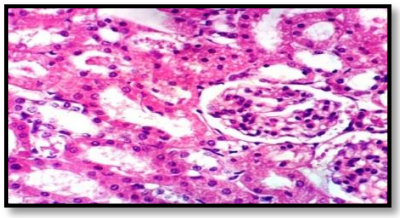

Photo (10): Kidney of rat from group 9(nephritic LSP 10% treatedrats) it clear no histopathological change (H & E X 400).

Technological results:

Technological results of organoleptic evaluation of bread:-

Results in table (18) revealed that insignificant (P≤0.05) differences in all organoleptic evaluation factors of control bread and bread supplemented with 2.5% , 5% and10% LSP. **Agarwal and Sharma, (2013)**confirmed that *L. Sativum* seeds are rich source of many compounds nutritional helpful in preventing and curing various diseases and therefore Incorporation of garden cress seeds into food products like dahiwala bread developed, benefited all age group individuals for

nourishment and those at risk or suffering from anemia, fractures and diabetes mellitus and the other chronic degenerative diseases.

Table (18):Organoleptic evaluation of bread with *LepidiumSativum* powder (LSP) at 2.5 % , 5% and 10%.

Factor / Bread		Color	Odor	Taste	Texture	Overall acceptability
		M + SD	M + SD	M + SD	M + SD	M + SD
Control		9.5^a ±0.506	9.6^a ±0.483	9.7^a ±0.389	9.9^a±0.571	9.7^a ±0.322
*LepidiumSativum*powder (LSP)	2.5%	9.4^a ±0.544	9.5^a ±0.354	9.5^a ±0.481	9.9^a ±0.726	9.5^a ±0.609
	5%	9.4^a ±0.385	9.5^a ±0.422	9.5^a ±0.672	9.8^a ±0.654	9.7^a ±0.736
	10%	9.3^a ±0.471	9.6^a ±0.611	9.7^a ±0.712	9.8^a ±0.611	9.7^a ±0.810
LSD		0.9039	0.8980	1.0902	1.2108	1.2174

Means in the same column with different letters are significantly different (P ≤ 0.05).

Technological results of organoleptic evaluation of apple juice:-

Data in table (19) showed that all factors of color, odor, taste, texture and overall acceptability of control apple were insignificantly (P≤0.05) differences as compared to the corresponding factors in apple juice supplemented with 2.5%,5% and 10% LSP. Apple juice supplemented with 10 % LSP recorded higher scores in all factors of organoleptic than apple juice supplemented with 2.5% and 5 % LSP. **Singh *et al*., (2015)** confirmed that seeds of garden cress plants are good source of biologically active compounds as amino acids, minerals and fatty acids where it have the ability to act as in vivo and in vitro as the antioxidant capacity due to their high content of phenolic compounds. Therefore the functional health benefits of GCS may be exploited by incorporating it in several food formulations and health drink preparations.

Table(19):Organoleptic evaluation of apple juice with *LepidiumSativum* powder (LSP) at 2.5 % , 5% and 10%.

Factor / Apple Juice		Color	Odor	Taste	Texture	Overall acceptability
		M + SD	M + SD	M + SD	M + SD	M + SD
Control		9.7^a +0.483	9.7^a +0.422	9.7^a +0.348	9.8^a +0.471	9.3^a +0.530
Lepidium Sativum powder (LSP)	2.5%	8.9^a ±1.105	9.0^a ±1.093	8.5^a ±1.305	8.7^a ±1.073	8.5^a ±1.191
	5%	8.9^a ±1.232	9.0^a ±1.141	8.7^a ±1.261	8.7^a ±1.125	8.5^a ±1.306
	10%	9.3^a ±1.113	9.2^a ±1.064	8.9^a ±1.072	8.9^a ±1.091	8.8a ±1.074
LSD		1.9318	1.8362	2.0365	1.9704	2.0099

Means in the same column with different letters are significantly different (P ≤ 0.05).

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دراسة التأثيرات الكيميائية والتغذوية والبيولوجية العلاجية لحب الرشاد (الثفاء) على فئران التجارب.

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الملخص العربى:.

يهدف هذا البحث الي دراسة تأثير بذور حب الرشاد (الثفاء) بتركيز(2,5٪ - 5٪- 10٪) في النظام الغذائي لفئران التجارب المصابة بالتسمم الكبدي الحادث بالحقن بمادة برابع كلوريد الكربون والتسمم الكلوي الحادث بالحقن بمادة الجنتاميسين ومعرفة التقييم الحسى للخبز وعصير التفاح عند اضافته. تم تقسيم 45 فأر من الذكور البالغين الاصحاء سلالة سبراغ داولي إلى تسعة مجموعات كل مجموعة تحتوي علي 5 فئران. مجموعة (1): المجموعة الضابطة السالبة الطبيعية وتغذت على الغذاء الأساسي والماء فقط. المجموعة (2):المجموعة الضابطة الموجبة المصابة بالتسمم الكبدي وتغذت على الغذاء الأساسي والماء فقط. مجموعة (3):مصابة بالتسمم الكبدي وتغذت على الغذاء الأساسي محتوى على 2,5٪ من مسحوق حب الرشاد .مجموعة (4):مصابة بالتسمم الكبدي وتغذت على الغذاء الأساسي محتوى على 5٪ من مسحوق حب الرشاد .مجموعة (5):مصابة بالتسمم الكبدي وتغذت على الغذاء الأساسي محتوى على 10٪ من مسحوق حب الرشاد. مجموعة (6):المجموعة الضابطة الموجبة المصابة بالتسمم الكلوي وتغذت على الغذاء الأساسي والماء فقط . مجموعة (7):مصابة بالتسمم الكلوي وتغذت على الغذاء الأساسي محتوى على 2,5٪ من مسحوق حب الرشاد. مجموعة (8):مصابة بالتسمم الكلوي وتغذت على الغذاء الأساسي محتوى على 5٪ من مسحوق حب الرشاد. مجموعة (9):مصابة بالتسمم الكلوي وتغذت على الغذاء الأساسي محتوى على 10٪ من مسحوق حب الرشاد. وفى نهاية التجربة (بعد 28 يوم) تم تصويم الفئران 12 ساعة عن الغذاء وساعتين عن الماء ثم وزنهم ثم ذبحهم وتجميع عينات الدم في أنابيب زجاجية جافة معقمة واجراء طرد مركزي لمدة 10 دقائق حيث 3000 لفة دائرية في الدقيقة لفصل المصل (السيرم) ثم سحب المصل بعناية ونقله إلى أنابيب إبندورف الجافة والنظيفة والمرقمة برقم كل فأر على حدة وذلك لإجراء التحاليل البيو كيميائية . وتم حساب الوزن المكتسب ونسبة المأخوذ من الغذاء ومعدل كفاءة الاستفادة من الغذاء. اعضاء الكبد والكلي والقلب تم ازالهم جراحيا بعناية للفحص الهستوباثولوجى واظهرت نتائج جميع مجموعات التسمم الكبديوالكلوي والمعالجة بحب الرشاد انخفاض شديد في مستويات كلا من AST, ALT, ALP, GGT, urea, uric acid, creatinine, Glo, T.Bil, D.Bil,Ind.Bil, MDA,TC, TG, LDL-c, VLDL-c, AI and glucose بجانب زيادة كبيرة في مستويات كلا من BWG, FI, FER, Tp, Alb, GPX, SOD, CAT, GSTs, TAC, HDL-c and HDL-c/TC ratio .وفيما يتعلق بمستويات K و P انخفضت بينما مستويات Naو Ca ارتفعت في الفئران المصابة بالتسمم الكلوي والمعالجة بحب الرشاد، كما اظهر الفحص الهستوباثولوجى تحسن ملحوظ جدا للكبد والكلى في جميع المجموعات المصابة بالتسمم الكبدي والكلوي والمعالجة بمسحوق حب الرشاد وسجلت مجموعة حب الرشاد 10% أفضل النتائج في جميع المجموعات المعالجة من التسمم الكبدي والكلوي وايضا في التقييم الحسيللخبز وعصير التفاح.

الاستنتاج:-أثبتت هذه الدراسة أن حب الرشاد له فعالية كبيرة في علاج أمراض الكبد والكلى والحماية من المضاعفات المرتبطة بهم كما أنه يحتوي على العديد من المركبات الكيميائية النباتية التي تلعب دورًا مهمًا وفعالًا في عمليات التمثيل الغذائي وأداء وظائف بيولوجية هامة خلال دورة الحياة.

الكلمات المفتاحية:- حب الرشاد - التسمم الكبدي - التسمم الكلوي - وظائف الكبد - وظائف الكلى- المعادن الكبرى- الأنزيمات المضادة للأكسدة والمؤكسدة- دهون الدم- جلوكوز الدم- الفحص الهستوباثولوجى- التقييم الحسي.