J. Agric. Sci. Mansoura Univ., 32 (8): 6487 - 6496, 2007

BIOLOGICAL EVALUATION OF IRRADIATED CORIANDER FRUITS (*Coriandrum sativum* L.) AND IT'S ESSENTIAL OIL

Badee, A.Z.M. [*]; A.T. El-Akel[*]; A.H. Rady[**] and M.A. Abdelaleem [✉] [**]

[*] Food Science Department, Faculty of Agriculture, Cairo University.

[**] Atomic Energy Authority, Nuclear Research Center, Abou-Zaabal, P.N.13759, Egypt.

ABSTRACT

The effect of adding coriander fruits or its essential oil before and after irradiation at dose of 4 kGy to rat's diet was studied. The spice in different treatments had a significant hypolipidemic action. The levels of triglycerides were significantly decreased, while total cholesterol and glucose were non-significantly decreased in the serum of the animals of the experimental group which fed on diets containing coriander powder and coriander essential oil in all treatments comparing with the control group. The level of LDL and VLDL cholesterol was decreased while that of HDL cholesterol was increased in the experimental group compared to the control group. Also, liver and kidney functions were examined and there were no significant differences. The experiment showed there were no significant differences between treated groups and control group in blood hematology.

Keywords: Gamma irradiation; *Coriandrum sativum*; Essential oil; Cholesterol; Triglycerides; Lipoproteins

INTRODUCTION

Spices were reported to possess hypolipidemic activity (Sharma and Raghuram, 1991). In some studies on coriander fruits, no flavour changes were detected on irradiation at the higher decontamination dose of 10 kGy (Nair *et al*., 1996). The effect of both irradiation doses (5 and 10 kGy) on black pepper, anise, fennel, turmeric and coriander showed effective decontamination treatment on both doses, but there were observed losses of flavour components, particularly at the higher dose (10 kGy). Therefore, the recommendation is that the sensory changes in the threshold level were at doses between 5 and 10 kGy (Farag and El Khawas, 1996). In addition, Munasiri *et al*. (1987) confirmed that the dose 5 kGy had no effect on spices (black pepper, red chilli, turmeric, curry powder and coriander fruits) quality. The administration of coriander fruits (*Coriandrum sativum* L.) on the metabolism of lipids in rats fed on high fat diet with added cholesterol had a significant hypolipidemic action. The levels of total cholesterol and triglycerides significantly decreased in the tissues of the experimental group animals, which received coriander fruits.

The enhancement in high density lipoprotein (HDL) besides the decrease in low density lipoprotein (LDL) and very low density lipoprotein (VLDL) in serum could be beneficial in many heart diseases (Chithra and leelamma, 1997). Coriander essential oil might be useful for modeling the levels of arachidonate in lipids of cerebral membranes in specific conditions of health and disease (Weber *et al*., 1999). Some spices such as, coriander (2.0%), cumin (1.25%), ajwan (0.2%), fennel (0.5%), mint (1.0%) and garlic (0.5%)

✉ **Correspondent: Abdelrazek_MD@hotmail.com**

were examined for their influence on bile secretion rate and bile acid content of bile in experimental rats both as a result of continued dietary intake and single oral dose of the test spice. The biliary solids were higher in the case of dietary cumin, coriander, ajwan, fennel and mint (Platel and Srivnivasan, 2000). Nowadays, the use of ionizing radiation is one of the most effective means for microbial decontamination in dried herbs and phytopreparations (Migdal *et al*., 1998). Therefore, the main aim of the present study was to investigate the physiological effects of adding coriander fruits (powder) or its essential oil, before and after irradiation at dose of 4 kGy, to rats fed.

MATERIALS AND METHODS

Materials:

Animals: A total of 25 weanling male albino rats, average weight of (55-60g.) were used for the present study in the animal lab of the Research Institute of Ophthalmology, Giza, Egypt were used in the present study. The animals were divided into 5 groups (each of 5 rats). All rats were fed for 6 weeks of the experiments and water available *ad. Libitum*. The composition of the basal diet and experimental groups are shown in table (1).

Spices: Coriander fruits (*Coriandrum sativum* L.) were obtained from Agriculture Research Center (ARC) – Ministry of Agriculture, Cairo, Egypt. The fruits were divided into two groups whether irradiated or not irradiated. The first group was ground and mixed with the diets for (G4 and G5). The second group was treated by steam distillation and the obtained essential oil was mixed with diets for (G2 and G3).

Table (1): Experimental groups and diets.

Groups Ingredients	G1	G2	G3	G4	G5
Casein*	21.7	21.7	21.7	21.7	21.7
Corn starch	53.3	53.255	53.255	51.8	51.8
Sucrose	15	15	15	15	15
Vegetable oil**	5	5	5	5	5
Vitamin mix.	1	1	1	1	1
Mineral mix.	4	4	4	4	4
Coriander essential oil 0.9%	--	0.045	--	--	--
Irradiated coriander essential Oil 0.9%	--	--	0.045	--	--
Coriander powder 1.5%	--	--	--	1.5	--
Irradiated coriander powder 1.5%	--	--	--	--	1.5

*** Casein contained 90% protein. Basal Diet as designed by Tebib *et al*., 1997.**

**** Vegetable oil: Sunflower oil.**

Methods:

Irradiation treatment:

Coriander fruits and its essential oil were treated with gamma irradiation at dose 4 kGy by ^{60}Co source in Nuclear Research Center-Atomic Energy Authority of Egypt.

Blood sampling:

Blood samples were taken at the end of the experiment (42 days) of the administration of the tested materials (coriander powder and its essential oil). The blood samples were obtained from orbital plexus venous by means of the fine capillary glass tubes according to the method described by Schermer,

1967. Each sample was placed in a dry and clean centrifuge tube and allowed to clot (undisturbed) for 1-2 hr. at 37 °C. Sera were then removed using a Pasteur pipette and centrifuge for 10 min. at 3000 rpm to remove any suspended red blood cells. The clean non haemolysed supernatant serum was then pipetted into a Wasserman tube and kept frozen at -17 °C until analysis. Serum triglycerides (TG), total cholesterol (TC), high density lipoprotein (HDL), low density lipoprotein (LDL), very low density lipoprotein (VLDL), serum transaminases (ALT and AST), createnine, urea and glucose were determined. Finally, Whole blood samples were collected from eye vein under diethyl ether anesthesia as mentioned by (Dhandapani *et al*., 2002). The samples were taken into tubes with heparinized as anticoagulation and detection of hemoglobin, red blood cells (R.B.Cs), white blood cells (W.B.Cs), platelets and lymphocytes were done.

Analytical methods:

Determination of triglycerides:

Triglycerides in serum were determined by using the enzymatic colourimeteric method described by Trinder (1969) and Tietz (1995).

Determination of total cholesterol:

Total cholesterol in serum was determined by enzymatic colourimeteric method according to Trinder (1969).

Determination of high-density lipoprotein cholesterol (HDL):

Separation of HDL fraction with phosphotungstic acid in the presence of magnesium ions and enzymatic colorimetric determination was estimated according to Tietz (1995).

Determination of low-density lipoprotein cholesterol (LDL):

Separation of LDL fraction with heparin and enzymatic colourimeteric determination was estimated according to Tietz (1995).

Determination of serum Very low-density lipoprotein cholesterol (VLDL):

Serum VLDL-cholesterol was calculated according to Wallach (1992) using the following equation:

$$\text{VLDL-cholesterol} = \frac{\text{Serum triglycerides}}{5}$$

Determination of liver functions (ALT and AST):

Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities were assayed by the method of Reitman and Frankel (1957).

Determination of kidney functions (creatinene and urea):

Createnine in serum was measured using the method of Young *et al*. (1972) and urea was measured using the method of Patton and Crouch (1977).

Determination of glucose:

Glucose in serum was determined by enzymatic colourimeteric method according to Barham and Trinder (1972).

Organs:

At the end of the experimental period (42 days), rats were sacrificed then brain, liver, pen renal, heart, kidney, tests, lung and spleen were removed from rats immediately and weighted (Chithra and Leelamma, 1997; Willatgamuwa *et al*., 1998 and Al-Mofleh *et al*., 2006).

Statistical analysis:

The obtained results subjected to statistical analysis using the standard analysis of variance as outlyined by Snecdecor and Cochran (1980). Factorial analysis containing one factor in randomized completely blot design (RCBD) as described by Gomez and Gomez (1984) was used. The differences between means were tested for significance against the least significance range (LSR).

RESULTS AND DISCUSSIONS

The effect of administration of coriander fruits powder and its essential oils for a period of 6 weeks on body weight of rats were studied. The data are summarized in table (1).

Table (1): Effect of feeding with different experimental diets on body weight (gram) of rats.

Treatment [A]	Weeks [B]						X
	0	1	2	3	4	5	
Control							
G1	54.2^{h}±1.11	78.6^{g}±1.63	117.6^{f}±1.12	159de±2.59	181.8^{c}±4.29	216.6^{a}±4.37	**134.6^{c}**
Essential oil							
G2	56^{h}±1.30	72.6^{g}±6.03	112^{f}±7.23	160.8^{de}±7.76	190.6^{bc}±7.26	219.4^{a}±8.39	**135.2^{bc}**
G3	56.2^{h}±1.80	82.8^{g}±2.87	123.8^{f}±3.73	168.6^{d}±3.28	195.6^{b}±4.95	220.4^{a}±5.32	**141.2^{a}**
Powder							
G4	55.4^{h}±1.75	78^{g}±1.41	116.2^{f}±1.96	155.6^{e}±4.91	191^{b}±4.19	217.2^{a}±4.59	**135.6^{bc}**
G5	55.6^{h}±2.06	79^{g}±3.09	118.6^{f}±2.40	167de±4.73	197^{bc}±5.42	221.4^{a}±7.91	**139.8^{ab}**
X	**55.48^{f}**	**78.20^{e}**	**117.6^{d}**	**162.2^{c}**	**191.2^{b}**	**219.0^{a}**	

- **Each value represents the mean ± Standard Error (S.E.)**
- **The mean value with different superscript alphabets in a column indicate significant differences (P<0.05) using LSD test.**
- **A = LSD between columns (treatments) was 5.086.**
- **B = LSD between rows (storage period) was 3.526.**
- **Interaction between A x B was 12.46.**
- **G1 = rats fed basal diet (control).**
- **G2 = rats fed basal diet + coriander essential oil.**
- **G3 = rats fed basal dist + irradiated coriander essential oil.**
- **G4 = rats fed basal diet + coriander powder.**
- **G5 = rats fed basal diet + irradiated coriander powder.**

As shown from data in table (1), there were no-significant differences among the body weights of rats for control group and all other treatments at zero time and as well as after the sixth week. All animals group fed on diets containing coriander powder or its essential oil had a pronounced increase in body weight. Meanwhile, groups fed on irradiated coriander essential oil and irradiated coriander powder had the highest nonsignificant increase in body weight compared to control group. This might be due to the increase of feed intake of these tasted groups which, might have more acceptable flavour for

the animals. The above-mentioned data are in harmony with the findings of Chithra and Leelamma (1997).

As shown in table (2), daily gain in body weight also followed the same trend where it observed non-significant differences between treated groups and control group. Food intake / day represented significant differences between values for the treated groups and control group as it increased from 28.208 gm/day for control group (G1) to 30.216, 31.648, 30.32 and 31.32 gm/day for groups fed on diets containing coriander essential oil (G2), irradiated coriander essential oil (G3), coriander powder (G4) and irradiated coriander powder (G5), respectively. Food Efficiency Ratio (FER) showed non-significant differences among values of the experimental treatments compared with control group.

From the data in table (3) it could be noticed that organs weight and relative organs weight (%) were not showed significant differences in liver, kidney, brain, heart, lung, spleen, pen-renal and tests between treated groups and control group. The previous data are in the same line with Kanki *et al*. (2003), who found that there were no-significant differences in organs weight in F344 rats (specific pathogen-free F344/DuCrj male and female rats) fed with powder diet containing paprika color at dose levels of 0 (basal diet), 0.62, 1.25, 2.5 and 5%.

The glucose value non-significantly decreased, as shown in the table (4), in animals fed coriander essential oil or coriander powder in the fed on diets containing diet compared to those fed the basal diet. This might be due to stimulate their secretion of insulin and lowered their blood sugar. Similar results obtained by Willatgamuwa *et al.* (1998), who found that the effect of dietary regimen containing 1.25% cumin powder was remarkably beneficial in reducing hyperglycemia and glucosuria of diabetic rats. On the other hand, oral administration of 0.25 g kg^{-1} body weight of cumin to diabetic rats resulted in significant reduction in blood glucose (Dhandapani *et al*., 2002).

The results in table (4) indicated that significant decreases in triglyceride levels were observed in animals fed on diets containing coriander fruits essential oil (G2) as well as coriander powder (G4). Simultaneously, irradiation process minimized this effect. While a non-significant decrease in total cholesterol was observed**.** Coriander fruits had a significant hypolipidemic action, similar inhibition in the rise in serum cholesterol and triglyceride in animals fed on coriander fruits and a high fat diet with added cholesterol as has been reported by Chithra and Leelamma (1997). In the animals that administered curcumin 0.2% or capsaicin 0.015% or garlic 2.0% in the diet, significant hypotriglyceridemic effect was noticed (Kempaiah and Srinivasan, 2006). The inhibition in cholesterol related to that the administration of coriander fruits had a profound influence on the metabolism of lipids in animals fed a cholesterol containing diet (Chithra and Leelamma, 1997). At the end of the experiment (6 weeks), glucose determined immediately after sacrificing.

The administration of the coriander spice brought about a significant alteration in the serum lipoproteins (Chithra and Leelamma, 1997). Serum HDL, LDL and VLDL of animals from all the groups are summarized in table (4).

T2-3

It could be noticed that the significant increase in serum high-density lipoprotein (HDL) for rats fed incorporated coriander essential oil (treated or non-treated) compared with normal groups was higher than the significant increase in HDL in rats fed incorporated coriander fruits powder (treated or non-treated) compared with normal groups. The results in the line with findings of Chithra and Leelamma (1997).

Table (4): Effect of feeding with different experimental diets on serum triglycerides, glucose, cholesterol and lipoproteins in rats.

	G1	Essential oil		Powder		LSD
		G2	G3	G4	G5	
Glucose (mg/dl)	154.24^{a} ± 26.19	111.79^{a} ± 10.79	108.33^{a} ± 9.91	136.33^{a} ± 17.78	131.61^{a} ± 8.75	**45.98**
Triglyceride (mg/dl)	208.84^{a} ± 14.22	101.16^{b} ± 25.27	140.79^{ab} ± 31.60	108.12^{b} ± 37.72	110.87^{b} ± 25.83	**88.26**
Cholesterol (mg/dl)	93.03^{a} ± 8.99	81.11^{a} ± 3.32	87.86^{a} ± 8.86	78.65^{a} ± 8.86	80.54^{a} ± 5.94	**23.23**
Lipoproteins						
HDL (mg/dl)	35.78^{c} ± 0.43	48.12^{a} ± 0.48	48.84^{a} ± 0.34	45.58^{b} ± 0.67	46.06^{b} ± 0.80	**1.518**
LDL (mg/dl)	12.87^{a} ± 6.57	9.65^{a} ± 1.82	8.25^{a} ± 4.25	7.84^{a} ± 3.31	9.77^{a} ± 4.53	**13.62**
VLDL (mg/dl)	41.77^{a} ± 2.84	20.23^{b} ± 5.05	28.16^{ab} ± 6.32	21.62^{b} ± 7.54	22.17^{b} ± 5.16	**17.65**

- **Each value represents the mean ± Standard Error (S.E.)**
- **The mean value with different superscript alphabets in rows indicate significant differences (P<0.05) using LSD test.**

Supplementation with 1% of the normal diet with turmeric and garlic (turmeric + garlic, each 0.5% W/W) for ten weeks restored the normal lipid profile and a notable increase in serum HDL/LDL ratio was observed (Ashraf *et al*., 2005). A significant decrease in atherogenic index (total cholesterol /HDL cholesterol) in herbal supplemented animals, suggests the atheroprotective potential of these herbs (Ashraf *et al*., 2005).

On the other hand, the oxidation of low-density lipoproteins (LDL) plays an important role in the development of atherosclerosis (Ramírez-Tortosa *et al*., 1999 and Ramachandran *et al*., 2003). The data in table (4) indicates that LDL decreased non-significantly in blood serum of male's albino rats that fed with 0.9% coriander essential oil and 1.5% powder compared to rats fed on normal group. These results were in the line with findings of (Ramírez-Tortosa *et al*., 1999).

Very low-density lipoprotein (VLDL) given in table (4) showed significant decrease between coriander 0.9% essential oil and 1.5% powder compared with control one. The increasing in VLDL content in the blood serum promoted hyperlipidemic and hypertriglyceridemia and played an important role in atherogenesis and then coronary heart disease (CHD) might happened (Assmann *et al*., 1999).

Liver functions were determined and then the data are tabulated in table (5). Aspartate amino transferase (AST) and alanine amino transferase (ALT) did not show any significant differences between rats of all the experimental treatments and control group. The obtained results indicated that no

significant differences were observed in both ALT and AST between controls and the group fed with both 0.9% essential oil (whether irradiated or not irradiated) and 1.5% powder (irradiated or not irradiated). These results were in agreement with (Kanki *et al*., 2003).

Kidney functions were determined and the obtained data are tabulated in table (5). Creatinene and urea did not show any significant effect for treatments and control group. The obtained results indicated that no significant differences were observed in both creatinene and urea between controls and the group fed with both 0.9% essential oil (whether irradiated or not irradiated) and 1.5% powder (irradiated or not irradiated).

Table (5): Effect of feeding with different experimental diets on serum liver and kidney functions of rats.

	G1	Essential oil		Powder		LSD
		G2	G3	G4	G5	
Liver function						
AST (U/L)	$37.6^{a}\pm 3.45$	$32.3^{a}\pm 3.71$	$38.9^{a}\pm 2.59$	$39.1^{a}\pm 4.65$	$36.4^{a}\pm 4.44$	**12.15**
ALT (U/L)	$16.4^{a}\pm 3.49$	$19.6^{a}\pm 3.34$	$16.2^{a}\pm 1.96$	$17.2^{a}\pm 3.72$	$20.4^{a}\pm 3.06$	**9.744**
Kidney function						
Creatinene (mg/dl)	$0.62^{a}\pm 0.075$	$0.69^{a}\pm 0.075$	$0.66^{a}\pm 0.055$	$0.66^{a}\pm 0.086$	$0.68^{a}\pm 0.088$	**0.2472**
Urea (mg/dl)	$21.65^{a}\pm 2.18$	$20.96^{a}\pm 5.06$	$20.40^{a}\pm 4.59$	$23.06^{a}\pm 0.89$	$21.18^{a}\pm 3.43$	**10.60**

- **Each value represents the mean ± Standard Error (S.E.)**
- **The mean value with different superscript alphabets in rows indicate significant differences (P<0.05) using LSD test.**

The results of hematological data were summarized in table (6). With hematology, no significant differences appeared in hematology tests between control groups and the groups that had coriander fruits either essential oil or powder (hemoglobin, R.B.Cs., W.B.Cs., platelets and lymphocytes). These results were in agreement with Kanki *et al*. (2003).

From the above mentioned result, it could be understood that there was no toxic probability from diets supplemented with irradiated coriander fruits or its irradiated essential oil at the pervious used doses.

Table (6): Effect of feeding on different experimental diets on blood hematology of rats.

	G1	Essential oil		Powder		LSD
		G2	G3	G4	G5	
Hemoglobin (g/dl)	$12.0^{a}\pm 0.58$	$12.3^{a}\pm 0.06$	$11.5^{a}\pm 0.06$	$11.4^{a}\pm 0.06$	$12.0^{a}\pm 0.58$	**0.9553**
R.B.Cs (ml/cm)	$4.3^{a}\pm 0.06$	$4.4^{a}\pm 0.06$	$4.2^{a}\pm 0.06$	$4.2^{a}\pm 0.06$	$4.3^{a}\pm 0.06$	**0.2113**
W.B.Cs (ml/cm)	$6.7^{a}\pm 0.06$	$5.8^{a}\pm 0.06$	$5.6^{a}\pm 0.06$	$6.6^{a}\pm 0.06$	$6.2^{a}\pm 0.06$	**1.217**
Platelets (thou/cm)	$200^{a}\pm 5.78$	$205^{a}\pm 2.89$	$190^{a}\pm 5.78$	$195^{a}\pm 2.89$	$190^{a}\pm 2.89$	**16.47**
Lymphocytes (%)	$67^{a}\pm 0.06$	$73^{a}\pm 0.06$	$55^{a}\pm 0.06$	$52^{a}\pm 0.06$	$74^{a}\pm 0.06$	**25.72**

- **Each value represents the mean ± Standard Error (S.E.)**
- **The mean value with different superscript alphabets in rows indicate significant differences (P<0.05) using LSD test.**

CONCLUSION

From all previous data, coriander fruits (both powder and essential oil) could be used as anti-diabetic (hypoglycemic), cholesterol-lowering (hypocholesterolemia), hypolipidemic, hypotriglyceridemic, atheroprotective agents (anti- atherosclerosis) and as condiment in some food products.

ACKNOWLEDGMENT

The authors wish to express their deepest gratitude and appreciation to Dr. Naglaa H. M. Hassanen, Lecturer of food science & technology, Food Technology Research Institute, Agriculture Research Center, Cairo, Egypt, for her sincere help through the investigation.

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التقيم البيولوجى لثمار الكزبره (*Coriandrum sativum* L.) المعامله إشعاعيا وزيتها الطيار

عادل زكى محمد بديع*، أاحمد توفيق العاقل*، على حسن راضى و محمد عبد الرازق عبد العليم****

***قسم علوم الاغذيه – كليه الزراعه – جامعه القاهره .**

****هيئه الطاقه الذريه – مركز البحوث النوويه . أبو زعبل ص. ب. ١٣٧٥٩ القاهره – مصر.**

تم دراسه تاثير اضافه ثمار الكزبره المطحونه وكذلك زيتها الطيار سواء غير المشععه او المشععه الى عليقه فئران التجارب بجرعه اشعاعيه ٤ كجراى وكذلك زيتها الطيار . واتضح من الدراسه ان اضافه الكزبره لعليقه فئران التجارب ذات تاثير مخفض للدهون. كذلك وجد ايضا انخفاض معنوى فى محتوى الجلسريدات الثلاثيه بينما كان انخفاض الكوليستيرول والجلوكوز غير معنوى فى بلازما فئران التجارب والتى تم اضافه الكزبره سواء المطحونة او الزيت الطيار الى عليقتها مقارنه بفئران المقارنه. وكان من الملاحظ انخفاض مستويات كلا من الليبوبروتين منخفض الكثافه والليبوبروتين منخفض الكثافه جدا على العكس من الليبوبروتين مرتفع الكثافه الذى اظهر زيادة معنوية ملحوظة. وقد تضمنت الدراسه ايضا دراسه كل من وظائف الكبد والكلى والذى اظهرت عدم وجود اختلافات معنويه بين الفئران المعامله والفئران الكنترول. وكذلك تم عمل صوره دم لفئران التجارب والتى اوضحت انه ليس هناك فروق معنويه بين المجموعات المعامله وفئران الكنترول.

Table (2): Effect of feeding with different experimental diets on body weight gain and (Feed Intake Ratio) FER.

Treatment	Initial Body weight	Final Body weight	Net gain	Daily Body weight	Percentage of daily body weight	Food Intake	Food Intake / day	Food Efficiency Ratio (FER)
Control								
G1	$54.2^{a} \pm 1.11$	$216.6^{a} \pm 4.37$	$162.4^{a} \pm 4.07$	$3.87^{a} \pm 0.097$	$386.67^{a} \pm 9.67$	$1184.736^{c} \pm 195.24$	$28.208^{c} \pm 4.65$	$0.155^{a} \pm 0.027$
Essential oil								
G2	$56^{a} \pm 1.30$	$219.4^{a} \pm 8.39$	$163.4^{a} \pm 8.28$	$3.89^{a} \pm 0.197$	$389.05^{a} \pm 19.71$	$1269.072^{b} \pm 222.32$	$30.216^{b} \pm 5.29$	$0.1455^{a} \pm 0.024$
G3	$56.2^{a} \pm 1.80$	$220.4^{a} \pm 5.32$	$164.2^{a} \pm 3.80$	$3.91^{a} \pm 0.090$	$390.95^{a} \pm 9.05$	$1329.216^{a} \pm 207.84$	$31.648^{a} \pm 4.95$	$0.1385^{a} \pm 0.024$
Powder								
G4	$55.4^{a} \pm 1.75$	$217.2^{a} \pm 4.59$	$161.8^{a} \pm 4.91$	$3.85^{a} \pm 0.117$	$385.24^{a} \pm 11.69$	$1273.44^{b} \pm 210.35$	$30.32^{b} \pm 5.01$	$0.146^{a} \pm 0.030$
G5	$55.6^{a} \pm 2.06$	$221.4^{a} \pm 7.91$	$165.8^{a} \pm 6.55$	$3.95^{a} \pm 0.156$	$394.76^{a} \pm 15.60$	$1315.44^{ab} \pm 217.47$	$31.32^{ab} \pm 5.18$	$0.147^{a} \pm 0.032$
LSD	**3.753**	**18.49**	**17.66**	**0.419**	**42.05**	**49.05**	**1.168**	**0.01762**

- **Each value represents the mean ± Standard Error (S.E.)**
- **The mean value with different superscript alphabets in a column indicate significant differences (P<0.05) using LSD test.**

Table (3): effect of feeding with different experimental diets on the organs weight (in gram) of rats.

Treatment	Kidney		Lung		Liver		Heart		Spleen		Tests		Pen renal		Brain	
	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%
	Control															
G1	$1.78^{a} \pm 0.10$	$0.82^{a} \pm 0.05$	$1.18^{a} \pm 0.07$	$0.55^{a} \pm 0.04$	$7.84^{a} \pm 0.57$	$3.62^{a} \pm 0.26$	$0.74^{a} \pm 0.05$	$0.34^{a} \pm 0.02$	$0.58^{a} \pm 0.07$	$0.27^{a} \pm 0.03$	$2.88^{a} \pm 0.09$	$1.33^{a} \pm 0.05$	$1.6^{c} \pm 0.15$	$0.74^{c} \pm 0.07$	$1.06^{a} \pm 0.17$	$0.48^{a} \pm 0.07$
	Essential Oil															
G2	$1.94^{a} \pm 0.14$	$0.88^{a} \pm 0.04$	$1.2^{a} \pm 0.12$	$0.55^{a} \pm 0.06$	$7.58^{a} \pm 0.49$	$3.48^{a} \pm 0.27$	$0.74^{a} \pm 0.07$	$0.34^{a} \pm 0.03$	$0.62^{a} \pm 0.06$	$0.29^{a} \pm 0.04$	$3.08^{a} \pm 0.09$	$1.41^{a} \pm 0.04$	$2.18^{abc} \pm 0.33$	$0.98^{abc} \pm 0.13$	$1.1^{a} \pm 0.07$	$0.50^{a} \pm 0.03$
G3	$1.82^{a} \pm 0.08$	$0.83^{a} \pm 0.05$	$1.48^{a} \pm 0.11$	$0.67^{a} \pm 0.04$	$7.94^{a} \pm 0.62$	$3.62^{a} \pm 0.32$	$0.7^{a} \pm 0.05$	$0.32^{a} \pm 0.02$	$0.58^{a} \pm 0.04$	$0.26^{a} \pm 0.02$	$2.96^{a} \pm 0.13$	$1.34^{a} \pm 0.04$	$1.92^{bc} \pm 0.23$	$0.87^{bc} \pm 0.09$	$1.08^{a} \pm 0.07$	$0.49^{a} \pm 0.032$
	Powder															
G4	$1.96^{a} \pm 0.12$	$0.90^{a} \pm 0.05$	$1.44^{a} \pm 0.17$	$0.66^{a} \pm 0.07$	$8.44^{a} \pm 0.34$	$3.90^{a} \pm 0.22$	$0.76^{a} \pm 0.05$	$0.35^{a} \pm 0.03$	$0.54^{a} \pm 0.07$	$0.25^{a} \pm 0.03$	$2.96^{a} \pm 0.24$	$1.36^{a} \pm 0.10$	$2.22^{ab} \pm 0.19$	$1.02^{ab} \pm 0.08$	$1.34^{a} \pm 0.08$	$0.62^{a} \pm 0.04$
G5	$1.92^{a} \pm 0.13$	$0.87^{a} \pm 0.05$	$1.5^{a} \pm 0.17$	$0.68^{a} \pm 0.064$	$7.34^{a} \pm 0.45$	$3.32^{a} \pm 0.19$	$0.72^{a} \pm 0.06$	$0.32^{a} \pm 0.02$	$0.62^{a} \pm 0.06$	$0.28^{a} \pm 0.02$	$2.9^{a} \pm 0.05$	$1.31^{a} \pm 0.05$	$2.68^{a} \pm 0.18$	$1.21^{a} \pm 0.07$	$1.24^{a} \pm 0.05$	$0.56^{a} \pm 0.03$
LSD	**0.3338**	**0.6085**	**0.4282**	**0.1748**	**1.410**	**0.7392**	**0.1748**	**0.07344**	**0.1799**	**0.08480**	**0.4261**	**0.1799**	**0.5996**	**0.2614**	**0.2998**	**0.1341**

- **Each value represents the mean ± Standard Error (S.E.)**
- **The mean value with different superscript alphabets in a column indicate significant differences (P<0.05) using LSD test.**