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Evaluation of Therapeutic and Protective Influences of Camel Milk Against Gamma Radiation– Induced Hematotoxicity, Hepatotoxicity and Nephrotoxicity in Albino Rats

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ABSTRACT

Camel milk so called white gold of the desert is more similar to human milk than any other milk. Fresh camel milk provides particular health benefits depending on the bio-effective fractions in it. Aim of the work is investigating protective effects of camel milk in gamma irradiated abino rats was investigated. Methods of this work: Ninety six of Sprague Dawly healthy adult male albino rats were utilized, classified and labeled in 16 groups. Biochemical determinations of hepatological and nephrological parameters were determined from collected blood samples. Histo-pathological examination were done for liver and kidneys. Results: IRR caused significant changes in kidneys and liver functions as well as protein profile. Serum levels of ALT, AST and ALP increased significantly, also serum levels bilirubin, urea, uric acid and creatinine levels were elevated, whereas serum protein profile (total soluble protein, albumin and globulin levels) was decreased paralleled with dose dependent.Concerning hematological parameters, IRR resulted in a significant decrease in the values of Hb, RBCs count, platelets count, MCH and HCT %, while insignificantly changed the value of MCV, MCHC and WBCs count. These changes were paralleled with the dose dependent.Camel milk treatments in the IRR rats have improved their irradiated status and attenuated the alteration of liver and kidney functions as well as, hematological abnormalities associated with IRR harmful effect.

Keywords
Gamma-irradiation, camel milk. Liver, kidney, rats, protein profile, hematological parameter, oxidative stress.

1.Introduction

Although, radiotherapy represents an essential therapeutic modality of several tumors, yet it induces side effects on the normal healthy tissues in the form of biochemical and physiological changes depending on the absorbed dose [1]. This side effects are caused by generation ofreactive oxygen species (ROS) which induce oxidative harmful effect or damage to the living biomolecules such as nucleic acids, protein lipid by oxidative stress.

This oxidative stress is associated with several degenerative diseases such as cancers, liver, kidneys and heart injuries, etc. [2,3]. Antioxidants interfere with radical chain reactions and protect cellular biomolecules from this oxidation stress [4].

Fresh camel milk provides particular health benefits depending on the bio-effective fractions in it [5]. Camel milk has potential therapeutic properties that are anti-carcinogenic [6,7], anti-diabetic [8,9], anti-hypertensive [10] anti- allergic [11], hepato-protective [12] and hypo-lipidimic [13,14] effects. This milk contains all the essential nutrients found in other milks and more [8]. As reported by [5,8], the camel milk composition was of compatibility with that of cow milk. The camel milk has insulin, Zn, vitamins C and E contents more than the other milks [8,15]**.** Also camel milk therapeutic efficacy may be due to the lack of coagulations in acidic medium of human stomach and to its other health beneficial influences that were even higher than those in cow and buffalo milks [8].

The objective of the present study is to evaluate the potential effects of camel milk as antioxidant against gamma irradiation harmful effect in liver and kidney, as well as blood

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profile.

2. Materials and Methods

2.1. Obtaining Camel milk

During the experimental period (14 days) camel (camelusdromedarius) milk samples were collected from areas around faculty of agricultural farm (Kerdasa, Giza, Egypt).

2.2. Animals

Ninety six of Sprague Dawly adult male albino rats (weighting 160-170 g) were utilized in the present study. The tested rats were obtained from Research Institute of Ophthalmology Giza, Egypt. The animals were housed under standard conditions for light (dark 12 h and light 12 h) fresh air ventilation, temperature 25-30 ^{o}C and 60-65% humidity. The experimental rats were allowed free access to a standard requirement diet and water. All experiments on animals were carried out in accordance with the National Institutes of Health guide for the care and use of laboratory animals (NIH publications No. 8023 revised 1978).All the studied animals were conducted in accordance with criteria of Investigation and Ethics committee of community lows governing the use of experimental animals.

2.3.Irradiation

Whole-body gamma-irradiation (from 137Cs source of Radiation) was performed at the National center for Radiation Research and Technology (NCRRT), Nasr city, Cairo, Egypt, using an AECL Gamma cell-40 biological irradiator. The rats were kept into cages that were placed in the irradiated chamber of the gamma-cell, where rats were irradiated at an acute single doses of 3, 5 and 7Gy delivered at a dose rate of 0.012 Gy/s throughout the period of irradiation (IRR).

2.4.Experimental design

The studied rats were divided into 4 groups (normal healthy rats without gamma irradiation) and 12 groups (gamma-irradiated rats); 6 rats in each group as follows:

G1: Normal healthy group ingested by saline solution as normal control.G2, G3 and G4: Normal healthy groups ingested by 2, 4 and 6 ml of camel milk/100g body weight, respectively.G5, G6 and G7: (gamma-irradiated control groups): IRR groups irradiated with single doses of 3, 5 and 7Gy, respectively.G8, G9 and G10: IRR groups (3Gy single dose) treated by ingestion by 2, 4 and 6ml of camel milk/100g body weight, respectively.G11, G12 and G13: IRR groups (5Gy single dose) treated by ingestion by 2, 4 and 6 ml of camel milk/100g body weight, respectively.G14, G15 and G16: IRR groups (7Gy single dose) treated by ingestion by 2, 4 and 6 ml of camel milk/100g body weight, respectively.

Rats were ingested with camel milk doses for 2 week consecutive days after gamma-irradiation. By the end of the experimental period (two weeks) all rats were subjected to overnight fasting before being scarified by decapitation. Blood samples, collected from each rat, were divided into two portions, the first one was immediately used for determination of hematological parameters and the other portion of blood was centrifuged to separate serum for the biochemical determinations of hepatological and nephrological parameters.

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2.5.Hematological analysis

The complete blood count (CBC) was performed on an automated hematology analyzer using mixed whole blood to which EDTA was added to prevent clotting. All CBC analysis was measured by system XT-2000 il XT-1800 i, hematology analyzer corporation Kobe, Japan.

2.6.Biochemical analysis

Serum samples were used to determine the activities of aspartate and alanine amino transferase (AST and ALT) according to [16], Serum ureaaccording to[17], uric acidaccording to[18] and creatinine according to the methods of[19]. The contents of bilirubinaccording to[20], total soluble proteinaccording to[21]and albumin according to [22]were determined, while alkaline phosphatase (ALP) activity determined according to [23].

2.7. Histopathological analysis

Liver and kidneys were weighted then fixed immediately in 10% neutral formalin and histopathological procedures were carried out according to the pathological studies microscopy using the standard micro-technique. Sections of liver and kidney at 5 um were stained with alum hematoxylin and eosin and the sections were examined with the light microscope for histopathological changes [24].

2.8. Statistical analysis

Data were analyzed by one-way analysis of variance (ANOVA) using Excel 2003 Microsoft Crop (11.5612.5606), Redmond, WA software package. Result were presented as means ± standard deviation of the means (X+SD), P values <0.05 were ranged as statistically significant.

3. Results and Discussion

3.1. Effects of camel milk against gamma radiation (IRR) on liver and kidneys weight

The protective effects of camel milk against gamma radiation (IRR) induced hepato-toxicity, nephron-toxicity and hemato-toxicity were studied.Regarding liver's and kidneys' weight, in healthy normal control rats (Fig. 1), it has been found that liver and kidneys weight showed the lowest relative weight (organ weight/100g body weight) but in the gamma irradiated rats (G5) they showed the highest ones (Tables, 1 and 2). The other groups, ingested with therapeutic materials (camel milk as treatments agent) against gamma irradiation exposures showed improved values which were lower than those of gamma-irradiated control, but higher than the values of healthy normal control. The changes (either for increased values by gamma irradiation exposures or attenuated the alteration of liver and kidneys weight) were paralleled with the dose- dependent).

3.2. Biochemical analysis

These protective activities of camel milk were evaluated by determinations of liver functions (ALT, AST and ALP activities as well as the serum level of bilirubin), kidney functions (urea, uric acid and creatinine levels in sera of the experimental rats) and serum protein profile.

Table (1) showed that gamma-irradiated rats (IRR) had significant increase in the activity of

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ALT, AST and ALP compared to normal control ones (Fig.2). The same trend was observed in ALT/AST ratio (Fig. 3) and bilirubin serum content (Fig. 4) which significantly increased relative to those of normal control. The harmful effect of gamma irradiation was dose-dependent. Ingestion of camel milk improved and decreased the gamma irradiation harmful effects on liver function parameters.

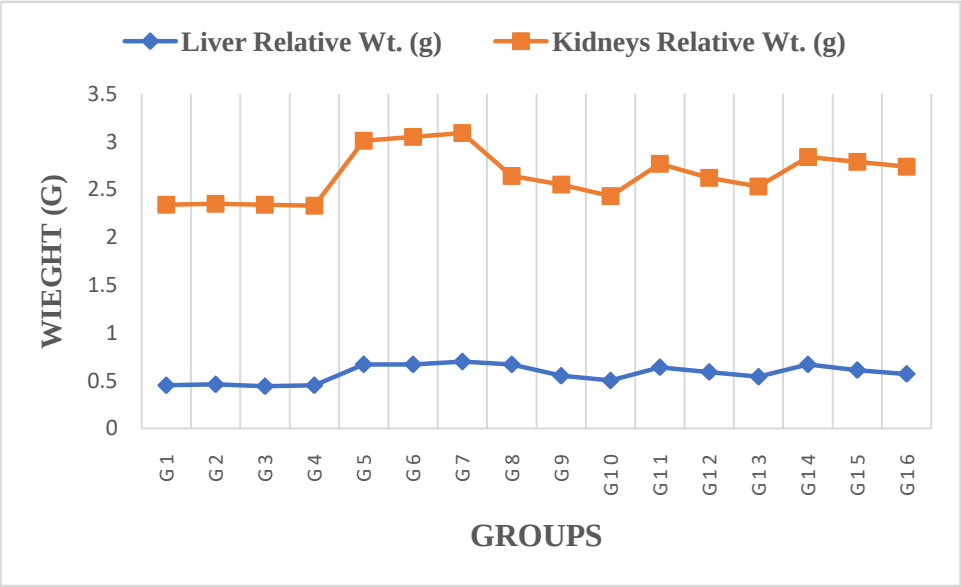

Figure 1. Liver and kidneys weight of treated experimental rats relative to normal control.

Gamma irradiation exposure (with 3, 5 and 7Gy) caused significant increase in serum levels of ALT, AST and ALP and bilirubin, while the ingestion of camel milk (with 2, 4 and 6 ml/100g b.w) into the IRR rats resulted in significant reduction of the harmful effects of gamma rays on liver functions. The harmful intensities paralleled with the increasing gamma irradiation dose, and the improvement of camel milk was also dose-dependent when compared with normal control.

In case of nephrotoxicity caused by gamma irradiation and nephron-protective effect of camel milk, Table (2) shows that in IRR, had significant increases in the kidneys function parameters (significantly increased levels of serum urea (Fig.5), uric acid and creatinine (Fig. 6)) compared to normal control, and this is attributed to the harmful effect of gamma irradiation. Again, the toxicity of gamma rays increased with increasing of their doses.Gamma- irradiation (IRR) reduced oxidative stress in hepatic and renal tissues of albino rats.

The results of protein profile presented in Table (2) and Figures (7 and 8) showed that serum total soluble protein, albumin and globulin contents were significantly decreased in gamma-irradiated rats (IRR) compared to normal control ones. These abnormal values of the serum protein profile were reduced paralleled with increasing gamma rays dose. Camel milk treatments against gamma irradiation in IRR rats alleviated and improved the values of these parameters, i.e. camel milk ingestion into IRR rats increased these disturbed values to around those of normal rats. The readjusted and improved values in IRR-rats treated with camel milk ingestion were dependent on the milk dose.

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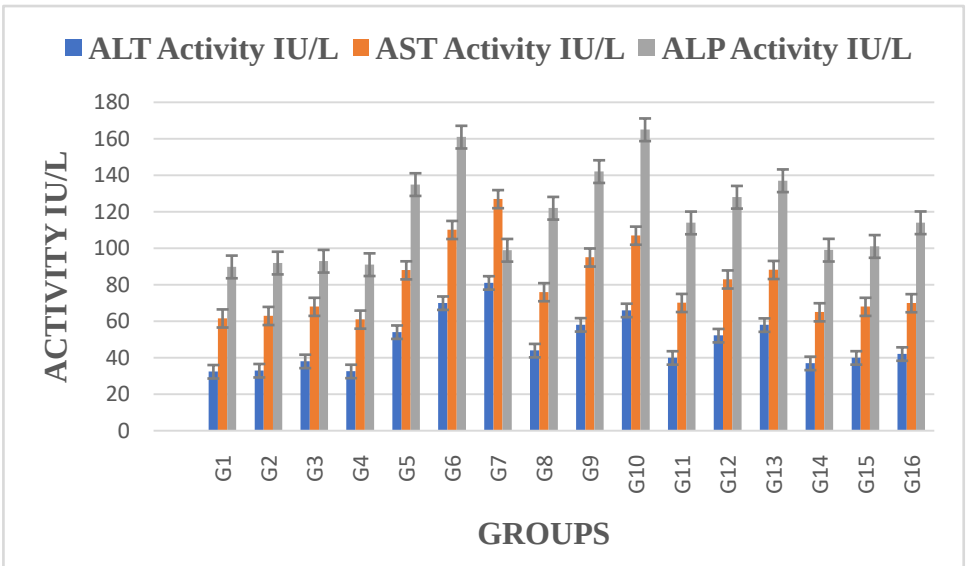

Figure2.ALT, AST and ALP activities of treated experimental rats relative to normal control.

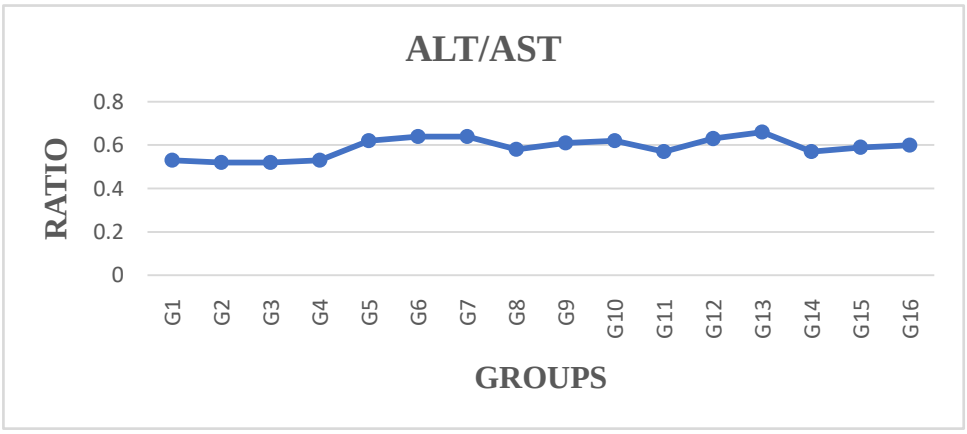

Figure 3.ALT/AST ratioof treated experimental rats relative to normal control.

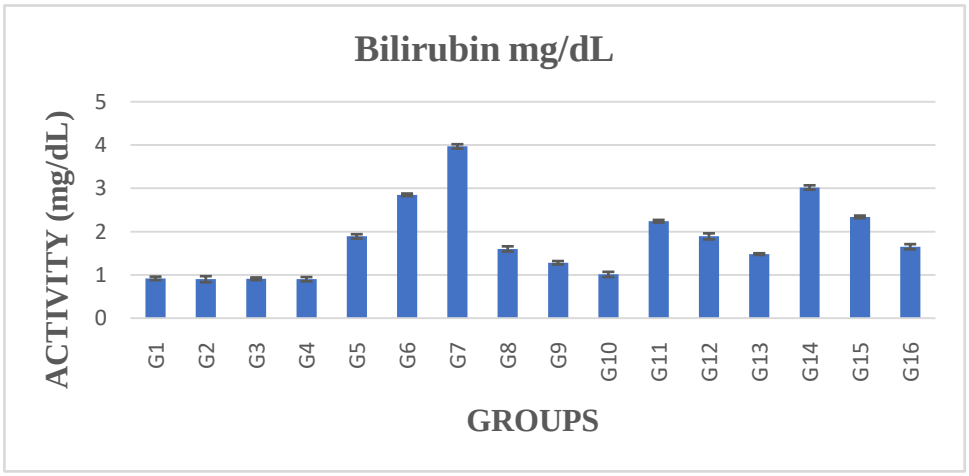

Figure 4. Total bilirubin content of treated experimental rats relative to normal control.

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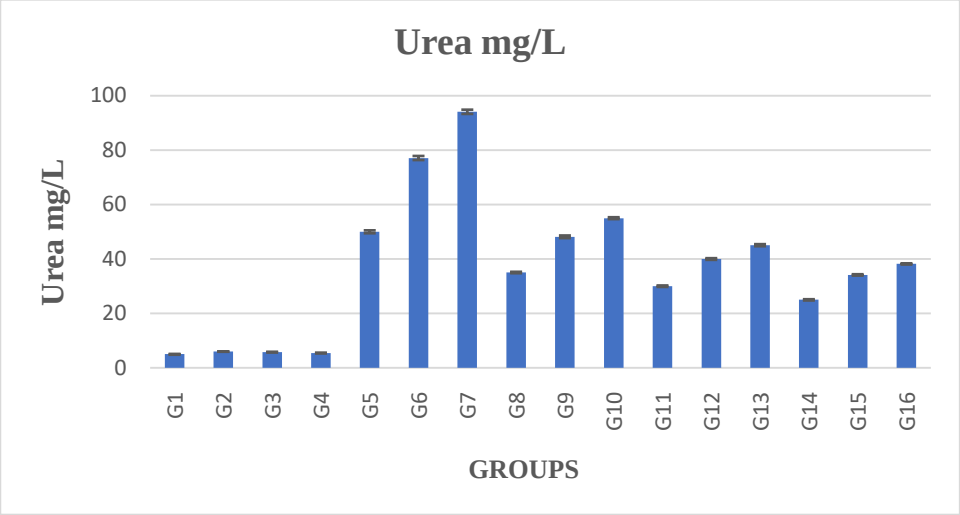

Figure 5. Urea activity of treated experimental rats relative to normal control.

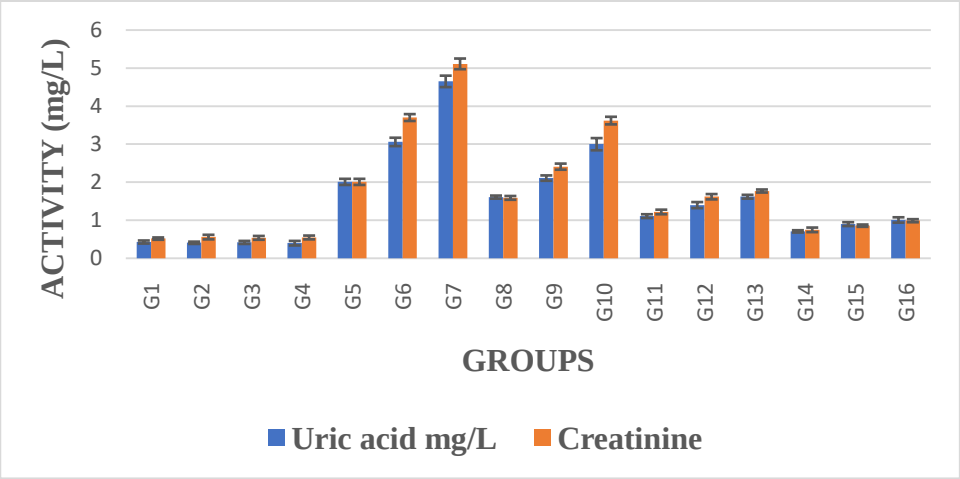

Figure 6. Uric acid and creatinine of treated experimental rats relative to normal control.

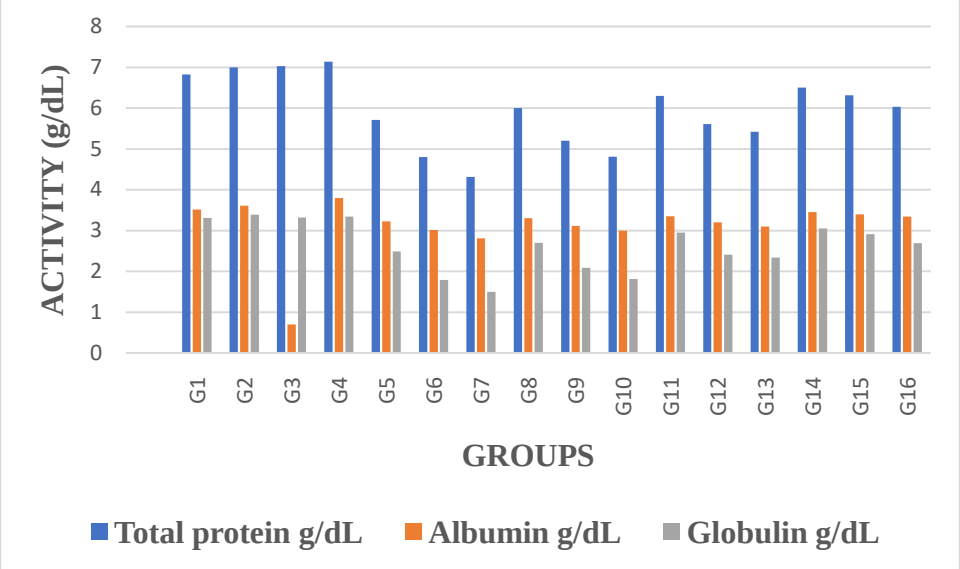

Figure 7. Protein profile of treated experimental rats relative to normal control.

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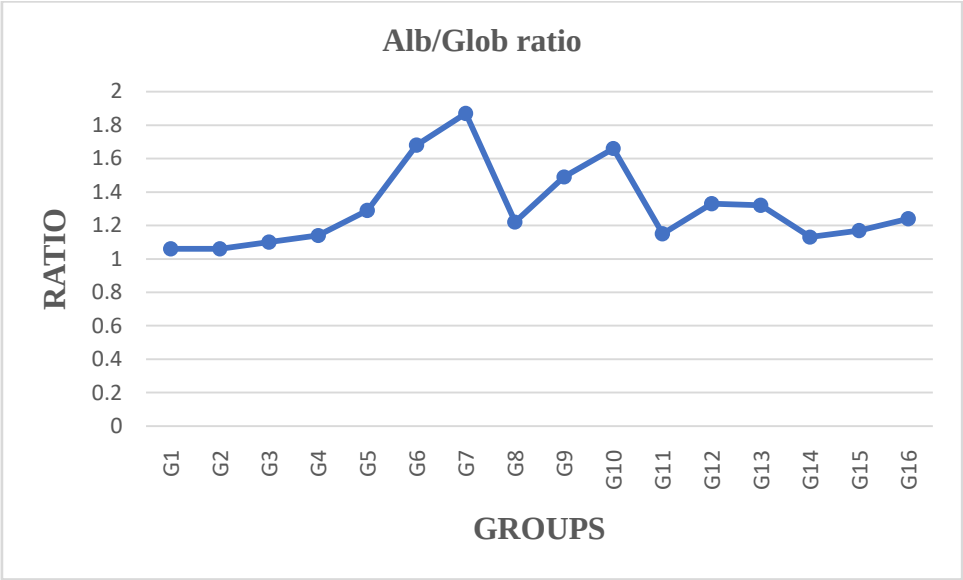

Figure 8. Albumin/Globulin ratio of treated experimental rats relative to normal control.

3.3. Hematological analysis

Also, protective activity of camel milk was evaluated by determinations of blood CBC (RBCs and WBCs profiles). In the IRR groups, gamma-irradiation exposure caused significant decreases in hemoglobin levels as well as red blood cells (RBCs), corpuscular hemoglobin counts (mean corpuscular value (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) values which statistically different, compared to those of the normal healthy control groups (Table 3).

Regarding the hematological properties of the experimental gamma-irradiated rats, Table (4) showed that the mean values of WBCs profile reveled insignificant increase in WBCs count, differential leucocyte count of Neutrophils (NEUT), lymphocytes (LYMPH), monocytes (MONO), eosinophiles (EO) and basophiles (BASD). These changes ranged from 10%-45% compared to the normal health control rats. Moreover, such changes showed improvements in these parameters caused by camel milk treatments either for health or gamma-irradiated animals. However, the insignificant increment of WBCS profile may be considered as an indicator for first defensive mechanism against gamma-irradiation.

Concerning blood platelets (PLTs) counts, data in Table (4) showed that gamma irradiation exposure caused about 11% decrease in the total PLTs count compared to normal control group. On the other hand, camel milk ingestion caused no change in the total PLTs count in treated normal rats relative to normal control group, but for IRR groups the camel milk treatments improved the harmful induced effect by gamma-irradiation. The damages were paralleled with the gamma-irradiation dose and the improvements were camel milk dose dependent.

Concerning RBCs picture or profile, IRR-rats showed significant decrease in Hb and RBCs count, platelets count, MCH and HCT, despite the insignificant change (parallel with the dose-dependent) in MCV, MCHC and WBCs count. The results of the present revealed that, in gamma-irradiated rats the RBCs profile was found to be more sensitive than WBCs profile. RBCs count, Hb, hematocrit, platelets and leucocytic levels were significantly decreased in gamma irradiated rats, compared to control ones. This is attributed to the damaging effect due

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Table 1. Liver function of the experimental rats (control and irradiated) treated with camel milk.

	Liver Relative Wt. (g)	ALT (IU/L)	AST (IU/L)	ALP (IU/L)	ALT/AST	Bilirubin (mg/dL)
G1	0.45±0.06	32.42±1.32	61.63±2.12	89.88±2.38	0.53	0.92±0.04
G2	0.46±0.02	33.00±1.47	63.00±2.54	92.00±3.06	0.52	0.90±0.07
G3	0.44±0.05	38.1±1.65	68.01±1.85	93.01±2.35	0.52	0.91±0.03
G4	0.45±0.03	32.60±1.73	60.99±1.67	91.10±2.95	0.53	0.90±0.05
G5	0.67±0.05	54.12±2.29	88.00±1.25	135.00±1.98	0.62	1.89±0.05
G6	0.67±0.06	70.01±2.09	110.12±1.58	161.01±1.86	0.64	2.85±0.03
G7	0.7±0.03	81.10±2.62	127.02±1.37	99.00±3.13	0.64	3.97±0.05
G8	0.67±0.07	44.00±1.86	76.03±2.43	122.03±2.56	0.58	1.60±0.06
G9	0.55±0.05	58.12±1.43	95.04±2.67	142.12±2.46	0.61	1.28±0.04
G10	0.50±0.05	66.03±2.24	107.00±2.38	165.04±3.52	0.62	1.01±0.06
G11	0.64±0.03	40.00±1.95	70.12±1.96	114.00±4.02	0.57	2.24±0.03
G12	0.59±0.02	52.20±1.64	83.00±2.08	128.06±2.68	0.63	1.89±0.07
G13	0.54±0.04	58.00±2.47	88.20±2.63	137.10±3.08	0.66	1.48±0.02
G14	0.67±0.06	37.00±2.18	65.02±1.63	99.05±3.86	0.57	3.02±0.05
G15	0.61±0.02	40.01±1.12	68.00±1.72	101.11±2.91	0.59	2.34±0.03
G16	0.57±0.05	42.13±1.68	70.00±1.78	114.07±3.64	0.60	1.65±0.06

Values are means of ± SD.P values <0.05. G1, Normal Control (NC); G2, NC+2 ml milk; G3, NC+4 ml milk; G4, NC+6 ml milk; G5, Irradiated control (IRR) 3GY; G6, IRR 5Gy; G7, IRR 7Gy; G8, IRR 3Gy + 2 ml milk; G9,IRR 3Gy +4 ml milk; G10, IRR 3Gy +6 ml milk; G11, IRR 5Gy +2 ml milk; G12, IRR 5Gy +4 ml milk; G13, IRR 5Gy +6 ml milk; G14, IRR 7Gy +2 ml milk;G15, IRR 7Gy +4 ml milk; G16, IRR 7Gy +6 ml milk.

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Table 2. Kidney function and serum protein profile for the experimental rats (control and irradiated) treated with camel milk.

	Kidneys Relative Wt. (g)	Urea (mg/L)	Uric acid (mg/L)	Creatinine (mg/L)	Total protein (g/dL)	Albumin (g/dL)	Globulin (g/dL)	Alb/Glob
G1	2.34±0.15	5.00±0.15	0.43±0.04	0.52±0.03	6.82±0.06	3.51±0.12	3.31	1.06
G2	2.35±0.20	6.00±0.06	0.41±0.03	0.56±0.06	7.00±0.23	3.61±0.08	3.39	1.06
G3	2.34±0.13	5.81±0.12	0.42±0.04	0.54±0.05	7.03±0.08	0.7±0.05	3.32	1.10
G4	2.33±0.18	5.46±0.15	0.40±0.06	0.55±0.05	7.14±0.14	3.80±0.22	3.34	1.14
G5	3.01±0.12	50.00±0.54	2.01±0.08	2.01±0.08	5.71±0.17	3.22±0.16	2.49	1.29
G6	3.05±0.13	77.10±0.75	3.06±0.11	3.70±0.09	4.80±0.21	3.01±0.07	1.79	1.68
G7	3.09±0.21	94.07±0.78	4.65±0.15	5.11±0.14	4.31±0.15	2.81±0.15	1.50	1.87
G8	2.64±0.9	35.04±0.26	1.61±0.04	1.59±0.05	6.00±0.11	3.30±0.15	2.70	1.22
G9	2.55±0.11	48.17±0.48	2.11±0.07	2.41±0.08	5.20±0.26	3.11±0.11	2.09	1.49
G10	2.43±0.14	55.00±0.35	3.00±0.16	3.62±0.10	4.81±0.13	3.00±0.24	1.81	1.66
G11	2.77±0.08	30.02±0.27	1.11±0.05	1.22±0.06	6.30±0.20	3.35±0.18	2.95	1.15
G12	2.62±0.16	40.00±0.31	1.40±0.08	1.62±0.07	5.61±0.16	3.20±0.13	2.41	1.33
G13	2.53±0.20	45.08±0.38	1.62±0.05	1.77±0.04	5.42±0.15	3.10±0.16	2.34	1.32
G14	2.84±0.15	25.00±0.23	0.71±0.03	0.75±0.06	6.50±0.12	3.45±0.14	3.05	1.13
G15	2.79±0.17	34.16±0.25	0.90±0.05	0.86±0.03	6.31±0.19	3.40±0.20	2.91	1.17
G16	2.74±0.08	38.20±0.22	1.01±0.07	0.99±0.04	6.03±0.23	3.34±0.09	2.69	1.24

Values are means of ± SD. P values<0.05. G1, Normal Control (NC); G2, NC+2 ml milk; G3, NC+4 ml milk; G4, NC+6 ml milk; G5, Irradiated control (IRR) 3GY; G6, IRR 5Gy; G7, IRR 7Gy; G8, IRR 3Gy + 2 ml milk; G9, IRR 3Gy +4 ml milk; G10, IRR 3Gy +6 ml milk; G11, IRR 5Gy +2 ml milk; G12, IRR 5Gy +4 ml milk; G13, IRR 5Gy +6 ml milk; G14, IRR 7Gy +2 ml milk; G15, IRR 7Gy +4 ml milk; G16, IRR 7Gy +6 ml milk.

exposure to gamma radiation; which depletes the bone marrow as it directly destroys the hematopoietic stem cells [25]via necrosis [26].

The ingestion of camel milk results in improved blood cells profile, and this is attributed to the fact that camel milk contained immune stimulatory potential and therefore can boost the immune system. Also, camel milk showed hematinic potential, and hence it can be used in treatment or prevention of anemia [5, 8, 27, 28].

Table 3. RBCs profile of the experimental rats (normal and irradiated treated with camel milk).

	Hb g/dL	**RBCs count10^3\UL**	**HCT%**	**MCV Mm^3**	**MCH Pg**	**MCHC g\dL**
G1	14.00	6.49	41.51	52.22	28.98	34.91
G2	14.41	6.61	42.40	52.50	29.31	35.10
G3	14.80	6.70	43.61	52.91	29.70	35.00
G4	15.00	6.76	44.81	53.29	30.00	36.07
G5	12.00	6.00	37.11	53.00	26.00	33.00
G6	11.01	5.00	34.02	55.00	23.01	32.06
G7	9.92	4.01	30.12	56.61	18.12	31.5
G8	12.51	6.21	39.01	54.01	27.01	33.51
G9	11.60	5.50	32.02	56.00	25.00	33.00
G10	10.42	4.52	35.03	56.11	24.16	32.01
G11	12.91	6.31	39.00	53.50	28.00	34.00
G12	12.00	6.70	38.02	55.014	27.03	33.62
G13	11.70	4.71	36.00	55.6	26.12	33.00
G14	13.20	6.41	40.00	53.00	28.50	33.60
G15	13.41	6.00	39.10	54.02	28.00	34.00
G16	13.60	5.30	37.02	54.31	27.01	33.71

G1, Normal Control (NC); G2, NC+2 ml milk; G3, NC+4 ml milk; G4, NC+6 ml milk; G5, Irradiated control (IRR) 3GY; G6, IRR 5Gy; G7, IRR 7Gy; G8, IRR 3Gy + 2 ml milk; G9, IRR 3Gy +4 ml milk; G10, IRR 3Gy +6 ml milk; G11, IRR 5Gy +2 ml milk; G12, IRR 5Gy +4 ml milk; G13, IRR 5Gy +6 ml milk; G14, IRR 7Gy +2 ml milk; G15, IRR 7Gy +4 ml milk;G1, IRR 7Gy +6 ml milk.

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Table 4.WBCs profile and platelets count of the experimental rats (normal and irradiated treated with camel milk).

	WBC 10^3/UL	NEUT 10^3/UL	LYMPH 10^3/UL	EO 10^3/UL	BASO 10^3/UL	Mono 10^3/UL	Platelets count
G1	10.21	1.51	11.62	0.33	0.02	0.84	590.99
G2	10.83	1.60	12.00	0.34	0.021	0.89	592.01
G3	11.00	1.66	12.09	0.35	0.022	0.90	594.11
G4	11.20	1.71	12.43	0.36	0.024	0.91	597.23
G5	10.31	1.55	11.61	0.33	0.02	0.84	513.41
G6	10.50	1.57	11.12	0.34	0.02	0.85	461.00
G7	10.80	1.60	12.00	0.34	0.021	0.88	349.21
G8	10.50	1.61	11.69	0.33	0.02	0.86	551.23
G9	10.63	1.64	11.73	0.34	0.021	0.87	574.24
G10	11.01	1.71	12.11	0.35	0.023	0.90	600.01
G11	10.70	1.60	12.00	0.35	0.023	0.88	575.62
G12	10.81	1.61	11.99	0.36	0.022	0.88	544.44
G13	11.00	1.70	12.12	0.36	0.023	0.89	580.01
G14	10.40	1.57	11.66	0.33	0.02	0.85	419.97
G15	10.80	1.60	11.77	0.35	0.021	0.87	592
G16	11.10	1.70	12.06	0.36	0.024	0.91	591.21

G1, Normal Control (NC); G2, NC+2 ml milk; G3, NC+4 ml milk; G4, NC+6 ml milk; G5, Irradiated control (IRR) 3GY; G6, IRR 5Gy; G7, IRR 7Gy; G8, IRR 3Gy + 2 ml milk; G9, IRR 3Gy +4 ml milk; G10, IRR 3Gy +6 ml milk; G11, IRR 5Gy +2 ml milk; G12, IRR 5Gy +4 ml milk; G13, IRR 5Gy +6 ml milk; G14, IRR 7Gy +2 ml milk; G15, IRR 7Gy +4 ml milk;G1, IRR 7Gy +6 ml milk.

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3.4. Histopathological analysis

Moreover, the histo-pathological examinations in liver and kidney tissues and their relative weights were carried out to support the biochemical parameters.Histological observations basically supported the results obtained from serum parameters analysis either for liver or kidneys tissue assays. It was clear that the hepatic cells are extremely and severely damaged as they are responsible for both detoxification and biotransformation processes. The histology of liver in normal healthy control group showed no histological changes (Fig. 9). The histology of normal control rats treated with the highest dose of camel milk (6 ml) also showed no histological changes (Fig 10). These findings supported the hypothesis that camel milk improves liver function. In contrast, histology of liver of gamma irradiated (7Gy) rats (Fig. 11) showed portal infiltration with leucocytes compared with IRR group (7gy) treated with the highest dose of camel milk (6 ml) which showed Kupffar cells activation (Fig. 12), due to the treatment with camel milk.

Regarding the effects IRR on the kidneys, histology of normal healthy control group treated with camel milk and those of normal healthy control showed no histological changes. These results supported that camel milk has beneficial activity on kidneys function (Figs. 13 and 14). The histology of kidneys section in IRR (gamma irradiated (7gy) group control) showed marked vacuolations of endothelial lining of glomerular tuft and epithelial lining of renal tubules with pyknosis of their nuclei (Fig. 15). Although, kidneys are the second target organ in the animal body for many toxic effects. Figure 16 shows that the histological examination of IRR (7gy) treated with camel milk (6ml) which showed granularity of epithelial lining renal tubules. Hence, the ingestion of camel milk showed good improvements in kidneys and liver functions of gamma-irradiated animals.

Peroxidative degradation of biomembranes is one of the principle causes of hepato-toxicity and nephron-toxicity induced gamma rays exposure. These evidenced by the elevation in all markers of liver function and kidney function. Thus necrosis or membrane damage elevated these parameters into the circulation[29], elevated levels of serum enzymes and other parameters and are indicative of cellular leakage and loss of functional integrity of the cell membranes in liver and kidneys tissues[3, 30]. On the other hand, oral ingestion of camel milk into IRR rats is related to the functions of liver and kidney tissues. The increases in these marker parameters are common hepatotoxins of experimental animals for liver and kidney diseases [2].

Liver is considered the key organ in metabolism, detoxification and secretory functions in the body and its disorders are numerous with no effective renders connected with other organs including the kidneys. The increase in liver and kidneys weights (relative weight) under the effect of gamma irradiation may be due to the tumefaction or enlargement related to their collagen accumulation and across such stress condition of gamma radiation exposures [1, 3].

The above results of hepato-toxicity, and nephron-toxicity of gamma radiation in rats, as well as camel milk protective effects were supported by the present studies of histopathology in liver and kidneys. The control sections of liver and kidneys showed normal histological features (Figs. 9 and 13) evidenced by the low values in the marker parameters of liver and kidneys (Tables, 1 and 2). Liver of IRR-rats showed portal infiltration with leucocytes, whereas kidneys of IRR-rats

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showed marked vacuolations of endothelial lining glomerular tuft and epithelial lining renal tubules with pyknosis of their nuclei. These confirmed the biochemical data in Tables 1 and 2. The IRR-rats treated by camel milk showed granularity of the epithelial lining renal tubules (Figs. 12 and 16).

Regarding the protein profile of the experimental rats, gamma rays exposure significantly decreased total soluble protein, albumin and globulin in sera of IRR-rats relative to normal control ones in which their protein profiles were improved and re-adjusted by camel milk ingestion. These may be attributed to the due to the effect of ROS (produced due to exposure to gamma rays) which induce oxidative damage to vital cellular molecules and structure; including protein, fluids, DNA and membranes [31, 32]. The harmful ROS induced physiological disorders and diseases which contributed to radiation injury[33-36].

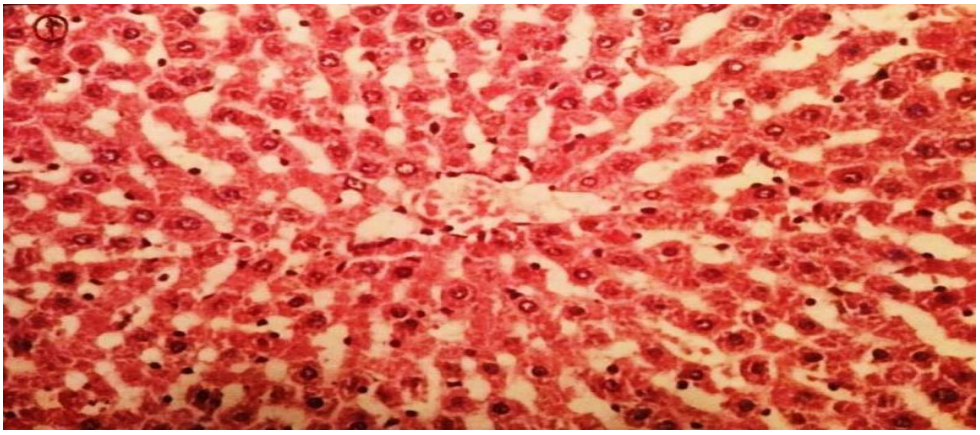

Figure 9. Liver of a rat from group 1 (a normal healthy control rat), showing the normal histological structure of the hepatic lobule (H and E x 400).

Figure 10. Liver of a rat from group 4 (a normal healthy rat ingested with 6 ml camel milk), showing the normal histological structure of the hepatic lobule (H and E x 400).

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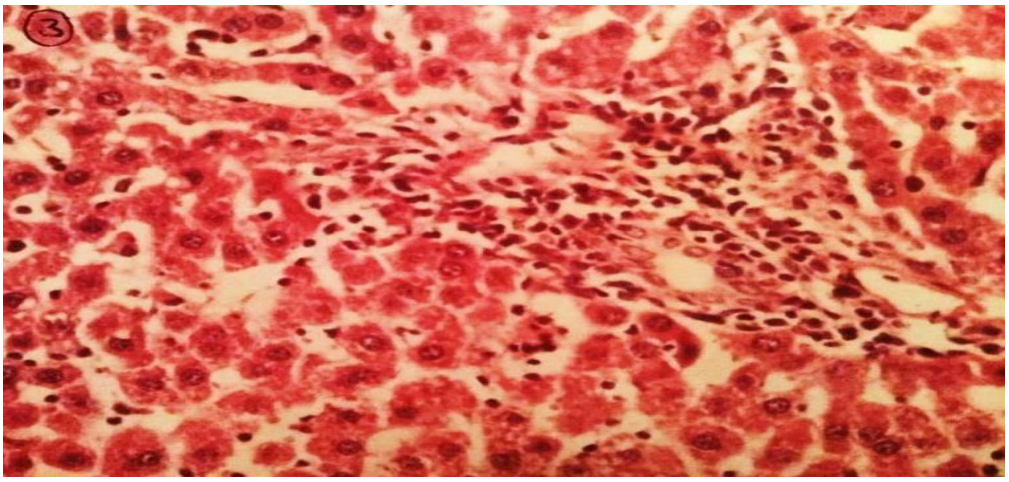

Figure 11. Liver of a rat from group 7 (ɤ-irradiated rat, exposure 7Gy), showing portal infiltration with leukocytes (H and E x 400).

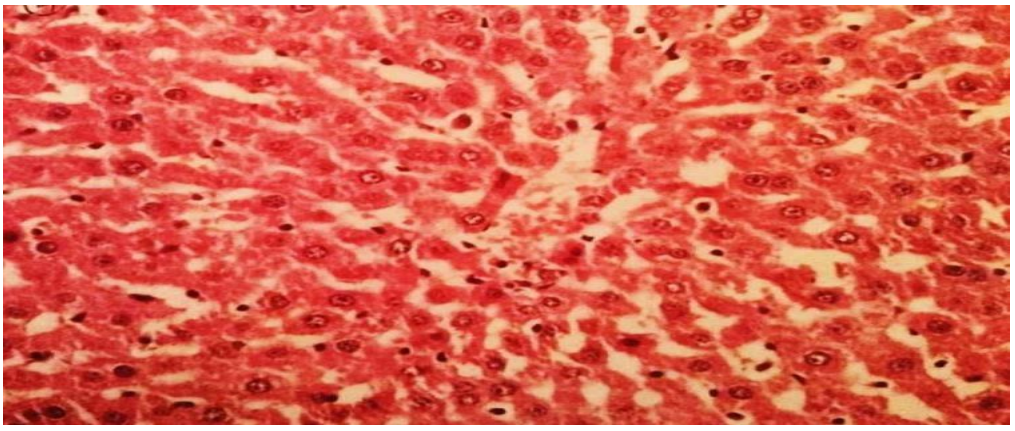

Figure 12. Liver of a rat from group 16 (ɤ-irradiated rat, exposure 7Gy and ingested with 6 ml camel milk), showing kupffer cell activation (H and E x 400).

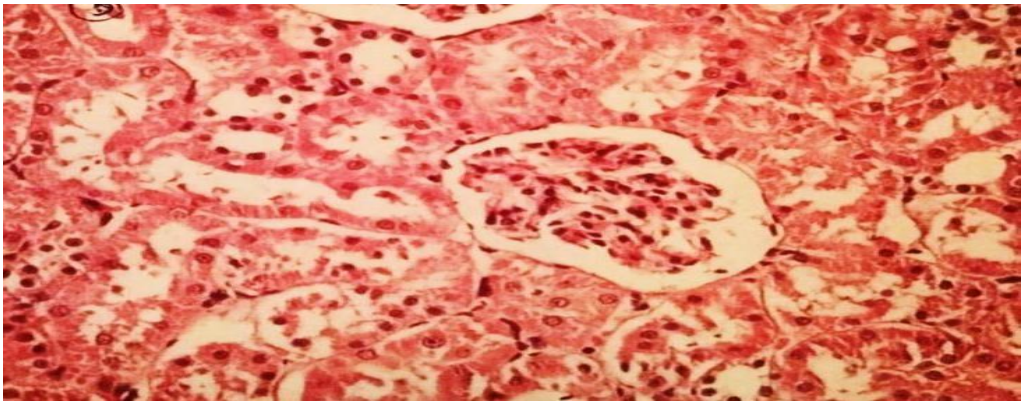

Figure 13. Kidney of a rat from group 1 (a normal healthy control rat), showing the normal histological structure of renal parenchyma (H and E x 400).

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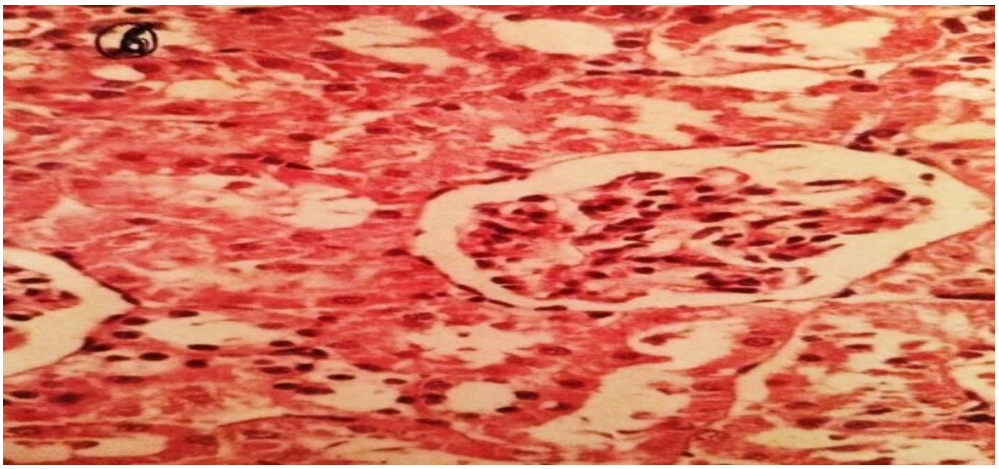

Figure 14. Kidney of a rat from group 4 (a normal healthy rat ingested with 6 ml camel milk), showing the normal histological structure of renal parenchyma (H and E x400).

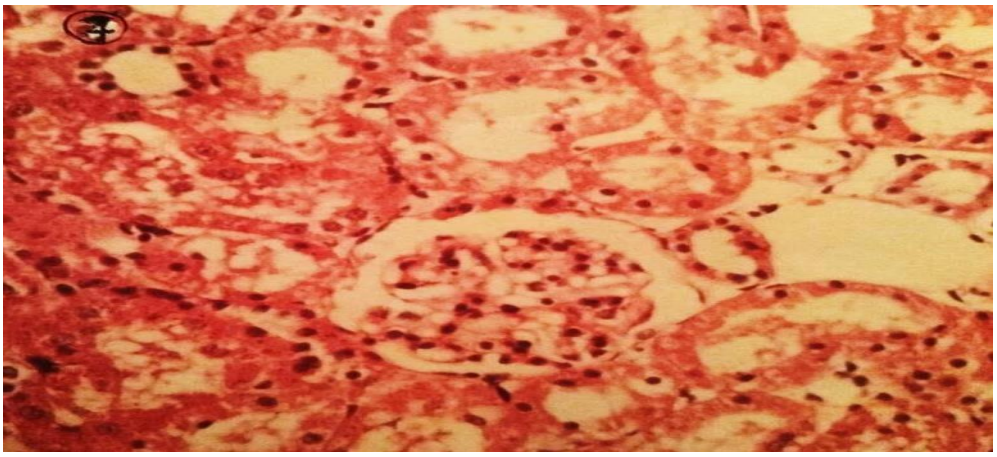

Figure 15. Kidney of a rat from group 7 (ɤ-irradiated rat, exposure 7Gy), showing markedvaculations of endothelial lining glomerular tuft and epithelial lining of renal tubules with pyknosis of their nuclei (H and E x 400).

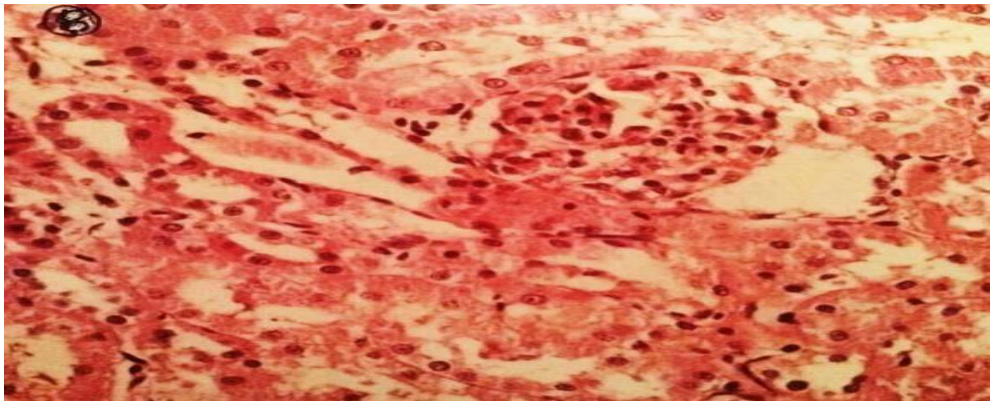

Figure 16. Kidney of a rat from group 16 (ɤ-irradiated rat, exposure 7Gy and ingested with 6 ml camel milk), showing slight granularity of

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epithelial lining of renal tubules(H and E x 400).

4. Conclusions

Gamma radiation exposure caused significant increases in the activity liver enzymes (AST, ALT and ALP) and bilirubin content in serum. Also, gamma radiation exposure caused elevation in marker parameters of kidney functions, as well as their weights, while serum protein profile was decreased. Dose-dependent gamma rays exposure combined with camel milk ingestion resulted in significant restorations of biomarkers of both liver and kidney function, as well as their weights. These may be attributed to the membrane stabilizing activity which prevents the leakage of intracellular biomarkers. This is in agreement with the commonly accepted view that biomarkers serum levels of both the liver and kidneys functions, as well as their weights and protein profile, restore their normal levels due to healing of liver and kidneys tissues and regeneration hepato and nephron- cytes as shown in the present histopathological examination.

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Conflicts of Interest
The authors declare no conflict of interest.

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