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Radiation Effect on Body Weight in Mice

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THIS STUDY was conducted to examine the hypothesis that deposition of fat and for protein in animal's body before irradiation or using radioprotector material such as soyabean oil may reduce the hazard effects of radiation on body weight. Therefore, 286 mice (144 males and 142 females) after chemical maturity were used in the study. The animals were divided to 4 major groups. The first group was fed on chow diet, the second group was fed on radioprotector diet (basel diet), the third group was fed on high energy diet and the forth group was fed on high protein diet, for 7 weeks before the exposure to gamma-rays. At the exposure day each nutritional group was divided to 3 exposure treatments (non - irradiated 800 and 1200 rads). The previous hypothesis was studied for 42 days after irradiation. The data showed that :

1. There was a reduction in body weight in both sexes following the exposure. The rate of weight loss increased with increasing the dose level and with increasing the post - irradiation days.

2. The sixth and the 14*th* day after the irradiation to 800 rads witnessed the greatest rate of weight loss. During these two weeks the chow diet group appaered to be more resistant while the high protein diet group appeared to be less resistant to the hazard effect of radiation on body weight.

3. Following the second week of irradiatian the rate of weight loss in the animals which were exposed to 800 rads began to improve except the chow diet group which died at the and of this period. At the 42 days after the exposure the body weight averages other other groups did not reach the values of the pre-exposure level.

4. The animals which were exposed to 1200 rads did not show any resistance to the hazard effect of radiation on body weight since the body weight decreased sharply until death.

The effect of ionizing radiation on body weight has been manipulated in several investigations.

Douglas and Tyree (1954) found that exposing the rats to single total body and single partial body x-rays resutled in weight loss which fell into distinct patterns in relation to x-ray dosage. On the other hand, Willie *et al.* (1952) found that the pattern of weight change following radiation differs markedly between species. The rate of weight loss was very high in rats and moderate in mice, while guinea pigs continued to gain weight. On the contrary, Tyler and Stearner (1966) exposed chicks at age of 3 to 4 days to different doses of gamma-rays from 60. They found that between 170 and 800 days of age

there was a slow but constant increase in body weight in the group which received about 400 rads. Brisbin (1972) found that at 32 day old broiler chicks which were exposed to 0-900 rads of gamma rays at the age of 2 days, body weight decreased 22 grams on the average for each additional two rads.

The sensitivity to ionizing radiation seems to depend on the sex in chicks (Shebaite., 1975 and Ezzat 1977), in mice (Carter *et al.*, 1956 and Grosfill *et al.* 1959) and in beagles (Garner *et al.* 1974). It was observed that the female appeared to be more sensitive to ionizing radiation than the male.

The objective of this study was to follow the changes in live weight of the mice divided into different sexwised and exposed nutritional groups to gamma rays to be compared with the group not exposed to irradiation.

Material and Methods

The experiment was performed on Charles River mice bredi n the Experimental Animals Laboratory, Body Composition Unit, Radio-biology Department, Atomic Energy Establishment at Inchas. The mice were raised in aluminum cages 45 X 24 X 22 cm. bedded with wood shavings. The new born mice were left with their parents until 3 weeks of age, Men sexed and the males were separated from the females. The animals were supplied with tap water (Containing 0·1 terramycin) and regular chow diet. All animals were reared under similar conditions.

Two hundred and eighty-six mice (144 males and 142 females) following the sexual maturity age (11 weeks) were used in this study. The animals were divided to four nutritional groups, where the average body weight between groups within sex was approximately the same as shown in Table 1. The nutritional groups were as follows :

1· Chow diet : The commercial prepared pelleted ration consisting of not less than 13% Crude protein, 9·5% fat, 3% Crude fiber and 6·5 ash.

2· Basel diet : consisted of the regular chow diet with and additive of 3% soyabean oil as radioprotector.

3· High energy diet : Consisted of the regular chow diet with an additive of 40% rice storch.

4· High protein diet : Consisted of the regular chow diet with an additive of 30% skim milk.

For the said reasons each animal group was fed *ad libitum* for 7 weeks on its special diet before the exposure to gamma-rays. At the end of the nutritional treatments, the averages of body weight for the different groups increases (Table 1). On the day of exposure, each nutritional group within sex was divided to three exposure groups with approximately the same body weight. Whole body irradiation was applied for each animal under study. The source of irradiation was 60 gamma cell 280 located in the Nuclear Physics Department A.R.E. Atomic energy Establishment. The dosimetry of the source at the exposure day was $1·02 \times 10^5$ Rad/hair.

TABLE 1. Effect of feeding additives on body weight in the three dietary regime groups compared with chow diet group.

Item	Chow diet 88		Basel diet		High energy diet		High protein diet	
	Male	Female	Male	Female	Male	Female	Male	Female
Before feeding . . . . treatment. .	27.81±	23.23±	27.42±	23.24±	27.74±	23.16±	27.88±	23.23±
	3.21	2.31	2.49	2.81	2.77	3.20	3.56	5.0
	(30)	(27)	(35)	(40)	(39)	(36)	(40)	(39)
After (7 weeks) . . .	28.67±	28.24±	9.54±	25.58±	30.84±	26.78±	31.34±	26.93
	2.52	2.4	3.01	2.61	1.12	3.14	3.20	4.0
	(30)	(27)	(35)	(40)	(39)	(36)	(40)	(39)

a = Mean (g) L.S.D.

The number between brackets is the No. of animals.

Following the exposure, the same regime diet for each group was used. Individual body weight of the surviving animals was recorded daily for the first 2 weeks, every couple of days for the third week, every three days for the fourth week and the fifth and the sixth weeks after the exposure which was the end of the experiment.

Statistical analysis were punched on IBM Cards for each animal under study as the input data, where the 201 N.C.K. computer at the American University Computer Center in Cairo was used-All of the statistical analysis were made accoridng to Snedecor and Cochran (1968).

Results and Discussion

a. Male mice

The changes in body weight averages of the irradiated male mice following the exposure to 800 and 1200 rads in the nutritional are presented in Table 3. The data revealed a lag in weight gain or retardation in growth at the first few days after irradiation.

The chow dietary groups exposed to 800 R (Table 3) started to loose weight from the first day after the exposure until the sixth day. The rate of weight loss during this period was 17% in the high protein diet. 16·7% in the high energy diet, 14·9% in the basel diet and 7·5% in the chow diet. During the 7*th* and the 8*th* day the four groups gained weight, however, from the 9*th* day the weight decreased again. The rate of weight loss was very high in the 14*th* day. It agreed with Brisbin (1972), Shebeuta *et al.* (1975) and Ezzat (1977).

TABLE 2. **Body weight averages at the exposure day**

Group	Treatment	Male	Female
Chow diet	Non-irrad.	28.5[a]	27.7
	800 R.	28.7	28.4
	1200 R.	28.8	28.8
Basel diet	Non-irrad.	29.5	25.8
	800 R.	29.6	25.4
	1200 R.	29.5	25.5
High energy diet	Non-irrad.	30.9	26.7
	800 R.	30.7	26.9
	1200 R.	30.9	26.8
High protein diet	Non-irrad.	31.2	27.2
	800 R.	31.6	26.5
	1200 R.	31.2	27.2

Many Literature reported that exposing the animals to lethal doses of irradiation lead to severe anorexia and the animals refused feed for several days before death (Smith *et al.*, 1952, Dovgleas and Tyree, 1954).

Douglas and Tyree (1954) pointed out that doses of less than 1000 R elicited a pattern of weight loss similar to that seen in the starving animals a lugh rate of weight less on the first two postirradiation days followed by a progressively decreasing loss on the succeeding days. After 1000 and more roentgens, however, there was a high rate of weight loss on the first day, a marked decrease on the second day, a return to the initial high rate on the third day, and maintenance of this rate until death. The previous findings of Douglas and Tyree (1954) is in agreement with the results of this study.

Female mice

The body weight averages of the surviving female mice following the exposure to 800 and 1200 rads in the nutritional treatments are presented in Table 4). The four dietary groups which were exposed to 800 R of gamma-rays

TABLE 3. Body weight and percentage changes of the surviving male mice following the exposure to 800 and 1200 rads in the nutritional treatments.

a. Exposure to 800 rads

Days after exposure	Chow diet			Basel diet			High energy diet			High protein diet		
	No of Survivors	Live weight		No of Survivor	Live weight		No of Survivor	Live weight		No of Survivor	Live weight	
	No	gms	%	No		%	No		%	No		%
0	10	28.9	100	15	29.6	100	15	30.7	100	15	31.6	100
1	10	27.9	96.5	15	27.9	94.2	15	28.9	94.1	15	29.6	93.8
2	10	27.7	95.7	15	27.3	92.1	15	28.9	94.0	15	29.2	94.2
3	10	27.7	95.6	15	26.9	90.7	15	28.2	91.9	15	28.7	90.7
4	10	27.7	95.6	15	26.2	88.5	15	27.3	88.8	15	27.8	88.1
5	10	26.9	93.1	15	25.5	85.9	15	26.6	86.6	15	27.8	88.1
6	10	26.8	92.5	15	25.2	85.1	15	25.6	83.3	15	26.2	82.8
7	8	26.5	91.7	15	25.8	87.2	15	26.0	84.8	15	27.7	85.7
8	8	27.0	93.2	15	26.0	87.8	15	26.0	83.7	15	27.7	87.6
9	7	27.0	93.4	15	25.1	84.9	12	25.7	82.0	15	26.8	84.9
10	7	27.9	96.6	15	25.1	84.7	12	25.2	81.2	15	26.1	82.6
11	6	27.1	93.8	15	24.7	83.5	11	24.9	80.7	15	25.5	80.8
12	6	27.9	96.4	15	25.1	84.6	11	24.8	81.5	15	25.0	79.2
13	5	27.2	93.9	15	24.4	82.3	10	25.0	80.9	14	24.6	77.9
14	5	27.4	94.9	15	23.9	80.6	10	24.8	84.2	12	24.5	77.6
15	0			15	24.4	82.5	10	25.9	86.4	11	27.2	88.9
17				15	25.7	86.7	10	26.8	86.8	11	27.3	86.4
18				15	24.9	83.9	10	26.7	88.4	10	28.0	88.6
21				15	25.2	25.0	10	26.7	88.2	10	27.7	88.1
22				15	26.2	88.3	10	27.1	88.1	10	29.2	92.5
25				15	26.2	88.3	10	27.1	88.1	10	28.5	90.0
28				15	26.4	89.0	10	27.1	90.6	10	29.2	92.5
30				15	25.4	86.5	10	27.8	91.2	10	28.9	91.3
35				15	27.1	91.4	10	28.0		10	29.3	92.6
42				15	24.9	83.9	10	26.9	82.7	10	28.5	90.3
				15	27.5	92.8	10	27.8	90.7	10	29.2	92.4

b. Exposure to 1200 rads

0	10	28.2	100	15	29.5	100	15	30.9	100	15	31.2	100
1	10	27.3	96.7	13	29.5	99.5	15	28.8	93.7	15	28.8	92.1
2	10	27.0	95.5	13	28.8	97.6	15	29.2	94.4	15	29.2	93.4
3	10	26.8	94.9	13	27.5	93.2	15	27.2	88.2	15	27.4	87.7
4	10	26.3	93.2	13	25.9	87.5	15	25.7	83.3	15	25.6	82.0
5	8	25.9	91.8	12	24.3	82.3	15	24.3	78.5	15	24.6	78.6
6	8	25.6	90.8	11	23.1	78.1	12	23.4	75.8	14	30.0	73.7
7	2	25.4	90.0	8	23.2	78.5	10	23.5	76.7	13	22.9	73.2
8	2	25.1	88.7	8	22.1	76.8	7	22.2	71.9	9	22.4	71.7
9	2	24.9	88.2	5	21.5	72.9	1	20.7	67.0	7	21.1	67.4
10	2	24.2	85.7	3	20.6	69.8	0			2	20.8	66.4
11	2	24.3	86.1	1	21.5	72.8				0		
12	2	24.5	86.8	0								
13	2	24.0	85.0									
14	2	23.7	83.8									

TABLE 4. Body weight and percentage changes of the surviving female mice following the exposure to 800 and 1200 rads in the mutritional treatments.

Days after exposure	Chow diet			Basel diet			High energy diet			High protein diet		
	Survivors	Live weight		Survivors	Live weight		Survivors	Live weight		Survivors	Live weight	
	No.	G	%	No.	G	%	No.	G	%	No.	G	%
a. Exposure to 800 rads.												
0	10	28.2	100	15	25.4	100	15	26.9	100	15	26.5	100
1	10	27.3	96.8	15	24.4	95.8	14	25.6	95.3	15	24.2	91.3
2	10	26.6	94.8	15	23.3	91.6	14	25.6	95.2	15	24.2	91.1
3	10	26.5	94.1	15	23.5	92.5	14	25.4	94.6	15	23.4	88.1
4	10	26.4	93.7	15	22.9	90.1	14	25.0	93.1	15	23.3	87.7
5	10	26.1	92.6	15	21.6	87.6	14	23.4	87.1	15	22.6	85.1
6	10	25.7	91.3	14	23.0	90.5	14	24.9	89.2	15	23.0	86.7
7	10	24.6	87.4	14	22.4	88.2	14	24.1	89.7	15	22.5	84.7
8	9	23.6	83.8	14	21.6	85.3	13	23.8	88.7	15	22.0	82.8
9	9	23.4	83.1	14	21.6	85.1	13	23.8	86.8	15	21.3	80.2
10	8	23.5	83.4	13	21.1	82.9	12	23.3	88.1	15	21.1	79.5
11	8	23.2	82.3	13	21.4	84.0	11	24.2	90.1	15	20.7	78.1
12	8	23.1	81.9	12	20.7	81.4	11	24.3	88.1	13	20.9	78.1
13	8	23.3	82.8	12	20.5	80.6	10	23.7	90.9	13	20.5	78.9
14	5	23.7	84.0	12	20.9	82.2	10	24.4	92.2	12	21.6	77.4
15	0			12	21.5	84.7	10	24.8	91.0	12	21.4	81.3
17				12	21.8	85.7	10	24.4	91.1	12	22.0	80.9
18				11	21.4	84.0	9	24.5	99.1	12	22.0	83.0
21				11	22.7	89.4	9	24.5	94.8	11	22.8	85.9
22				11	23.2	91.2	9	25.5	97.2	11	22.2	83.6
25				10	23.1	90.9	9	26.1	96.1	11	22.6	85.1
28				10	24.8	97.4	9	25.8	98.9	11	22.3	83.9
30				10	23.2	91.4	9	26.6	98.9	11	23.4	88.2
35				10	24.6	96.8	9	25.2	93.8			
b. Exposure to 1200 rads.												
0	10	27.7	100	15	25.6	100	15	26.8	100	15	27.2	100
1	10	27.6	99.7	15	23.9	93.5	15	25.4	94.6	15	24.4	89.7
2	10	27.2	98.1	15	23.3	91.4	15	25.3	94.4	15	24.2	89.0
3	10	26.9	97.2	15	23.3	91.1	15	24.5	91.1	15	22.7	83.4
4	10	26.6	96.0	15	22.1	86.4	14	23.1	86.1	14	22.2	81.7
5	10	25.6	92.5	14	20.9	81.8	14	21.5	80.0	11	21.4	78.9
6	10	24.5	88.5	14	19.8	77.7	12	19.9	74.0	10	20.6	75.7
7	10	24.6	88.9	14	20.0	78.2	9	20.1	75.0	9	19.4	71.6
8	6	24.4	88.1	14	19.5	76.5	8	19.4	72.3	4	20.0	73.8
9	6	24.0	86.5	14	18.4	72.2	7	18.3	68.3	4	18.7	68.8
10	6	23.7	85.4	11	18.5	72.6	5	17.9	66.9	2	16.2	59.7
11	6	23.0	83.1	9	18.0	70.5	0					
12	6	22.4	80.8	4	18.2	71.2						
13	6	21.7	78.2	1	17.2	62.2						
14	4	21.0	75.6	1	17.3	67.7						
15	0			0								

(Table 4) began also to loose weight from the second day after exposure and reached high rate in the sixth day. They reached 22.4%, 19.4%, 19% and 5.1% in the high protein, basel diet, high energy and chow diet, respectively. Following the second week of radiation there was an improvement as shown in Table 2 except the chow diet group were all animals died. However, the observed gain in body weight of the basel diet, high energy, and high protein diet did not reach the value of the pre-exposure (Table 2) even after the 6 weeks of irradiation.

Table 3 shows the changes in body weight for the four dietary groups exposed to 1200 rads. Body weight decreased sharply after the exposure and the percent weight loss reached its maximum extent after two days. The percent weight loss reached 33.6% in the high protein group, 30% in basel diet and 14 3% in chow diet. All the surving animals in the high energy group died at the 8*th* day after exposure with percent body weight loss of 28.1%.

The previous results of weight changes in the four dietary groups, have established certain response pattern of dose rate-dependent. The correlation between the changes in body weight of mice and radiation doses has been reported in mice by Chapman *et al.* (1950) and Chapman *et al.* (1955) in rat by Dewglas and Tyree (1954), Smith *et al.* (1952) and in irradiated chicks by Briskin and Thomas (1971). The observed reduction in body weight after irradiation to gamma-rays is in rate of weight loss was 17.4% in high protein diet, 15.2% in the basel diet, 12.9% in the high energy diet and 8.7% in the chow diet. However, the four dietary groups gained weight during the 7*th* and the 8*th* day. From the 9*th* day, the four dietary groups lost weight again, but the high energy group gained weight from the 10*th* day until the 14 day after the exposure. On the average, the dietary groups continued to loose weight until the end of the experiment. The rate of weight loss was 22%, 19.4% and 16% in the high protein, basel diet and in the chow diet respectively, comparing with 9% in the high energy group. This pattern of weight loss is similar to the pattern of weight loss in the male dietary groups. It is interesting to note that there was a sex difference between male and female chow diet group (Tables 3 and 4). The percent weight loss after 6 days of irradiation was 7.5% in male chow diet group and 8.7% in the females, while after 14 days of exposure it was 5.1% in males and 16% in females. This sex difference is in agreement with Chapman (1955), Carter *et al.* (1956) and Crosfill *et al.* (1959) in mice, with Garner *et al.*, (1974) in beagles and with Shebaita *et al.* (1879) in Chickens. The above mentioned reports attributed this sex difference to the difference in sensitivity between the two sexes to ionizing radiation.

In the four dietary groups that were exposed to 1200 rads (Table 4) a severe weight loss was observed with no recovery. The data in Table 3 and 4 showed that the rate of weight loss in both males and females increased with increasing the close level. The rate of weight loss was very high in high protein diet, high energy diet and basel diet, respectively in both sexes than that in the chow group.

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التأثير الاشعاعى على وزن الجسم فى الفئران

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كليتى الزراعة ـ جامعة القاهرة وجامعة الزقازيق وهيئة الطاقة الذرية ـ مصر

أجريت هذه الدراسة بهدف معرفة تأثير أشعة جاما المؤينة على مكونات جسم الحيوانات الزراعية وخصوصا الثدييات ولاختبار صحة الافتراض القائل بأن زيادة نسبة الدهن أو البروتين فى جسم الحيوان أو استخدام بعض المواد المضادة للاشعاع مثل زيت فول الصويا قبل التعرض للاشعاع يؤدى الى تقليل الآثار الضارة بالاشعاع على كل من وزن الجسم نسبة النفوق ومكونات الجسم المختلفة ٠

ولاجراء هذه الدراسة استخدم ٢٨٦ جرزا من نوع تشارلز ريفر (١٤٤ ذكر ، ١٤٢ انثى) وصلت جميعها الى عمر النضج الكيماوى ٠ حيث قسم كل من الذكور والاناث الى أربعة مجاميع رئيسية متقاربة فى متوسط وزن الجسم حيث تم تغذية المجموعة الأولى على العليقة العادية الخاصة بالجرزان وغذيت المجموعة الثانية على عليقة عادية تحتوى على ٣٪ زيت فول الصويا (كمادة مضادة للاشعاع) وغذيت المجموعة الثالثة على مجموعة عادية تحتوى على ٤٠٪ نشا أرز ـ أما المجموعة الرابعة فقد غذيت على عليقة عادية تحتوى على ٢٠٪ لبن مجفف وقد استمرت كل مجموعة فى التغذية على العليقة الخاصة بها لمدة ٧ أسابيع قبل التعرض لأشعة جاما المؤينة وهذا بهدف زيادة نسبة الدهن والبروتين فى جسم الجرزان كوسيلة لتلافى الآثار الضارة للاشعاع على الجسم ٠

وفى اليوم المحدد للتعرض للاشعاع قسمت كل مجموعة من المجموعات الغذائية الأربعة داخل كل جنس الى ثلاثة مجاميع متساوية تقريبا فى المتوسط وزن الجسم حيث عرضت المجموعة الأولى الى ١٢٠٠ راد ـ والثانية الى ٨٠٠ راد من أشعة جاما المؤينة واستخدمت المجموعة الثالثة كمجموعة للمقارنة دون تعرض للاشعاع وذلك لتقدير مكونات الجسم بها ٠ هذا وقد استمر البرنامج الغذائى السابق الخاص لكل مجموعة عقب التعرض للاشعاع لمدة ٦ أسابيع تم خلالها اختبار الافتراض السابق وذلك لدراسة أثر الاشعاع على كل من :

وزن الجسم ، نسبة النفوق ومكونات الجسم المختلفة وهى (كمية الدهن الكلية ، وزن الجسم الخالى من الدهن ، كمية الماء فى الجسم ، وزن الجسم الجاف الخالى من الدهن ، كمية البروتين فى الجسم ، كتلة الأنسجة الموجودة خارج الخلايا ، الماء خارج الخلايا ، رماد الجسم وكمية البوتاسيوم فى الجسم) ٠ ويمكن تلخيص نتائج هذه الدراسة كما يلى :

١ ـ حدث انخفاض ملحوظ فى وزن الجسم فى كل من ذكور واناث المجاميع المعاملة غذائيا التى عرضت الى ٨٠٠ راد ابتداء من اليوم الأول للتعرض ٠ وقد وجدت علاقة طردية بين معدل النقص فى وزن الجسم وكل من جرعة الاشعاع والأيام بعد التعرض فقد وجد أن معدل النقص فى وزن الجسم يزداد بزيادة الجرعة الاشعاعية وزيادة الأيام بعد التعرض ٠

٢ ـ شهد اليوم السادس من التعرض انخفاض كبير فى وزن الجسم فى ذكور واناث المجاميع المعاملة غذائيا والمعرضة لـ ٨٠٠ راد ـ فقد بلغ هذا النقص ١٧٪ ، ١٦ر٧٪ ، ١٤ر٩٪ ، ١٧ر٥٪ ـ فى ذكور المجاميع التى غذيت على عليقة غنية فى البروتين وعلى عليقة غنية فى النشا وعلى عليقة بها مادة مضادة للاشعاع

(زيت فول الصويا) وعلى عليقة عادية على الترتيب • أما بالنسبة للاناث فقد بلغ مقدار النقص فى وزن الجسم فى اليوم السادس من التعرض ٤ر١٧٪ فى المجموعة التى غذيت على عليقة غنية فى البروتين ، ٢ر١٥٪ فى المجموعة التى غذيت على عليقة بها مادة مضادة للاشعاع (زيت فول الصويا) ، ٩ر١٢٪ فى المجموعة التى غذيت على عليقة غنية فى النشا و٧ر٨٪ فى المجموعة التى غذيت على عليقة عادية • خلال اليوم السابع والثامن عقب التعرض حدث زيادة طفيفة فى وزن الجسم عن اليوم السادس ولكن ابتداء من اليوم التاسع حدث نقص جديد فى وزن الجسم وقد بلغ هذا النقص حده الأقصى فى اليوم الرابع عشر عقب التعرض حيث بلغ معدل نقص ٤ر٢٢٪ ، ٤ر١٩٪ ، ١٩٪ ، ١ر٥٪ فى الذكور التى غذيت على عليقة غنية فى البروتين ، وعلى عليقة بها مادة مضادة للاشعاع ، عليقة تحتوى على نسبة عالية من النشا وعليقة عادية على الترتيب • أما النقص الحادث فى وزن الجسم فى الاناث فى اليوم الرابع عشر فقد وصل الى ٢٢٪ فى المجموعة التى غذيت على عليقة غنية فى البروتين ، ٤ر١٩٪ فى المجموعة التى غذيت على عليقة بها زيت فول الصويا ، ١٦٪ فى المجموعة التى غذيت على عليقة عادية ، ١ر٩٪ فى المجموعة التى غذيت على عليقة فى النشا •

٣ ـ عقب الأسبوع الثانى للتعرض ل ٨٠٠ راد حدث تحسن طفيف فى معدل النقص فى وزن الجسم فى جميع المجاميع التى عرضت للاشعاع والمعاملة غذائيا فيما عدا المجموعة التى غذيت على عليقة عادية فقد نفقت جميعها خلال الأسبوع الأول والثانى عقب التعرض • الا أنه فى بقية المجاميع الأخرى فان وزن الجسم فى نهاية الأسبوع السادس من التعرض لم يصل الى مقدار الوزن قبل التعرض فقد بلغ النقص ٣ر٩٪ ، ٦ر٧٪ ، ٢ر٧٪ ـ فى ذكور المجاميع التى غذيت على عليقة غنية فى النشا ـ وعلى عليقة غنية فى البروتين وعلى عليقة بها زيت فول الصويا ـ أما بالنسبة للاناث فقد بلغ معدل النقص ٨ر١١٪ ، ٢ر٦٪ ، ٢ر٣٪ ـ فى المجاميع التى غذيت على عليقة غنية فى البروتين وعلى عليقة غنية فى النشا وعلى عليقة بها زيت فول الصويا •

٤ ـ المجاميع التى عرضت الى ١٢٠٠ راد فقد كان معدل النقص حادا وسريعا سواء فى الذكور أو فى الاناث وقد استمر هذا المعدل السريع للنقص فى وزن الجسم حتى نفقت جميع الجرزان فى كل مجموعة فقد بلغ معدل النقص فى وزن الجسم للذكور عند النفوق ٦ر٣٣٪ ، ٣٣ر٪ ، ٢٨٪ ، ٢ر١٦٪ فى المجاميع التى غذيت على عليقة غنية فى البروتين ، عليقة غنية فى النشا ، عليقة بها زيت فول الصويا ، عليقة عادية على الترتيب • أما بالنسبة للاناث فقد بلغ معدل النقص فى وزن الجسم عند النفوق ٣ر٤٠٪ ، ١ر٣٣٪ ، ١ر٣٢٪ ، ٣ر٢٤٪ فى المجاميع التى غذيت على عليقة غنية فى البروتين ، عليقة غنية فى النشا ، عليقة بها زيت فول الصويا وعلى عليقة عادية على الترتيب •