



342 / -
2005

:

(B1, B2, B3, B4) (4, 8, 15, 30 ppm)

60-) 7

/ 8 4

.(/ 1

(B2 B1)

30 A

(P<0.0001) (±) 6 ± %77 6 ± %69

/ 30 15

9 ± %42

B4 B3

(P<0.04) 14 ± %49 (P<0.39) 12 ± %50

/ 30 15

B4 B3

3 ± %72 1 ± %86

8 4

) B2 B1

%100

.(/

(/ 8 / 4)

7

C2 C1

/ 30 / 15

(7)

50

30

C1

(P<0.0001) 5 ± %77 5 ± %82

9 ± %42

C2

/ 8 4

. / 4

/ 8

/ 30 15

. / 30

(/ 4.8)

6±%69

/ 4

(P<0.007) 5±%82

/ 4

:

Abstract

The aim of this study was to evaluate the potential radio-protective effects of different selenium supplement concentrations of 4, 8, 15 and 30 ppm in rats before and after irradiation. Four groups of rats were administered different concentrations of selenium in drinking water for 30 days before irradiation starting from the ablation which considered as day 0. The results showed that the sodium selenite of 4 ppm and 8 ppm enhance the 30-day survival of irradiated rats at 7 Gy (^{60}Co source, whole body irradiation dose rate of $1\text{Gy}\cdot\text{min}^{-1}$) compared to the control group. The mean cumulated probability of survival of rats was $69\%\pm 6$ (Mean \pm S.E) and $77\%\pm 6$ in 4 and 8 ppm groups, respectively versus $42\%\pm 9$ for control group ($P<0.0001$). Our data also indicated that sodium selenite with concentrations of 15 and 30 ppm had no significant reduction in mortality. The mean cumulated probability of survival of rats was $50\%\pm 12$ ($P=0.39$) and $49\%\pm 14$ ($P=0.04$), respectively. The toxic effects of selenium were observed at 15 ppm and 30 ppm, the mean cumulated probability of survival of rats was $86\%\pm 1$ and $72\%\pm 3$, respectively after 30 days of selenium intake.

To evaluate the potential radio-protective effects of different selenium supplement concentrations of 4, 8, 15 and 30 ppm in rats after irradiation. Two groups of rats were administered 4, 8 ppm sodium selenite in drinking water for 30 days after irradiation. The two concentrations 15, 30 ppm were excluded because of their toxic effects. The results showed that the sodium selenite of 4 ppm and 8 ppm administered after irradiation enhance the 30-day survival of rats compared to the control group. The mean cumulated probability of survival of rats was $82\%\pm 5$ (Mean \pm S.E) and $77\%\pm 5$ in 4 and 8 ppm groups, respectively versus $42\%\pm 9$ for control group ($P<0.0001$).

We conclude that 4 and 8 ppm sodium selenite have a radio-protective effect if administered before and after irradiation. It was found that the 4 ppm administered after irradiation is better than those administered before. 15 and 30 ppm sodium selenite had no radio-protective effects in rats, this may be due to a synergism of toxicity and radiation effects.

Key words: Radio-protective effects, trace elements, selenium

	-1
7.....	-1.1
8.....	-2.1
9.....	-3.1
10.....	-4.1
11.....	-2
	-3
12.....	-1.3
12.....	-2.3
12.....	-3.3
12.....	-4.3
13.....	-5.3
13.....	-6.3
14.....	-7.3
	-4
14..... (A)	-1.4
15..... (B)	-2.4
15..... B1	-1.2.4
17..... B2	-2.2.4
19..... B3	-3.2.4
22..... B4	-4.2.4
24..... (C)	-3.4
24..... C1	-1.3.4
26..... C2	-2.3.4
27.....	-5

33.....	-6
34.....	-7
34.....	-8
35.....	-9

Ionizing radiation and its biological damage

-1.1

X) electromagnetic radiation

() particulate radiation

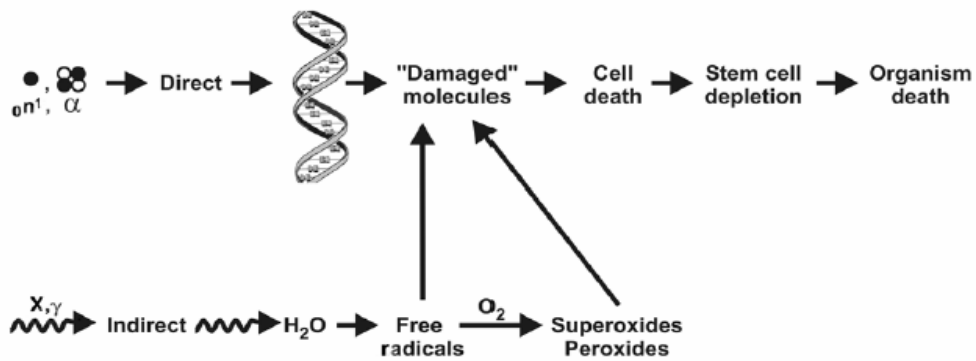
(

.[2,1] (1)

.[3,1]

DNA

:



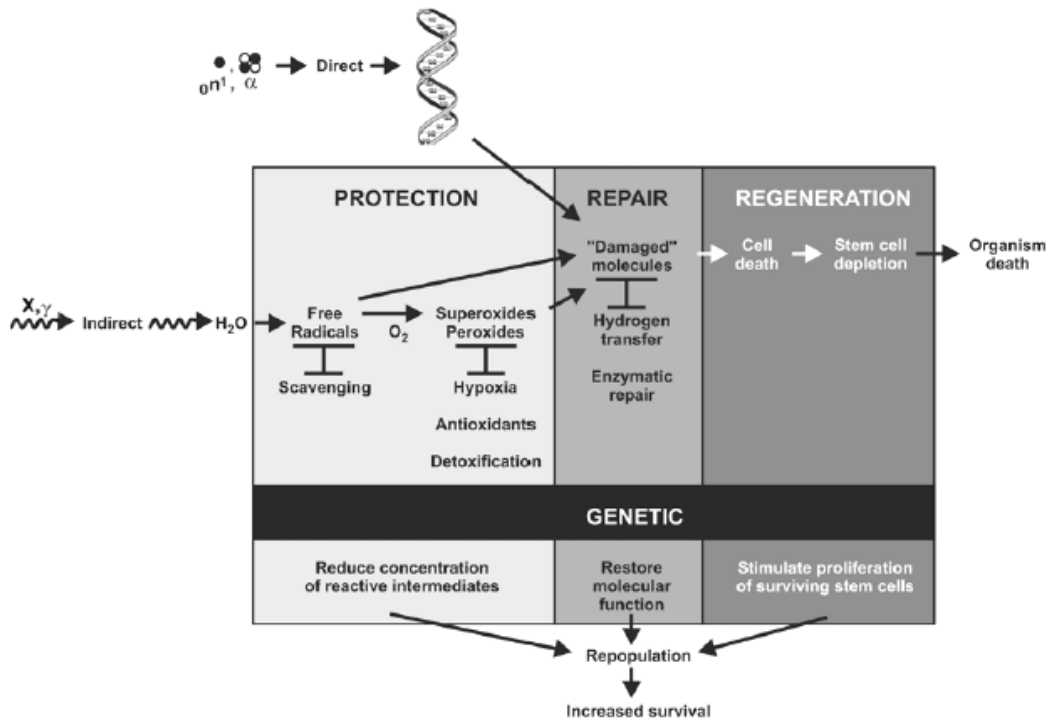
(1)

.DNA

-2.1

stimulate

.(2)



(2)

.[1]

.[2]

2-10

scavenge

hypoxia

[5,4]

(GSH-PX) glutathione peroxidase

[6]

endogenous scavenger

[7] Jozanov-Stankov

(AODS)

AODS

[8]

Radio-protectors

-3.1

radiotherapy

[9]

aminothiols

.WR-2721 WR-1065, WR-638

.Reed Army Hospital

[13,12,11,10]

metabolites

WR-1065

[14] natural polyamines

WR-2721

.antimutagenic properties

[15]

Diltiazem [17,16] Floersheim

.%93

free radicals

lipids peroxidation

Ionic leakage

[Ca²⁺] :

cellular dysfunction

[18]

(Diltiazem, Nifedine)

E

[19]

[20]

Selenium -4.1

trace element

10⁻²

[21]

glutathione peroxidase

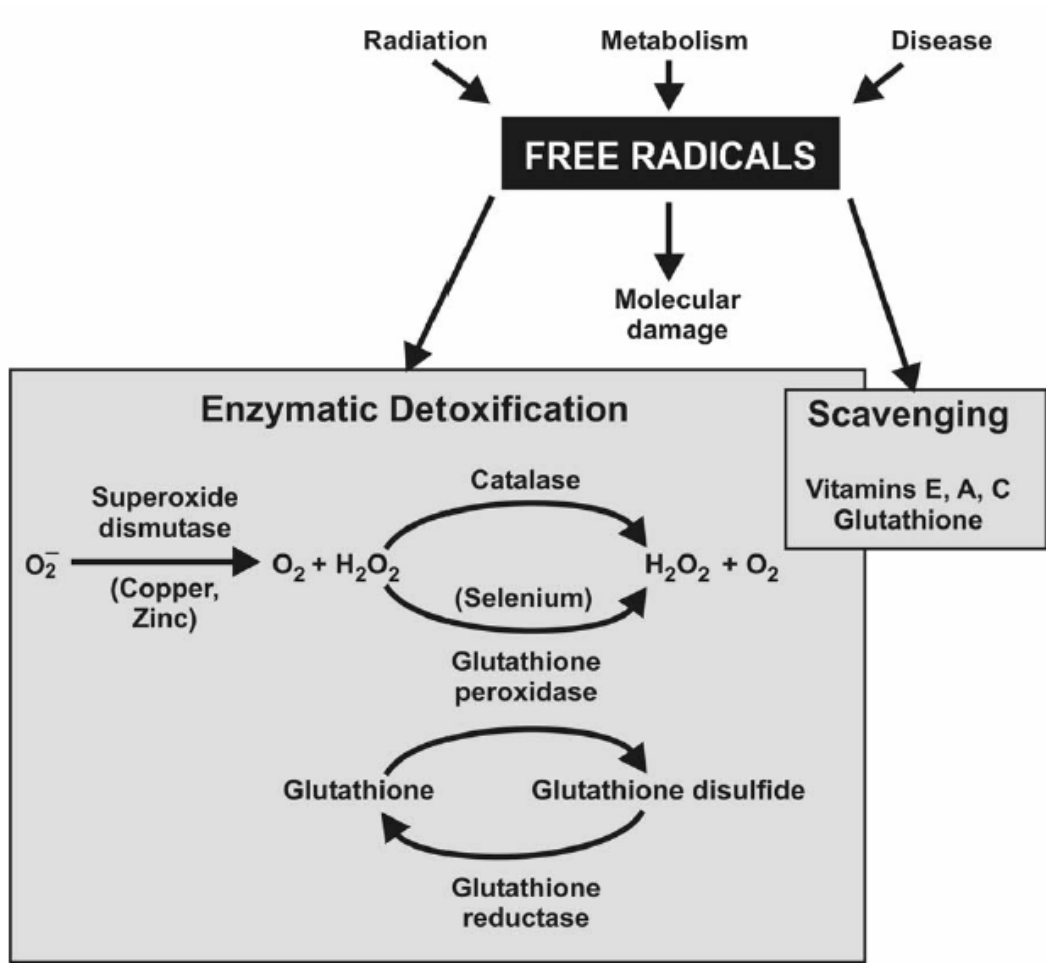
[22] selenocysteine

hydrogen peroxide

(3) [23]

E

. [24] organelles



(3)

scavenge

-2

()

-3

-1.3

- PROLABO Na2SeO3 -

-

-2.3

- TKA DI 425 Mixed-Bed Deionizer for Purified Water -

-(BC-1201) (0.000) Sartorius -

-

-

- 20 -

- ROBO - Russian design -

-()

-3.3

(100-85) Wistar

(/ 7-5) ()

B1) B 189 289

/ 30 15 8 4) (B4 B3 B2

7 (

:

. / 4 .(20 25) 45 : B1 -

. / 8 .(28 24) 52 : B2 -

. / 15 .(23 23) 46 : B3 -

. / 30 .(22 24) 46 : B4 -

/ 0.223 0.112 0.06 0.03

B4, B3, B2, B1

/ 16.3

(25 25) 50 A -

() 42-49 Kci .
 , ROBO-Russian design
 .1.25 Mev ,44.5 Kci
 / 1 ≈ 7
 . 423

-6.3

(Na₂SeO₃) sodium selenite

. PROLABO 172.94
 / 30 15 8 4 :
 13.70 6.85 3.65 1.83)
 .(/ 0.0137 0.00685 0.00365 0.00183) .(/
 :

.	/ 4	B1	0.03	-
.	/ 8	B2	0.06	-
.	/ 15	B3	0.112	-
.	/ 30	B4	0.223	-

-7.3

STATISTICA 6, Survival analysis (comparing two

P<0.05 . log-rank .samples)

-4

(A) -1.4

25 25 : 50
 . (6-5)
 . 7 (⁶⁰Co) 60 -
 .(2)

المجموعة الشاهدة:							
النسبة المئوية للبقيا للذكور والإناث %	الجرذان الإناث (25)			الجرذان الذكور (25)			المدة بعد التشيع (يوم)
	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان الناقة	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان الناقة	
100	100	25	0	100	25	0	1
100	100	25	0	100	25	0	2
96	100	25	0	92	23	2	3
54	56	14	11	52	13	10	4
50	48	12	2	52	13	0	5
42	40	10	2	44	11	2	6
40	40	10	0	40	10	1	7
40	40	10	0	40	10	0	8
26	28	7	3	24	6	4	9
20	28	7	0	12	3	3	10
10	12	3	4	8	2	1	11
8	8	2	1	8	2	0	12
4	0	0	2	8	2	0	13
0	0	0	0	0	0	2	14

(2)

(A)

() ()

14

±) 9±%42

14

.(

(B)

-2.4

B4 B3 B2 B1

7

(/ 30:15:8:4)

(/ 4) B1 -1.2.4

()

.%100

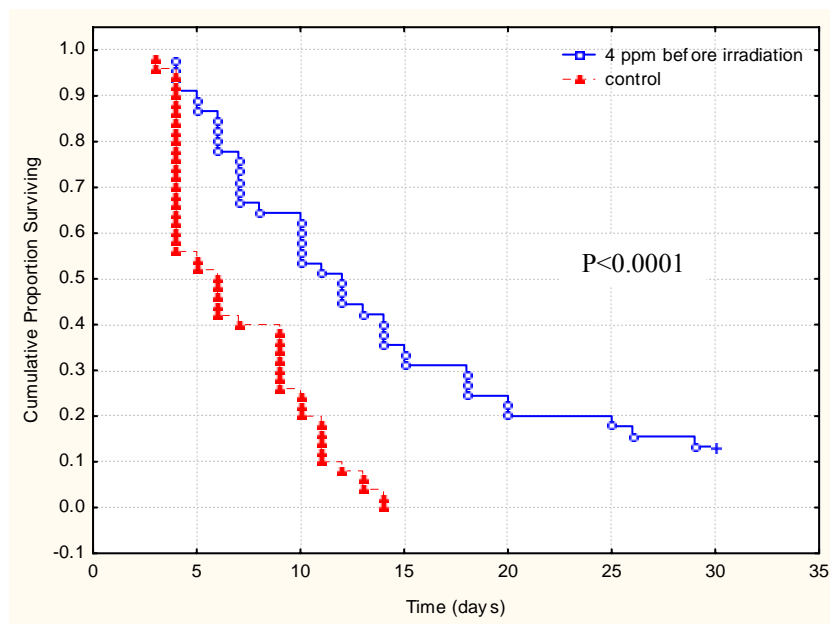
30

3)

.(

.(4)

. 6 ±%69



(4)

/ 4

)

7

(

المجموعة B1:							المدة بعد التشعيع (يوم)
النسبة المئوية للبقيا للذكور والإناث %	الجرذان الإناث (25)			الجرذان الذكور (20)			
	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان الناقة	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان الناقة	
100	100	25	0	100	20	0	1

100	100	25	0	100	20	0	2
100	100	25	0	100	20	0	3
91	92	23	2	90	18	2	4
87	88	22	1	85	17	1	5
77	84	21	1	70	14	3	6
65	80	20	1	50	10	4	7
63	76	19	1	50	10	0	8
63	76	19	0	50	10	0	9
52	68	17	2	35	7	3	10
50	64	16	1	35	7	0	11
43	56	14	2	30	6	1	12
41	56	14	0	25	5	1	13
34	48	12	2	20	4	1	14
30	44	11	1	15	3	1	15
30	44	11	0	15	3	0	16
30	44	11	0	15	3	0	17
23	36	9	2	10	2	1	18
23	36	9	0	10	2	0	19
19	28	7	2	10	2	0	20
19	28	7	0	10	2	0	21
19	28	7	0	10	2	0	22
19	28	7	0	10	2	0	23
19	28	7	0	10	2	0	24
17	24	6	1	10	2	0	25
15	24	6	0	5	1	1	26
15	24	6	0	5	1	0	27
15	24	6	0	5	1	0	28
13	20	5	1	5	1	0	29
13	20	5	0	5	1	0	30

(3)

7 30 / 4 B1

(/ 8) B2 -2.2.4

.%100

30

(4) .

(5) .

النسبة المئوية للبقيا للذكور والإناث %	الجرذان الإناث (24)			الجرذان الذكور (28)			المدة بعد التشيع (يوم)
	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان النافقة	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان النافقة	
100	100	24	0	100	28	0	1
100	100	24	0	100	28	0	2
100	100	24	0	100	28	0	3
95	100	24	0	89	25	3	4
93	96	23	1	89	25	0	5
87	96	23	0	79	22	3	6
85	92	22	1	79	22	0	7
82	92	22	0	71	20	2	8
82	92	22	0	71	20	0	9
64	67	16	6	61	17	3	10
56	54	13	3	57	16	1	11
48	46	11	2	50	14	2	12
42	38	9	2	46	13	1	13
38	33	8	1	43	12	1	14
36	29	7	1	43	12	0	15
36	29	7	0	43	12	0	16
36	29	7	0	43	12	0	17
32	25	6	1	39	11	1	18
30	25	6	0	36	10	1	19
29	25	6	0	32	9	1	20
29	25	6	0	32	9	0	21
29	25	6	0	32	9	0	22
29	25	6	0	32	9	0	23
29	25	6	0	32	9	0	24
29	25	6	0	32	9	0	25
29	25	6	0	32	9	0	26
29	25	6	0	32	9	0	27
21	13	3	3	29	8	1	28
15	8	2	1	21	6	2	29
15	8	2	0	21	6	0	30

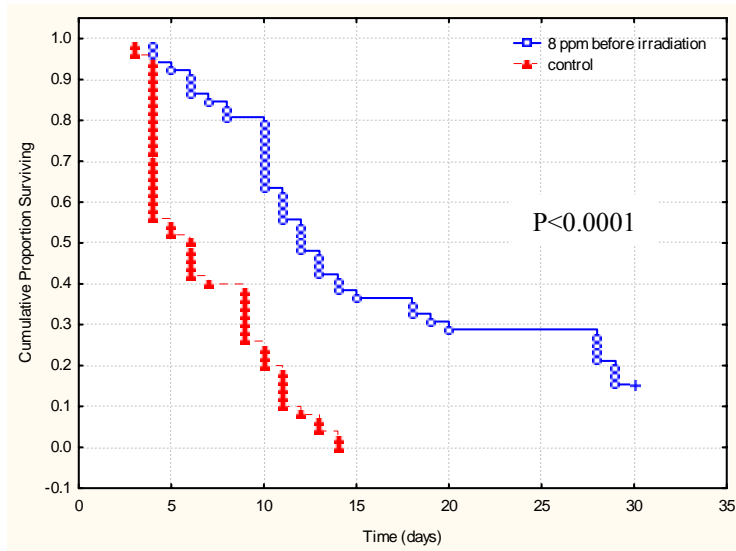
(4)

7

30

/ 8

B2



(5)

/ 8
) 7
(

(/ 15) B3 -3.2.4
()
%78

(5)

%74

11

.(6)

7 (5) (%76) .(6)
.(P=0.39) 12±%50 .(6)

المجموعة B3:							
النسبة المنوية للبقيا للذكور والإناث %	الجرذان الإناث (23)			الجرذان الذكور (23)			المدة بعد إعطاء السيينيوم (يوم)
	النسبة المنوية للبقيا (%)	عدد البقيا	الجرذان النافقة	النسبة المنوية للبقيا (%)	عدد البقيا	الجرذان النافقة	
100	100	23	0	100	23	0	1
100	100	23	0	100	23	0	2
96	96	22	1	96	22	1	3
96	96	22	0	96	22	0	4
93	96	22	0	91	21	1	5
93	96	22	0	91	21	0	6
91	96	22	0	87	20	1	7
91	96	22	0	87	20	0	8
91	96	22	0	87	20	0	9
91	96	22	0	87	20	0	10
91	96	22	0	87	20	0	11
89	91	21	1	87	20	0	12
89	91	21	0	87	20	0	13
87	87	20	1	87	20	0	14
85	87	20	0	83	19	1	15
83	83	19	1	83	19	0	16
83	83	19	0	83	19	0	17
83	83	19	0	83	19	0	18
83	83	19	0	83	19	0	19
83	83	19	0	83	19	0	20
78	78	18	1	78	18	1	21
78	78	18	0	78	18	0	22
78	78	18	0	78	18	0	23
78	78	18	0	78	18	0	24
78	78	18	0	78	18	0	25
78	78	18	0	78	18	0	26
76	74	17	1	78	18	0	27
76	74	17	0	78	18	0	28
76	74	17	0	78	18	0	29
76	74	17	0	78	18	0	30

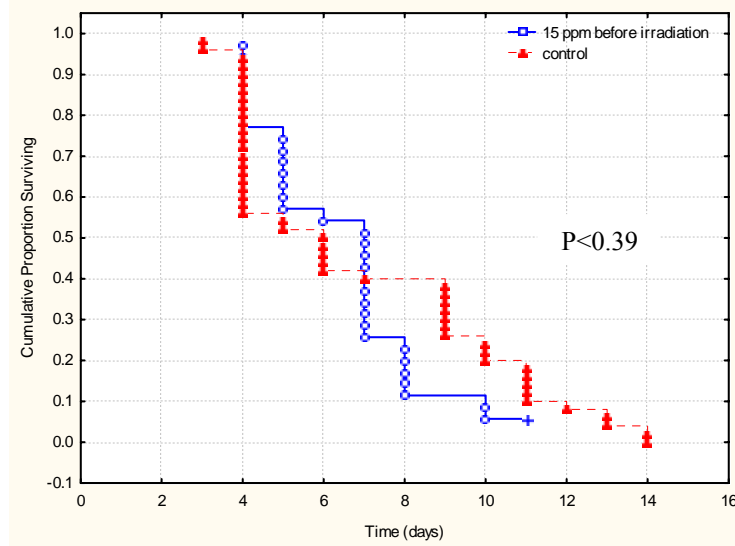
(5)

(30 / 15) B3

المجموعة B3:							
النسبة المئوية للبقيا للذكور والإناث %	الجرذان الإناث (17)			الجرذان الذكور (18)			المدة بعد التشيع (يوم)
	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان النافقة	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان النافقة	
100	100	17	0	100	18	0	1
100	100	17	0	100	18	0	2
100	100	17	0	100	18	0	3
77	82	14	3	72	13	5	4
57	65	11	3	50	9	4	5
54	65	11	0	44	8	1	6
26	24	4	7	28	5	3	7
11	6	1	3	17	3	2	8
11	6	1	0	17	3	0	9
6	6	1	0	6	1	2	10
6	6	1	0	6	1	0	11

(6)

B3

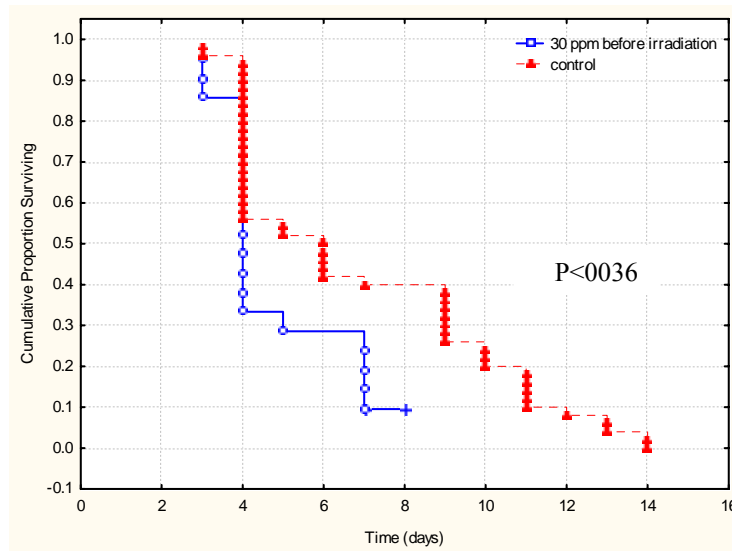


(6)

/ 15
) 7
 () B4 -4.2.4
 ()

7) %71
 %67
 %50
 %23
 7 .(7)
 .(7) 8

7 (7) (%46)
 .(8)
 .(P=0.04) 14±%49 .(7)



(7)

/ 30
) 7
 ()

المجموعة B4:							
النسبة المئوية للبقيا للذكور والإناث %	الجرذان الإناث (24)			الجرذان الذكور (22)			المدة بعد إعطاء السيلينيوم (يوم)
	النسبة المئوية للبقيا (%)	عدد البقا	الجرذان النافقة	النسبة المئوية للبقيا (%)	عدد البقا	الجرذان النافقة	
100	100	24	0	100	22	0	1
100	100	24	0	100	22	0	2
100	100	24	0	100	22	0	3
100	100	24	0	100	22	0	4
98	96	23	1	100	22	0	5
89	92	22	1	86	19	3	6
80	92	22	0	68	15	4	7
74	88	21	1	59	13	2	8
72	88	21	0	55	12	1	9
72	88	21	0	55	12	0	10
72	88	21	0	55	12	0	11
72	88	21	0	55	12	0	12
72	88	21	0	55	12	0	13
72	88	21	0	55	12	0	14
72	88	21	0	55	12	0	15
70	83	20	1	55	12	0	16
70	83	20	0	55	12	0	17
67	79	19	1	55	12	0	18
67	79	19	0	55	12	0	19
65	75	18	1	55	12	0	20
61	71	17	1	50	11	1	21
61	71	17	0	50	11	0	22
61	71	17	0	50	11	0	23
59	71	17	0	45	10	1	24
59	71	17	0	45	10	0	25
59	71	17	0	45	10	0	26
59	71	17	0	45	10	0	27
52	71	17	0	32	7	3	28
52	71	17	0	32	7	0	29
46	67	16	1	23	5	2	30

(7)

(30 / 30) B4

المجموعة B4:							
النسبة المئوية للبقيا للذكور والإناث %	الجرذان الإناث (16)			الجرذان الذكور (5)			المدة بعد التشيع (يوم)
	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان الناقة	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان الناقة	
100	100	16	0	100	5	0	1
100	100	16	0	100	5	0	2
86	81	13	3	100	5	0	3
33	38	6	7	20	1	4	4
29	31	5	1	20	1	0	5
29	31	5	0	20	1	0	6
10	6	1	4	20	1	0	7
10	6	1	0	20	1	0	8

(8)

B4

(c)

-3.4

50

7

(25) C2 (25) C1

8

/

4

(/ 1

60-)

C2 C1

/

/

30

/

15

(

/ 4) C1

-1.3.4

30

.(9)

%28

342

/ -

24

5±%82

.(8)

.(10) (P<0.0001)

المجموعة C1 و C2:						
المجموعة C2 (ذكور 25)			المجموعة C1 (ذكور 25)			المدة بعد التشيع وإعطاء السيلينيوم (يوم)
النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان النافقة	النسبة المئوية للبقيا (%)	عدد البقيا	الجرذان النافقة	
100	25	0	100	25	0	1
100	25	0	100	25	0	2
100	25	0	100	25	0	3
96	24	1	100	25	0	4
92	23	1	100	25	0	5
84	21	2	96	24	1	6
76	19	2	88	22	2	7
72	18	1	80	20	2	8
72	18	0	80	20	0	9
64	16	2	64	16	4	10
64	16	0	60	15	1	11
56	14	2	60	15	0	12
48	12	2	60	15	0	13
48	12	0	60	15	0	14
40	10	2	52	13	2	15
40	10	0	52	13	0	16
24	6	4	52	13	0	17
20	5	1	44	11	2	18
16	4	1	36	9	2	19
16	4	0	36	9	0	20
16	4	0	32	8	1	21
16	4	0	32	8	0	22
16	4	0	32	8	0	23
16	4	0	28	7	1	24
16	4	0	28	7	0	25
16	4	0	28	7	0	26
16	4	0	28	7	0	27
16	4	0	28	7	0	28
16	4	0	28	7	0	29
16	4	0	28	7	0	30

(9)

/ 8 4) C2 C1

. 7 30 (

(/ 8) C2 -2.3.4

30

.(9) %16

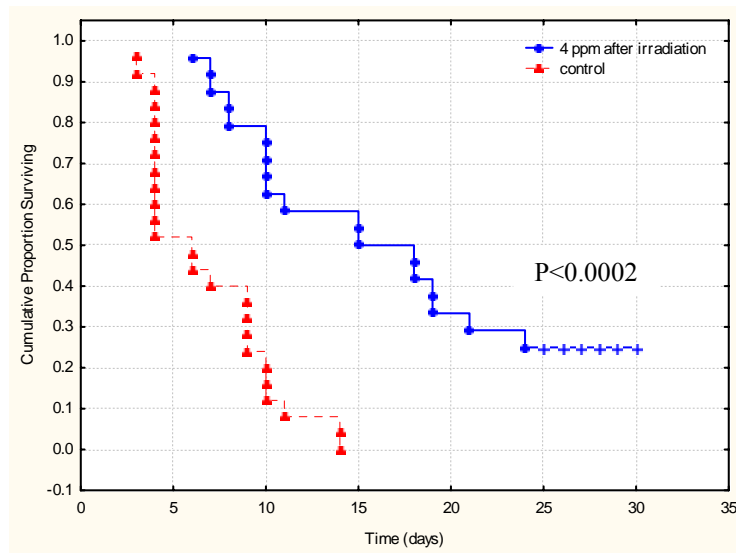
5±%77

.(9)

.(10) (P<0.0001)

/ 30 / 15) C4 C3

(

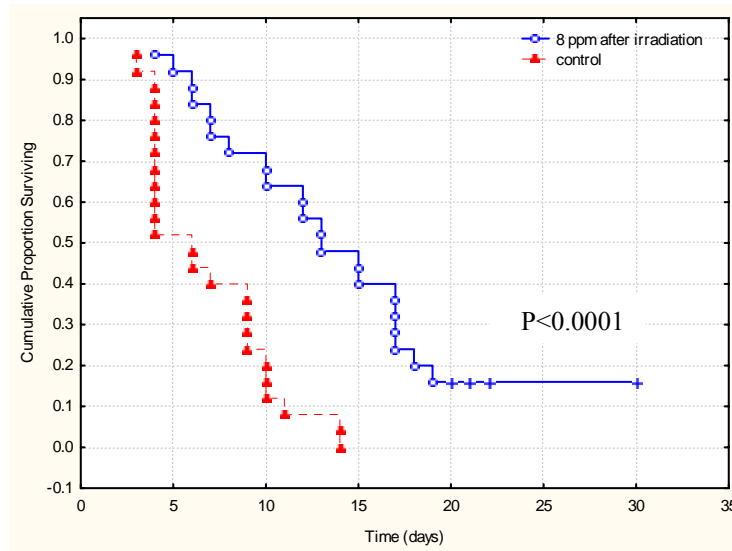


(8)

/ 4

()

7



(9)

/ 8

()

7

-5

9±%42

6 ± %77 6 ± %69 B2 B1

(±)

/ 8 4 .(10)

.(5.4) (P<0.0001)

1.6 B2 B1

1.8

/ 8 4

B2 B1

%15 %13

)

14

%0

0.06 0.03)

/ 8 4

.(2.3.4

(/

[26] Weiss .[25] (4 ppm)

9

22

peritoneum

/

0.8

[27] O'Dell

.(15)

1

(/ 4)

(±)

4.6±55

murine lupus

342

/ -

27

(P<0.04)

1.9±36

()

[28]

Knizhnikov

()

0.03

Chernobyl

400

[29]

()

diet

-1.5

leukemia

3.5

20	65 ± 10	8	A
5	53 ± 10	11	
0	42 ± 9	14	
29	85 ± 5	8	B1
23	77 ± 6	11	
16	69 ± 6	14	
42	93 ± 3	8	B2
33	86 ± 4	11	
19	77 ± 6	14	
4	66 ± 12	8	B3
2	50 ± 12	11	
1	49 ± 14	8	B4
20	46 ± 3	8	C1
15	88 ± 5	11	
15	82 ± 5	14	
18	90 ± 4	8	C2
16	84 ± 4	11	

12	77 ± 5	14	
----	--------	----	--

(10)

.(100 30 10)

B2 B1

(4.3)

%100

[30] National Toxicology Program (NTP)

0.4

renal papillary

/

%95

11

B3

12 ± %50

.(10)

10 ± %53

%95

/ 15

%90

11

1.1

B3

(P<0.39)

.(6)

%100

1 ± %86

.(5)

/ 8 4

.(/ 0.112) / 15

%95

8

B4

10 ± %65

14 ± %49

/ 30

(/ 0.223)

1.5

%60

8

%95

342

/ -

29

.(7) (P<0.04)

3 ± %72

. / 8 4

%100

. [30] National Toxicology Program (NTP)

.(/ 0.223)

/ 30

sulphydryl

.(31,30)

(B4 B3 B2 B1)

.(10) (/ 30 15 8 4)

7

%15

/ 8

%.13

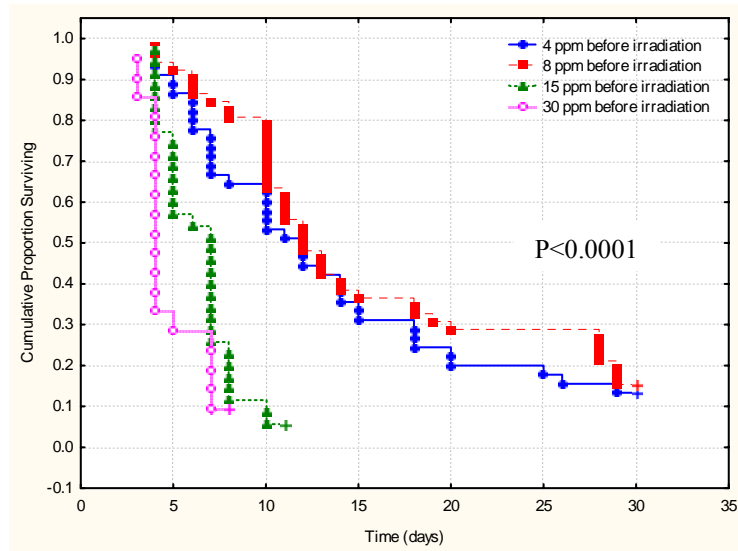
/ 4

/ 30

/ 15

/ 30 / 15

%0



(10)

(B4 B3 B2 B1)

30 15 8 4)

7

(/

C1)

5±%77 5±%82

(C2

.(10)

9±%42

(P<0.0001)

.(8,9)

(P<0.0001)

1.8 1.9

C2 C1

%16 %28

.(9)

14

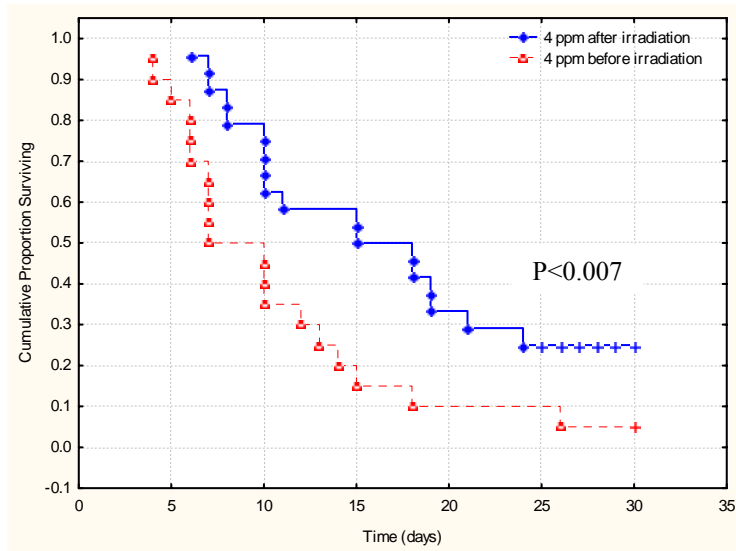
%0

C2 C1

(/ 4)

.(11)

(P<0.007)



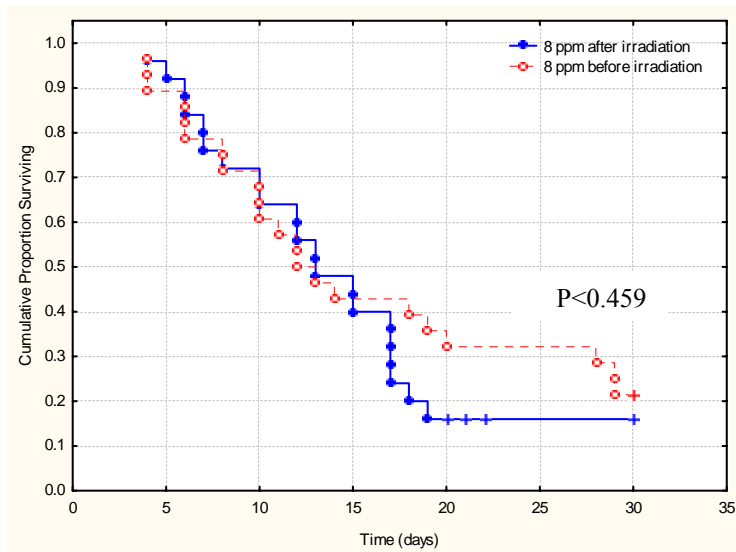
(11)

(/ 4)

(/ 8)

.(12)

(P<0.459)



(12)

(/ 8)

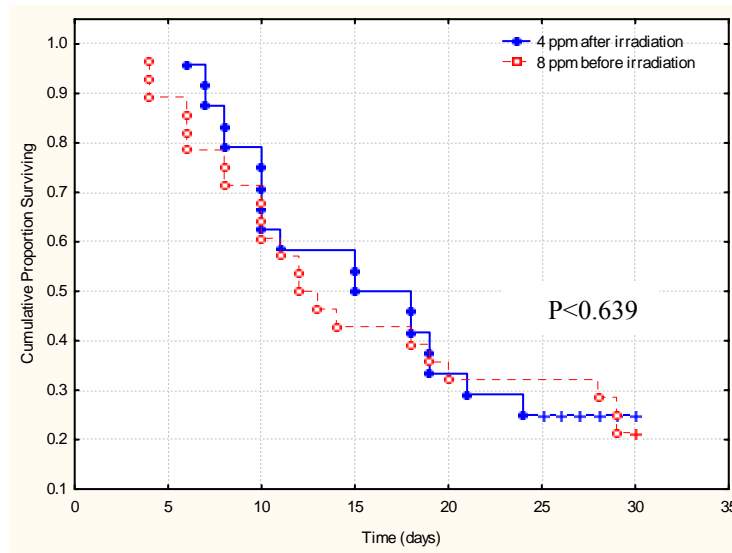
(/ 8)

(/ 4)

()

.(13)

(P<0.639)



(13)

(/ 8)

(/ 4)

-6

8 4

/ 8

/ 30 15

/ / 4

. / 30

(/ 4·8)

. / 4

-7

-1

.....

-2

.... C E

-8

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