SOME PHYSIOLOGIC FACTORS INFLUENCING RADIATION SENSITIVITY .2 GLUCOSE CONCENTRATION

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Introduction:

In our experiment on the yeast cell, survivals, which were indicated by the colony countings, seemed to be dependent of the activity of bubbling in culture media at the time of irradiation. This is the reason why we used always the cell in the same condition, say, cultured four days in Naegeli's solution. One of the cause of these differences in radioresistance looks like the amount of consumption of glucose, which is the constituent of Noegeli's solution as the energy source. This is assumed by the fact that bubbling occur again when glucose is added to the culture medium which bubbled no more.

On these account, colony counting and measurement of oxygen uptake and of carbondioxide evolution of the yeast cell cultured until at the time of irradiation in the culture media, to which various amounts of glucose were added (0 to 20%), were carried out.

Experimental method:

Saccharomyces Sake were used. Ordinary Naegeli's solution includes 10% of glucose. This concentration was changed in this experiment (O to 20%). Yeast cells were cultured in these media for four days and irradiated 20,000 r. After irradiation cells were disseminated on the plate culture media consisted of ordinary Naegeli's solution and agar, and counted the cells which were able to devide in the course of one or two days. For the measurement of oxygen uptake and carbondioxide evolution, irradiated cells were put in ordinary Naegeli's solution and measured by Warburg's manometer.

Experimental results:

Results obtained by colony counting were listed in Table 1. (% of disseminated)

Table 1.

	not irradiated	20,000r
conc. of Gl.		
0%	77.67±3.62	43.14±1.43
1%	79.30±0.75	44.08±1.80
5%	83.78±5.37	51.20±2.17
10%	84.49±3.18	51.54±1.24
20%	85.15±3.25	52.26±1.31

Table 2.

conc. of glucose	0%	1%	5%	10%	20%
survivals (in %)	55.5	55,5	61.0	61.0	61.5

The cells cultured in lower glucose concentration failed to bud to some extent, though not irradiated. Table 2. indicates the ratio of not irradiated and irradiated in each glucose concentration.

Survivals were increased up to 20% of glucose concentration.

Each 3,000,000 cells consumed oxygen as follows (Table 3.): Four days culture in the low glucose concentration resulted low oxygen consumption whenever put in ordinary culture media. But the radiation egect which reduced the oxygen consumption was less in the low concentration than in the high concentration. (Table 4).

Table 3.

oxygen consumption per		30,000,000			cells	in μl.
time (min.)		10	20	30	40	50	60
glucose conc.							
	0%	3	6	10	16	22	30
not	1%	4	7	11	17	24	34
irrad.	5%	6	10	16	23	30	42
	10%	6	13	24	36	50	62
	20%	7	15	28	44	60	73
	0%	3	6	9	14	20	25
	1%	4	7	10	14	21	28
irrad.	5%	4	6	10	13	20	29
(20,000r)	10%	5	8	12	21	30	39
	20%	4	7	15	23	33	44

Table 4.

reduction of oxygen consumption by irradiation					
conc. of glucose:	0%	1%	5%	10%	20%
reduction :	0.83	0.82	0.69	0.63	0.60

The evolution of carbondioxide was measured and the similar results as in the oxygen consumption were obtained. (Table 5. and Table 6.)

Table 5.

carbondioxide evolution per					3,000,000	cells	in μl.
time (min.)		10%	20%	30%	40	50	60
glucose conc.	0%	6	13	20	34	46	63
	1%	8	15	25	37	49	68
not	5%	21	37	53	68	83	101
irrad.	10%	20	50	78	102	129	156
	20%	22	52	85	118	152	184
	0%	6	13	19	30	42	51
irrd.	1%	7	13	22	32	46	62
(20,000r)	5%	13	19	29	39	57	79
	10%	15	27	39	54	77	95
	20%	15	25	46	66	87	107

Table 6.

reduction of corbondioxide evolution by irradiation					
conc. of glucose:	0%	1%	5%	10%	20%
reduction :	0,81	0,91	0,78	0,61	0,58

Respiratory quotients are listed in Table 7. There were no remarkable change in RQ values by irradiation.

Table 7.

Respiratory quotient					
conc. of glucose	0%	1%	5%	10%	20%
not irradiated	2.10	2.00	2.40	2.51	2.52
irradiated	2.04	2.21	2.58	2.43	2.43

Consideration and conculusion:

As previously mentioned[1], radiation sensitivity is closely related to the physiological condition of the cell at the time of irradiation. In this experiment, it was showen that the oxygen consumption and carbondioxide evolution were positively related to the concentration of glucose in the culture media. Reduction of these volumes by irradiation were on the contrary inversely correlated. There were no remarkable changes in the respiratory quotient as the consequence of irradiation. When the colony counting was adopted as an indicator radiation injury, the rediation injury was inversely related to the volume of oxygen comsumption and carbondioxide evolution at the time of irradiation.

These facts could be one explanation[2)~6)] of the reduction in radiation injury by means of lowering the oxygen tension, which in these cases were the results of metabolic activity.

1). The metabolic rate suffered the more reduction by irradiation when it was more active.

2). Greater oxygen consumption at the time of irradiation reduced the radiation injury in the cell.

References:

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放射線感受性に影響する2, 3の生理学的要素
2. 葡萄糖濃度

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抄　録

放射線感受性は，照射時に於ては細胞の生理学的な状態に密接な関係がある．

実験に於て，酸素消費及び炭酸ガス発生は，培養液に於ける葡萄糖の濃度に関係があり，照射によるこれ等の量の減少率は逆にこれ等の量の大な程大である．呼吸商は，照射による影響はみとめられない．

Colony counting を放射線障害の indicator とすればこの障害は照射時の酸素消費及び炭酸ガス発生の量と反対の関係があつた．

これ等の事実は低酸素圧による放射線障害の減少の一つの解釈であるとすることが出来る．次の事が結論された．

1) 代謝はその活性度が盛んな程照射による影響が大である．

2) 照射時に酸素消費が多い程，細胞に於ける放射線障害を減ずる．