THE INFLUENCE OF RADIATION ON IMMUNE REACTIVITY AND CYTOGENETIC STATUS OF SIMMENTAL COWS

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SUMMARY

Data on 31 Simmental cows of 3 and 4 lactations raised in the areas different in the level of radioactive contamination was used to study the influence of radiation on immune reactivity and somatic chromosome instability of cattle. The titer of normal antibodies to sheep erythrocytes was 2.5 times higher in the cows from the contaminated area than that in the cows from the control area. The trend to increase the immune response to *Salmonella dublin* and *Brucella abortus* was observed. It was established that in the cows from the contaminated area the frequencies of aneuploid cells and the ones with chromosome breaks were revealed to exceed 1.3 ($P < 0.05$) and 2.1 ($P < 0.001$) times as much, respectively, as compared to those of analogous mutations in the animals from the area with a low level of radionuclide contamination. The frequency of polyploid cells was 1.5 times higher in the cows from area 1 than that in the animals from area 2 ($P < 0.001$).
Keywords: Cattle, immune reactivity, mutation, radiation, contamination.

INTRODUCTION

Contamination of environment by sources of radiation and chemical compounds is threatening a series of regions on our planet. E.g., the Semipalatinsk nuclear test-field (SNTF) is located in Kazakhstan where for many years test nuclear explosions have been made. Totally 126 overground and air nuclear tests were made on SNTF from 1949 to 1962 and 348 underground nuclear tests. The expels of radioactive dusts into atmosphere took place very often when underground nuclear tests done. Hence it appeared that the radioactive contamination of different levels occurred in areas of Semipalatinsk, Novosibirsk regions and Altay Land. Environment contamination factors are known to be mutagenes, cancerogenes and teratogenes capable to change heredity of man, animal and plant bringing about mutations, individuals with congenital abnormalities, malignant formations and a series of other pathologies (Dubinin 1994; Pohl *et al.* 1991; Vogel and Motulsky 1990; Stephan and Oestreicher 1989). The great number of papers on the study of influence of radioactive contamination on heredity of man and wild animals cannot be compared to analogous researches carried out in farm animals, the papers showing the negative influence of environment mutagenes on immune and cytogenetic status of these species. Now the time has come to carry out researches in the species of farm animals that occupy an important ecological niche for their number and practical value. It is cattle that is referred to these species.

The research is aimed at the study of the influence of remote consequences of radioactive contamination on the immune reactivity and somatic chromosome instability of Simmental cattle.

MATERIALS AND METHODS

31 Simmental cows from 2 farms located in areas different in the level of radioactive contamination in Semipalatinsk region (Kazakhstan) were investigated in April 1993.
Area 1 - the farm far away from SNTF, low level of radioactive contamination (control).
Area 2 - the farm bordering SNTF, extreme level of radioactive contamination.
Blood samples were taken from clinically healthy animals of 3 and 4 lactations. The evaluation of immunologic status of the animals was done for the results of animal immune reactivity to vaccines *Salmonella dublin* and *Brucella abortus* as well as for normal antibody titers to sheep erythrocytes. The antibody titers to *S.dublin* and *Br. abortus* were determined through agglutination reaction. The titers of normal antibodies to sheep erythrocytes were determined for the results of heterohemagglutination. 2.5% suspension of sheep erythrocytes was used as antigen. The obtained data on the antibody titers was expressed in |lgx|. Somatic chromosome mutations were investigated in the same animals. All leukocyte cultures of animal peripheral blood were incubated at 37 °C for 48h using the method of Moorhead *et al.* (1960). Slides for microscopy were made by the air-drying method and stained with Giemsa stain (Graphodatsky and Radzably 1988). In each animal 100 metaphases were examined. Thus, 1413 metaphases in the animals from area 1 and 1600 ones in the cows from area 2 were investigated. The data of immunologic and cytogenetic analyses from the farms of the two areas was compared.

RESULTS AND DISCUSSION

The titer of normal antibodies to sheep erythrocytes was 2.5 times higher in the cows from the contaminated area than that in the ones from the control area ($P < 0.001$; Table 1).

Table 1. Cattle immune response to some antigens and normal antibody titers to sheep erythrocytes in the areas different in the level of radioactive contamination |lgx |

Antigen	Area 1			Area 2		
	Mean ± SD	Cv, %	*lim*	Mean ± SD	Cv, %	*lim*
S. dublin	1.36 ± 0.15	39.14	0.4 - 2.1	1.41 ± 0.15	37.98	0.9 - 2.7
Br. abortus	0.83 ± 0.13	57.87	0.1 - 1.6	1.03 ± 0.10	35.29	0.6 - 1.8
Sheep erythrocytes	0.26 ± 0.04	45.15	0.1 - 0.4	0.65 ± 0.08	41.75	0.3 - 1.0

Nezavitin (1995) identified the increase in immune response to *S. dublin* and *Br. abortus* by 25.4% and 52.3%, respectively, in Black and White cows in areas contaminated by ^{137}Cs as compared to those in the pure area. The trend to increase the immune response to *S. dublin* and *Br. abortus* is observed. It should be noted that there is the same immune response variation in the two areas. Nevertheless, a considerable increase in minimum

and maximum values of the immune response occurred both in contaminated area 1 and in pure area 2 with the same variation preserved in both. It can testify to homeostasis rearrangement on another level as a response to the influence of radiation. Thus, the change in mean values and limits of variation proves to be the unfavorable influence of environment.

The data is well-known on the negative influence of radiation on cattle somatic chromosome instability (Glazko *et al.* 1994; Kulikova *et al.* 1995, 1996). Before nearly twice increase in the frequency of cells with chromosome aberrations (fragments and breaks) was identified by us (Kulikova *et al.* 1996) in cows from the area contaminated by radionuclides as compared to the control. Table 2 presents the spectrum and frequency of somatic chromosome mutations in Simmental cows from different ecological areas.

Table 2. Somatic chromosome instability in Simmental cows in different ecological areas (Mean ± SD,%)

Index	Area 1	Area 2
Polyploidy	4.85 ± 0.38	3.19 ± 0.30
Aneuploidy	9.06 ± 0.76	11.56 ± 0.80
including hyperploidy	0.57 ± 0.20	1.25 ± 0.28
hypoploidy	8.49 ± 0.74	10.31 ± 0.76
Cells with fragments	4.32 ± 0.54	3.56 ± 0.46
Total number of fragments	5.17 ± 0.59	4.06 ± 0.49
Cells with breaks	1.49 ± 0.40	3.06 ± 0.43
Total number of breaks	1.63 ± 0.34	3.50 ± 0.46
Cells with aberrations	5.66 ± 0.62	6.44 ± 0.61
Total number of aberrations	6.79 ± 0.67	7.06 ± 0.66
including chromatid	3.82 ± 0.51	3.94 ± 0.49
chromosome	2.97 ± 0.45	3.63 ± 0.47

In the cows from the contaminated area the frequencies of aneuploid cells and the ones with chromosome breaks were revealed to exceed 1.3 ($P < 0.05$) and 2.1 ($P < 0.001$) times as much, respectively, as compared to those of analogous mutations in the animals from the area with a low level of radionuclide contamination. The frequency of polyploid cells was 1.5 times higher in the cows from area 1 than that in the animals from area 2 ($P < 0.001$). True differences were not revealed in Simmental cows from the compared ecological areas for the frequencies of chromosome fragments and as a whole for aberrations of both chromosome and chromatid types. We have established (Kulikova *et al.* 1995) that in the ecologically pure area of Novosibirsk region that is a part of Russia bordering Kazakhstan the frequency of chromosome aberrations in Simmental cattle is 2.5 times less than that in the animals from the contaminated area. In West Siberia the

increase in the level of radiation caused the one in the frequency of cattle leucosis from 2% to 4% (Kulikova *et al.* 1996).

Thus, the complex influence of radiation on cattle resistance and somatic chromosome instability was established. Hence when making up breeding programs it is necessary to consider ecological conditions in the areas of livestock raising.

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