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ERYTHROKINETICS IN ALUMINIUM-TREATED ANIMALS

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Broad dissemination of aluminium in nature and its usage in various economic branches, biosphere contamination and rising risks for affections of human organism under occupational and living conditions poses the question of a comprehensive investigation of aluminium actions. Recently, there appear data about aluminium influence on the nervous system [12,15,19], bones [11,14], kidneys [18] and respiratory organs [13].

Aluminium is stored and transported in blood mainly by erythrocytes [10]. It is known that erythrocytic contact with toxic substances leads to damage and reduction of erythrocyte resistance and vital capacity [5,7,8]. However, there are contradictory literature data about the changes in the blood picture under the action of aluminium [16,17,20].

That is why we decided to study erythrokinetics in animals treated with a relatively low dose of aluminium.

MATERIAL AND METHODS

The experiment is carried out on 126 white male rats (of them, 70 are intoxicated and form the first group and 56 are control and form the second group) of mean initial body mass of 125,0 + /-10,0 g. Animals of the I^{st} group were introduced by means of soft tube a 0,1 per cent aqueus solution of $AlCl_3$ in a dose of 3 mg Al/kg body mass for 40 consecutive days per os. Dose is determined after selection according to literature data about threshold aluminium concentrations in drinking water and overthreshold dosages enabling a biological effect in experimental animals [3,9]. A corresponding amount of distilled water is introduced by an analogous way in control animals. Ten intoxicated and eight control animals are killed by decapitation on the 5^{th}, 10^{th}, 15^{th}, 20^{th}, 25^{th}, 30^{th}, and 40^{th} day each. These terms are selected according to existing data that compensatory-adaptation reactions are most early formed in the erythron - till the $15\text{-}20^{th}$ day [2].

Erythrocyte mean life duration is estimated according to the speed of maturation of reticulocytes in vitro [6]. Erythrocyte and reticulocyte counts are determined after routine methods. Results are processed by the variation analysis.

RESULTS AND DISCUSSION

Results from the investigation of erythrokinetics show that erythrocyte mean life duration is about 66,6 days in control animals. It is established that it is shorter in erythrocytes of treated animals already during the first examination ($p < 0,05$) (fig. 1) and it demonstrates a tendency towards a further reduction till the $15\text{-}20^{th}$ day. Erythrocyte mean life duration decreases significantly ($p < 0,01$) after the 25^{th} day.

Parallelly to changes of erythrocyte mean life duration, alterations of reticulocyte and erythrocyte counts are observed.

Reticulocyte count is at the average $16,2.10^9$/l when control animals are concerned. It increases in the blood of intoxicated animals already on the 15^{th} day by 45,91 per cent ($p < 0,01$) (fig. 2). Higher values in comparison with control ones are registered till the 30th day. However,

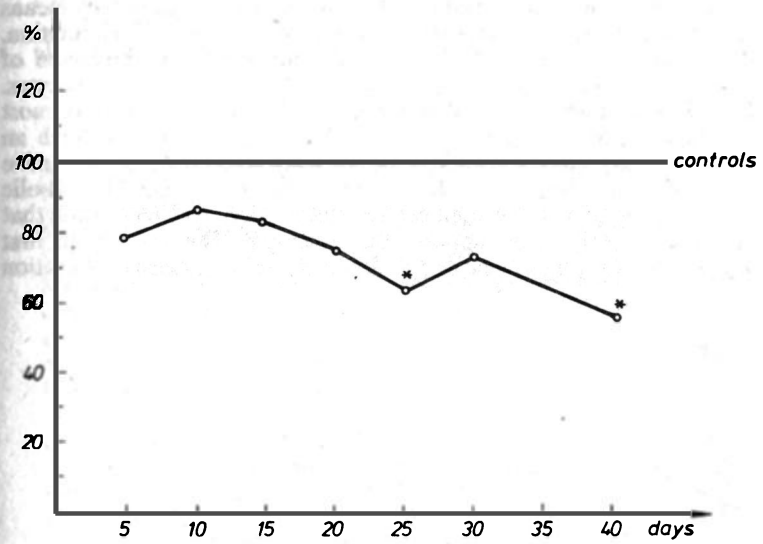

Fig. 1. Mean erythrocyte life duration

differences between these groups are statistically insignificant ($p < 0,05$) on the 40th day.

There is a certain phase difference in the changes of erythrocyte count of intoxicated animals. It is increased already on the 5th day by 17,8 per cent as compared with that of the control group ($p < 0,001$) (fig. 3). There is a decrease by about 13 percent on the 15th day ($p < 0,001$). Then a graduate increasing sets in and differences with control animals become statistically significant on the 30th day ($p < 0,01$). Erythrocyte count does not differ significantly ($p > 0,05$) between these two groups on the 40th day.

The analysis of these results indicates that aluminium in a dose of 3 mg/kg b.w. induces changes of peripheral blood already in the beginning of the experiment. It seems rather probably that

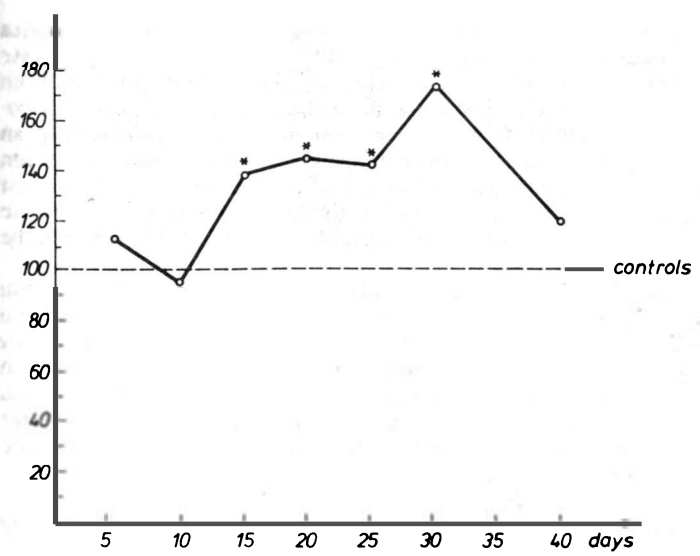

Fig. 2. Reticulocytes

initial erythrocyte count enhancement presents an immediate reaction of the organism by means of redistribution and reflectory liberation of erythrocytes from the deposits into the circulation. The elevated reticulocyte number after the 15th day can be considered an expression of erythropoiesis activation aiming a compensation of shortened life of mature erythrocytes. However, the established significant reduction of total erythrocyte count on this day results, most probably, from mature cell destruction initiated under the influence of aluminium. Such an assumption is based on the fact that any stress influence, toxic one incorporated, causes a relative oxygen deficit and alterations of intracellular metabolic processes with prevalence of catabolic ones which leads in the last reckoning to an intensified cellular destruction. Having in mind that older cells are less functionally active [4] it can be supposed that destructive alterations begin first in them. Probably, that is why a statistically significant decreasing of erythrocyte mean life duration

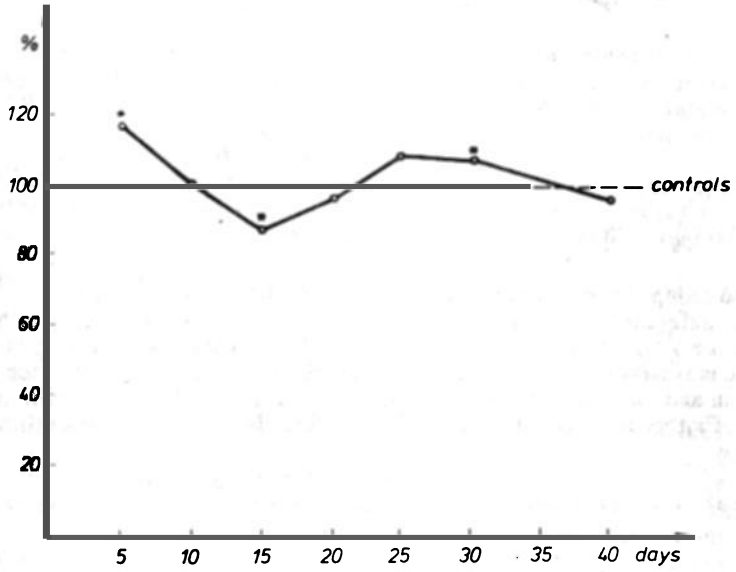

Fig. 3. Erythrocytes

is registered only on the 25th day. An increased production of young cells possibly compensates the shortened life duration and thus one can not establish any reliable differences of erythrocyte counts between these two animal groups on the 20th and on the 25th day, and one finds out even an increase of this count on the 30th day. Our results confirm the opinion that slight toxico-chemical influences are initially characterized by an activation of cellular proliferation, an acceleration of both morphological and chemical cellular differentiation and of their liberation into the blood flow which argues for the compensatory tension of regeneration [11]. In the last reckoning, on the last day of the experiment the remaining reduction of erythrocyte mean life duration is accompanied by such a count of both erythrocytes and reticulocytes that is within the limits of control values.

If we proceed from the assumption that toxic substance plays the role of a stress factor, the blood reaction in the initial stages of influence can be considered a particular manifestation of a general unspecific reorganization of the organism in the process of adaptation. As indicated by Barbashova [1], erythrocyte reaction in response to hypoxia develops rapidly but it argues for an inadequacy of adaptation reaction. Advancing shortening of erythrocyte mean life duration results, probably, from a direct aluminium action on the cell causing destruction of the cellular cytoplasmic membrane being the main locus of toxic actions [8] and thus one can expect in the next stage an exhausting of compensatory capacities at cellular level.

Our results obtained allow us to draw the following conclusions:

1. Phasic changes of erythrocyte and reticulocyte counts occur under the influence of a relatively

low aluminium dose.

2. Erythrocyte mean life duration decreases after the 20th day which can be related to the direct aluminium action on the cells.

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ЭРИТРОКИНЕТИКА У ЖИВОТНЫХ, ТРЕТИРОВАННЫХ АЛЮМИНИЕМ

Б. Кавалджиева, Д. Демирева

РЕЗЮМЕ

Авторами проведен эксперимент на 126 белых крысах самцах, 70 из которых подвергались воздействию алюминия и были отнесены к первой группе и 56, составляющих вторую контрольную группу животных. Начальная средняя телесная масса каждой крысы в эксперименте составляла 125,0 +/- 10,0 г. Животным первой группы ежедневно в течение сорока дней вводили через рот при помощи мягкого зонда 0,1-процентный водный раствор $AlCl_3$ в доз 3 мг Al/кг телесной массы. Число эритроцитов и ретикулоцитов, а также средняя продолжительность жизни эритроцитов определялись на 5-тый, 10-тый, 15-тый, 20-тый, 25-тый, 30-тый и 40-тый день.

Устанавливается некоторая фазовость средней продолжительности жизни эритроцитов. В более поздние стадии эксперимента наблюдается тенденция к уменьшению длительности жизни эритроцитов.