THE EFFECT OF LIGHT INTENSITY UPON HEMATOLOGICAL PARAMETERS OF BROWN RATS' BLOOD

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Abstract: The main idea of this topic is to assess the effect of light intensity upon selected elements of animals' blood (brown rat) as the influence of day and night cycles, or any other variations in light intensity affecting an organism have been proven by several studies. Three groups of animals have been observed in terms of an impact of varying light intensity (increased intensity, natural intensity and darkness). Obtained blood samples served for determining the amount of erythrocytes and hemoglobin, share of hematocrit and the number of leukocytes. Regarding erythrocytes, no significant increase that could be caused by heightened light intensity has been noticed. On the other hand, zero intensity has reduced the amount of erythrocytes down to 7.09 $T \cdot l^{-1}$ (compared to 8.29 $T \cdot l^{-1}$ when the intensity level got higher). The highest hemoglobin levels (172.68 $g \cdot l^{-1}$) as well as the amount of leukocytes (9.7 $g \cdot l^{-1}$) have been observed upon the control group. Heightened light intensity has not taken any effect on increased levels of blood parameters, although all observed parameters went down as a result of total lack of light (i.e. darkness).

Key Words: brown rat, intensity, lighting, blood, haematology

INTRODUCTION

Haematological examination enables to discover malfunctions of haematological system and equally, this analysis can prove useful when determining health prognoses and particular diseases or their diagnoses. Therefore, not only can haematological analysis give evidence of inner environment disorders, but also of welfare, physical shape and performance of animals. It is furthermore influenced by age, sex, breed and physical strain (Padalino et al. 2014, Roland et al. 2014).

Results of an experiment conducted at boar insemination station provide a direct impact of light intensity on semen as far as its quality is concerned. The results allow us to deduce a hypothesis for light intensity affecting hormone level in blood and potential effect on blood components (erythrocytes, leukocytes, haemoglobin, hematocrit) (Pecinova 2014).

A number of scientific studies mention a clear effect of light on food intake, sense of direction, increased enzyme activity, control of sexual cycle, and even metabolic rate, e.g. the one of animals living in a cave is much slower (Dominoni et al. 2013, Barker et al. 2010). The purpose of this study was to discover if light also takes part in affecting parameters of blood components in brown rats with regard to hematology.

Light is perceived by visual perception. This perception is transferred into the brain – or hypophysis to be more concrete, which consequently produces sex hormones. Such process influences a human's ethology as well as their psychology. A significant hormone *melatonin* produced by epiphysis is regulated by means of visual perception when sensing light conditions within external environment. *Melatonin* produced in the dark can actually be considered a night form of *serotonin*. *Melatonin* enables an organism to calm down and rest and once its production is limited, the organism asks for regeneration. On the contrary, heightened light intensity cheers up and inhibits production of *melatonin*. However, the intensity getting too high can result in a stressful situation (Barker et al. 2010, Pinel et al. 1994, Pum et al. 2008).

As the impact of ongoing day and night cycles has been confirmed by a great deal of studies, the experiment was to observe varying intensity affecting particular elements in animals' blood and in their behaviour respectively.

MATERIAL AND METHODS

A laboratory rat (*Rattus norvergicus* var. *Alba*) belonging to the Wistar tribe was selected for this experiment and groups of sexually mature male rats, aged two months were made.

The animals were divided into three groups, each having different light intensity. Each group contained 8 pieces. The first group (Variant 1) was kept under laboratory conditions with increased light intensity up to 400 lx for the period of 12 hours a day. Control group (Variant 2) was kept under conditions with natural lighting that changed, depending on cycles of day and night. The last group (Variant 3) was kept under conditions with reduced light intensity 0 lx, i.e. darkness.

The groups were kept in special boxes meant for breeding of laboratory rodents. Feeding, consisting of complete feed composition and water ad. lib., took place every day. As for bedding, ground pieces of corn cob were made use of. Surrounding temperature was 22°C on average.

The experiment took 40 days. After total anesthesia, blood samples were taken, which provided data for a statistical comparison of hematologic test results in relation to breeding conditions of a particular group. Levels of erythrocytes, leukocytes, hemoglobin and hematocrit were evaluated within each group.

Erythrocytes were determined by means of Hayem's solution. To determine leukocytes, we used Turk's solution first and then we counted them in Burker's chamber. Hemoglobin was determined photometrically, with the use of Drabkin's solution and a device called Spekol. For the determination of hematocrit, we centrifuged full capillary blood.

All data was processed in Statistica 12 software, using ANOVA data analysis and evidential differences were consequently determined by means of the Scheffe's method with level of conclusiveness $P>0.05$.

Table 1 Average values of observed parameters regarding brown rat (Rattus norvegicus) according to Vasku (2007)

Observed parameter	Average value
Erythrocytes	5.5–10 $T \cdot l^{-1}$
Hematocrit	0.46 $l \cdot l^{-1}$
Hemoglobin	130–150 $g \cdot l^{-1}$
Leukocytes	12.5 $G \cdot l^{-1}$

RESULTS AND DISCUSSION

Erythrocytes

From the viewpoint of monitoring the influence of light intensity on the level of experimental animals' blood erythrocytes, its effect being the cause of the increase of erythrocytes has not been directly proved. The group which was kept in the dark (Variant 3) showed statistically and conclusively the lowest amount of erythrocytes (7.09 $T \cdot l^{-1}$) as opposed to the control group (8.93 $T \cdot l^{-1}$) and the group having higher light intensity (8.29 $T \cdot l^{-1}$). Established difference between Variant 1 and 2 was not statistically evidential (see Table 2). Registered levels of erythrocytes did not exceed normal average levels for brown rats, according to Vasku (2007).

Hemoglobin

Received readings of hemoglobin showed following differences: Variant 2 had statistically and conclusively the highest hemoglobin level in blood (172.68 $g \cdot l^{-1}$). The amount of hemoglobin in Variants 1 and 3 was conclusively lower, Variant 3 reaching the lowest level 154.93 $g \cdot l^{-1}$. No statistically evident difference was found between Variants 1 and 3 (see Table 2). Levels of hemoglobin were higher in comparison to the standard of Variant 2. The levels were exceeded by 15% and in Variant 3, we registered boundary value. Variant 1 exceeded the standard by 7%, according to Vasku (2007).

Hematocrit

In reference to the determination of hematocrit, no statistically evident difference was found, except for Variant 3 showing slightly lower level (see Table 2). Measured values of hematocrit did not exceed common values, according to Vasku (2007).

Leukocytes

Received readings of leukocytes reached the highest level in Variant 2 (9.7 $G \cdot l^{-1}$), which was statistically and conclusively higher than in Variants 1 and 3. The lowest amount was found in Variant 3 (7.2 $G \cdot l^{-1}$). The difference between Variant 1 and 3 was not proved (see Table 2). Value variance of leukocytes was lower, according to Vasku (2007). With respect to approximate values provided in a chart for the Faculty of Medicine, Charles University in Prague, the amounts of leukocytes are lower in Variants 1 and 3. The reading in Variant 2 ranged within given boundaries (8–14 $G \cdot l^{-1}$).

Table 2 Results of hematological examination of the observed animal groups

Group	Erythrocytes ($T \cdot l^{-1}$)	Hemoglobin ($g \cdot l^{-1}$)	Hematocrit ($l \cdot l^{-1}$)	Leukocytes ($G \cdot l^{-1}$)
Variant 1	8.29 a	161.58 a	0.478 a	7.5 a
Variant 2	8.93 a	172.68 b	0.478 a	9.7 b
Variant 3	7.09 b	154.93 a	0.439 a	7.2 a

Statistically evident differences are indicated by different letters.

The results of Ji et al. (2014) make clear that blood composition, as well as the entire organism, are not only affected by intensity and time of exposure to light, but also its wavelength. Higher light intensity causes evident rise in blood volume in mice, however lower intensity can damage cells, although it may have a positive influence on blood circulation.

According to Barker et al. (2010), brown rats do not comply with higher light intensity conditions, which makes the animals much more timid. A more natural behavior was registered under lower light intensity.

Another experiment confirmed defensive behavior of the rats when being displayed to high light intensity (Godsil, Fanselow 2004).

Heightened light intensity caused increased serotonin secretion in brown rats. This effect was not affirmed in the case of dopamine (Pum et al. 2008).

Length of the light day affected concentration of luteinizing hormone in little sows, when longer day (16 light : 8 dark) made the concentration higher (Hälli 2006).

CONCLUSION

Heightened light intensity did not influence the parameters of hematological evaluation. As for erythrocytes, there was no significant increase in the amount caused by higher light intensity. On the other hand, zero intensity made the erythrocytes quantity go down. The highest hemoglobin readings were observed in control group, within which natural variations of light intensity took place. The lowest hemoglobin amount was registered in the group kept in the dark. The lowest hematocrit level was determined in the group kept in the dark and this particular value matched given average values. Quantity of leukocytes was the last observed parameter, which proved by the highest value in the control group. On the contrary, the lowest amount was in the group with zero light intensity. Because of the experiment results, it is convenient that further monitoring focusing on levels of the selected hormones be carried out.

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