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Hematological and biochemical profiles of rats (*Rattus norvegicus*) kept under microenvironmental ventilation system

Perfis hematológico e bioquímico de ratos (*Rattus norvegicus*) mantidos sob sistema de ventilação microambiental *

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SUMMARY

Previous studies reported that rats (*Rattus norvegicus*) kept under microenvironmental ventilation systems (MEV) present better productive and health parameters when compared to animals kept under general diluting ventilation (GDV). The objective of the present research trial was to evaluate hematological and biochemical profiles of rats kept under MVS. In order to achieve this objective, two different trials were designed: Trail 1 (E1), in which it was evaluated the reproductive performance of males and females submitted to two different air speed limits - FV1, from 0.03 to 0.26 m / sec and FV2, from 0.27 to 0.80 m / sec. In Trial 2 (E2) it was evaluated different bed change intervals (3, 5, 7 and 9 days), for males kept under constant air speed (0.5 m / sec). Values for hemogram and biochemical patterns of these animals were compared to those of rats kept under GDV. Results show statistical differences in some of the studied parameters not only for the comparison between GVD and E1 and GVD and E2, but also between both groups submitted to MEV (E1 and E2). However, values found for all studied parameters are inside the normal range reported for this species, what indicates that MEV does not induce important changes in the physiological parameters evaluated.

UNITERMS: Laboratory animals; Rats; Hematology; Biochemistry; Ventilation.

INTRODUCTION

The obtainment of standardized laboratory animals involves the use of international specific breeding and management techniques, which should be strictly followed. The concept of laboratory animals as biological reagents brought around the requirement for a standardization of the physical environment, mainly in relation to the atmospheric control of the animal facility[1,3,8,11].

The process that is used nowadays for animal facilities ventilation, the general diluting ventilation (GDV), presents some limitations[18,21]. In order to overcome these limitations, a ventilation system specific for laboratory animals in which cabinets[2,6,10,18,22,23] are used to ventilate directly the interior of the boxes was developed. This system is called microenvironmental ventilation (MEV). Recent studies demonstrate that mice and rats kept under MEV were exposed to lower ammonia levels and presented an increase in productivity and that offspring presented a lower incidence of pulmonary lesions[10,22,24]. Besides, Carissimi *et al.*[7] found that animals presented a lower incidence of pulmonary lesions even when bed change interval was higher than the one recommended for GDV. Because animals kept under MEV were more productive and presented less pulmonary lesions, a question is arisen in relation to the physiological response

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of these animals when kept under this ventilation system. The present trial was based on this premise and information in relation to hematological and biochemical profile of rats kept under MEV was gathered.

MATERIAL AND METHOD

Samples obtained for hematological and biochemical analyses were collected from animals kept in two different experimental trials, inside the microenvironmental ventilation system cabinets.

Animals

In Trial 1 (E1), sixty Wistar/Han rats (*Rattus norvegicus*) were used. They were divided in two groups: 20 males and 20 females, which where kept under MEV. A control group, with 10 males and 10 females, was kept in the GDV system. Animals in both groups were maintained as permanently mated, monogamic couples. Animals in the MEV system were submitted to two different levels of air speed. Air speed level 1 (FV1) ranged from 0.03 to 0.26 m/s (10 males and 10 females) and level 2 (FV2), from 0.27 to 0.80 m/s (10 males and 10 females).

In Trial 2 (E2), 100 Wistar/Han male rats were used. They were also divided in two groups: 80 rats submitted to different intervals of bed change, in the MEV system, and a control group, of 20 animals kept under GDV. Bed change intervals were: 3, 5, 7 and 9 days (respectively, groups IT3, IT5, IT7 and IT9). Both groups were constituted by 5 boxes, each of them with 4 animals. In the MEV system, air speed level was 0.5 m/s.

Animals of E1 were bred with 90 days of age and analyzed in the end of their reproductive period, that is, with 250 days of age. Animals of E2 were put in the trial with 40 days of age and were analyzed for 180 days.

Animals were kept in plastic cages, according to international recommendations for population density[14]. The bed was made of autoclaved *Pinus* sp chips. Animals received filtered water and commercial ration (Nuvilab CR-1®) *ad libitum* and were kept in a 12 hours light : 12 hours dark photoperiod.

Animals presented monitored sanitary status[15] and came from the animal facility in Departamento de Patologia of the Faculdade de Medicina Veterinária e Zootecnia of the Universidade de São Paulo.

Laboratory procedure

All animals were anesthetized using 5% sodium pentobarbital, in a 25 mg/kg dose. An incision on the abdominal skin was performed to expose the abdominal cavity. Blood was collected from the abdominal aorta artery by punction. After this procedure, animals were sacrificed by the sectioning of this artery.

For hematological analyses, 1 ml of blood was collected in a test tube with an anti-coagulant substance (EDTA). A COULTER T890® was used for white cell count, red cell count, hemoglobin concentration (Hb), hematocrit (Hct), mean corpuscular volume (VCM), mean corpuscular hemoglobin (HCM), mean corpuscular hemoglobin concentration (CHCM) and platelet count. In leukocyte differential count, blood smears, fixed and stained by the Romanowisk method were used. All these procedures were performed in the Seção de Hematologia of the Instituto Adolfo Lutz (São Paulo - SP).

For biochemical analyses, 5 ml of blood were collected, without anti-coagulant substances, in order to obtain serum samples. The following biochemical essays were performed: total protein, serum albumin, creatinin, alanin aminotransferase (GPT/ALT) and aspartate aminotransferase (GOT/AST), using WEINER LAB kits; alkaline phosphatase and urea, using LABTEST kits. Spectrophotometric reading was performed in a continuous flow system, in a BIO 2000 (BIOPLUS®) analyzer, in the laboratory of Diagnóstico Toxicológico of the Departamento de Patologia of the Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo.

Statistical analysis

The variance analysis (ANOVA) was used to identify possible differences between hematological and biochemical values studied. P level was 0.05.

RESULTS

Values obtained for hemogram elements and for biochemical parameters from animals submitted to MEV were compared to those from the animals kept under GDV, which is the most common system used in animals facilities.

In Trial 1, significative differences were found for the following biochemical tests: albumin and urea in groups GDV and FV1 and ALT activity in the comparison between GDV and FV2 in male rats; for female rats, alkaline phosphatase values for FV1 and FV2 and urea, for the comparison GDV and FV1 and FV2 (Tab. 1).

In hemogram evaluation (Tab. 2) of male rats used in different groups in Trial 1, there were significative differences for the following components in groups FV1 and FV2: erythrocyte count, hemoglobin concentration, leukocyte count and absolute neutrophil count.

In the evaluation of the hemogram of female rats used in the different groups of Trial 1, there were significative differences between the number of erythrocytes of animals in groups GDV and FV2, and FV1 and FV2. In the analyses of hemoglobin values, there were differences between FV1

Table 1

Values (mean ± standard deviation) for biochemical tests in male and female rats kept under Microenvironmental Ventilation System (MEV), using different levels of air speed (FV1 and FV2) and under General Diluting Ventilation system (GDV); n = 10. São Paulo, 1998.

Biochemical tests	Male System			Female System		
	GDV	MEV		GDV	MEV	
		FV1	FV2		FV1	FV2
Total protein (g/dl)	9.00 ± 2.60	6.78 ± 1.65	7.64 ± 0.95	8.28 ± 3.42	7.85 ± 1.30	9.37 ± 1.250
Albumin (g/dl)	5.72 ± 0.98[a]	3.88 ± 0.94[b]	5.00 ± 1.17[ab]	5.37 ± 0.75	5.00 ± 0.96	5.4 ± 0.91
Alkaline phosphatase (U/l)	70.83 ± 21.20	62.95 ± 19.30	72.86 ± 21.47	33.09 ± 14.40[ab]	44.39 ± 11.38[a]	27.83 ± 13.30[b]
Urea (mg/dl)	71.51 ± 15.44[a]	53.07 ± 6.73[b]	58.17 ± 17.01[ab]	73.88 ± 22.18[a]	55.66 ± 8.56[b]	55.56 ± 10.30[b]
Creatinine (mg/l)	9.84 ± 1.59	8.09 ± 0.89	8.70 ± 2.13	8.86 ± 2.49	7.83 ± 1.47	9.18 ± 1.28
ALT (U/l)	21.92 ± 6.88[a]	32.13 ± 13.00[ab]	35.09 ± 11.42[b]	22.17 ± 8.27	19.03 ± 7.67	15.71 ± 15.18
AST (U/l)	125.31 ± 27.04	131.31 ± 15.76	133.74 ± 45.98	94.98 ± 23.09	93.32 ± 18.25	100.93 ± 21.69

ALT = alanine aminotransferase;
AST = aspartate aminotransferase;
FV1: air speed level ranging from 0.03 to 0.26 m/s;
FV2: air speed level ranging from 0.27 to 0.80 m/s.
Different letters indicate that there are significative differences according to the ANOVA ($p < 0.05$)

Table 2

Hematological values (mean ± standard deviation) obtained for male rats kept under Microenvironmental Ventilation system (MEV) using different levels of air speed (FV1 and FV2) and under General Diluting Ventilation system (GDV); n = 10. São Paulo, 1998.

Hematological values	System		
	GDV	MEV	
		FV1	FV2
RBC ($x10^6/mm^3$)	7.77 ± 0.30[ab]	6.92 ± 1.28[a]	8.43 ± 0.12[b]
Hemoglobin (g/dl)	14.51 ± 0.48[ab]	14.03 ± 1.27[a]	15.50 ± 0.84[b]
PCV (%)	43.79 ± 1.67	44.14 ± 4.57	46.44 ± 2.31
MCV (fl)	56.68 ± 1.16	56.90 ± 2.96	55.51 ± 0.59
MCH (pg)	18.87 ± 0.46	18.59 ± 0.61	18.50 ± 0.39
MCHC (g/dl)	34.07 ± 0.67	33.34 ± 1.28	33.59 ± 0.89
Platelets ($x10^3/mm^3$)	718.60 ± 81.58	805.30 ± 216.10	795.30 ± 84.08
WBC ($x10^3/mm^3$)	3.1 ± 1.06[ab]	2.18 ± 0.93[a]	4.58 ± 1.93[b]
Lymphocytes ($x10^3/mm^3$)	2.47 ± 0.95	1.88 ± 0.94	2.52 ± 0.78
	(59.00 ± 9.6 %)	63.40 ± 14.25	57.50 ± 9.74
Neutrophils ($x10^3/mm^3$)	1.17 ± 0.6[ab]	1.00 ± 0.46[a]	2.00 ± 1.32[b]
	(40.00 ± 9.6 %)	35.90 ± 13.88	40.00 ± 11.92
Eosinophils ($x10^3/mm^3$)	0.06 ± 0.04	0.03 ± 0.02	0.04 ± 0.01
	(1.57 ± 1.13 %)	1.2 ± 0.45	1.00 ± 0.00
Monocytes ($x10^3/mm^3$)	0.00	0.00	0.1 ± 0.04
	(0.10 %)	0.10	2.33 ± 1.53

RBC = red blood cell;
PCV = packed cell volume;
MCV = mean corpuscular volume;
MCH = mean corpuscular hemoglobin;
MCHC = mean corpuscular hemoglobin concentration;
WBC = white blood cell;
FV1: air speed level ranging from 0.03 to 0.26 m/s;
FV2: air speed level ranging from 0.27 to 0.80 m/s.
Different letters indicate that there are significative differences according to the ANOVA ($p < 0.05$).

and FV2. In relation to hematocrit, significative differences occurred in groups GDV and FV2, and in groups FV1 and FV2. In CHCM, differences were found between GDV and FV1, and between FV1 and FV2. There was also a significative variation in the comparison between GDV and FV1 for the percentage of eosinophils (Tab. 3).

The evaluation of the animals in Trial 2, in relation to biochemical tests, demonstrated statistical differences in the comparison of GDV with groups IT7 and IT9, in relation to alkaline phosphatase activity (Tab. 4).

In the analysis of the results found for the hemogram components of animals in Trial 2, the number of erythrocytes in group IT3 was significatively lower than the one observed for group IT9. In the evaluation of HCM, there were significative differences between groups GDV and IT9, and between IT5 and IT9 (Tab. 5).

Table 3

Hematological values (mean ± standard deviation) obtained for female rats kept under Microenvironmental Ventilation system (MEV) using different levels of air speed (FV1 and FV2) and under General Diluting Ventilation system (GDV); n = 10. São Paulo, 1998.

Hematological values	System		
	GDV	MEV	
		FV1	FV2
RBC ($x10^6/mm^3$)	7.38 ± 0.41[a]	7.16 ± 0.95[a]	6.34 ± 0.17[b]
Hemoglobin (g/dl)	14.53 ± 0.66[ab]	13.94 ± 1.93[a]	12.54 ± 0.87[b]
PCV (%)	42.62 ± 2.00[a]	42.00 ± 5.90[a]	36.70 ± 2.69[b]
MCV (fl)	57.90 ± 2.90	58.60 ± 0.93	58.00 ± 1.37
MCH (pg)	19.72 ± 0.90	19.46 ± 0.66	19.86 ± 0.64
MCHC (g/dl)	34.15 ± 0.47[a]	33.14 ± 0.84[b]	34.21 ± 0.64[a]
Platelets ($x10^3/mm^3$)	738.90 ± 109.51	696.40 ± 101.74	708.30 ± 65.53
WBC ($x10^3/mm^3$)	3.17 ± 1.36	2.21 ± 0.54	2.26 ± 0.52
Lymphocytes ($x10^3/mm^3$)	2.12 ± 0.86	1.59 ± 0.38	1.7 ± 0.51
Lymphocytes (%)	68.30 ± 9.51	69.90 ± 10.76	77.50 ± 6.77
Neutrophils ($x10^3/mm^3$)	1.01 ± 0.66	0.55 ± 0.24	0.57 ± 0.3
	(30.40 ± 9.62 %)	28.00 ± 11.42	21.90 ± 6.71
Eosinophils ($x10^3/mm^3$)	0.04 ± 0.02	0.18 ± 0.38	0.03 ± 0.03
	(1.22 ± 0.44[a]%)	2.86 ± 1.77[b]	1.25 ± 0.50[ab]
Monocytes ($x10^3/mm^3$)	0.04 ± 0.01	0.04 ± 0.01	0.00
	(1 ± 0.00 %)	1.00 ± 0.00	0.00

RBC = red blood cell;
PCV = packed cell volume;
MCV = mean corpuscular volume;
MCH = mean corpuscular hemoglobin;
MCHC = mean corpuscular hemoglobin concentration;
WBC = white blood cell;
FV1: air speed level ranging from 0.03 to 0.26 m/s;
FV2: air speed level ranging from 0.27 to 0.80 m/s.
Different letters indicate that there are significative differences according to the ANOVA ($p < 0.05$).

Table 4

Values (mean ± standard deviation) for biochemical tests in male rats kept under the Microenvironmental Ventilation system (MEV), using an air speed of 0.5 m/s and different bed change intervals (IT3,IT5,IT7 and IT9) and for male rats kept under General Diluting Ventilation system (GDV); n = 20. São Paulo, 1998.

Biochemical tests	System				
	GDV	MEV			
		IT3	IT5	IT7	IT9
Total protein (g/dl)	8.47 ± 1.73	8.57 ± 1.67	8.60 ± 2.42	7.89 ± 1.92	7.92 ± 2.32
Albumin (g/dl)	4.89 ± 0.84	5.16 ± 0.85	5.30 ± 1.10	4.87 ± 0.80	5.03 ± 0.77
Alkaline phosphatase (U/l)	64.61 ± 12.02[a]	52.05 ± 23.14[ab]	50.18 ± 15.4[ab]	48.41 ± 15.22[b]	47.22 ± 18.29[b]
Urea (mg/dl)	56.98 ± 12.83	54.54 ± 10.36	52.03 ± 9.71	55.84 ± 12.10	55.45 ± 11.21
Creatinine (mg/l)	6.58 ± 1.82	8.04 ± 1.73	7.07 ± 2.79	6.89 ± 1.50	6.80 ± 1.40
ALT (U/l)	29.40 ± 10.87	26.63 ± 13.0	22.53 ± 6.96	29.13 ± 11.28	27.10 ± 10.23
AST (U/l)	145.64 ± 64.48	136.71 ± 48.01	140.05 ± 51.93	134.12 ± 24.77	118.32 ± 44.26

ALT = alanine aminotransferase;
AST = aspartate aminotransferase;
IT3, IT5, IT7 and IT9 = bed change interval of respectively 3, 5, 7 and 9 days.
Different letters indicate that there are significative differences according to the ANOVA ($p < 0.05$).

Leukogram of animals used in Trial 2 presented significative differences in relation to the number of leukocytes between groups GDV and IT3, and GDV and IT5, IT3 and IT7, IT3 and IT9. The absolute number of lymphocytes presented significative differences for groups GDV and IT3, GDV and IT5, IT3 and IT7, IT3 and IT9. In relation to relative values, only GDV and IT3 presented significative differences (Tab. 5).

Table 5

Hematological values (mean ± standard deviation) obtained for male rats kept under Microenvironmental Ventilation system (MEV), using an air speed of 0.5 m/s and different bed change intervals (IT3, IT5, IT7 and IT9) and for male rats kept under General Diluting Ventilation system (GDV); n = 20. São Paulo, 1998.

Hematological values	System			
	GDV	MEV		
		IT3	IT5	IT7	IT9
RBC (x10^6/mm^3)	8.11 ± 0.57^{ab}	7.69 ± 0.74^{a}	7.96 ± 0.56^{ab}	8.18 ± 0.57^{ab}	8.25 ± 0.58^{b}
Hemoglobin (g/dl)	14.82 ± 1.10	14.59 ± 0.90	14.65 ± 0.99	15.24 ± 0.93	15.11 ± 0.90
PCV (%)	44.52 ± 3.12	43.50 ± 3.03	43.98 ± 3.30	45.64 ± 3.31	45.27 ± 3.51
MCV (fl)	54.89 ± 1.08	56.82 ± 4.51	55.29 ± 1.19	55.81 ± 1.61	54.88 ± 1.14
MCH (pg)	18.26 ± 0.62^{a}	19.06 ± 1.40^{b}	18.43 ± 0.49^{ab}	18.68 ± 0.68^{ab}	18.27 ± 0.60^{a}
MCHC (g/dl)	33.28 ± 0.64	33.58 ± 1.21	33.35 ± 0.97	33.44 ± 0.99	33.33 ± 0.99
Platelets (x10^3/mm^3)	715.70 ± 124.60^{a}	714.47 ± 77.41^{ab}	708.00 ± 78.72^{a}	741.21 ± 106.03^{ab}	803,53 ± 84,89^{b}
WBC (x10^3/mm^3)	5.46 ± 2.25^{a}	3.12 ± 0.96^{b}	3.85 ± 1.52^{bc}	4.74 ± 1.91^{ac}	5,05 ± 1,50^{ac}
Lymphocytes (x10^3/mm^3)	4.66 ± 1.72^{a} (81.95 ± 7.07^{a} %)	2.24 ± 0.73^{b} 71.89 ± 10.94^{b}	2.97 ± 1.37^{bc} 75.8 ± 8.09^{ab}	3.75 ± 1.87^{ac} 77.06 ± 12.67^{ab}	3,97 ± 1,30^{ac} 78,32 ± 6,99^{ab}
Neutrophils (x10^3/mm^3)	0.96 ± 0.42 (17.11 ± 6.71%)	0.82 ± 0.38 26.28 ± 10.47	0.82 ± 0.37 22.6 ± 7.88	0.93 ± 0.46 21.61 ± 12.62	1.04 ± 0.44 20.84 ± 6.84
Eosinophils (x10^3/mm^3)	0.09 ± 0.04 (1.50 ± 0.67%)	0.07 ± 0.07 2.14 ± 1.29	0.08 ± 0.05 2.29 ± 1.54	0.08 ± 0.03 1.64 ± 0.74	0.06 ± 0.02 1.25 ± 0.45

RBC = red blood cell;
PCV = packed cell volume;
MCV = mean corpuscular volume;
MCH = mean corpuscular hemoglobin;
MCHC = mean corpuscular hemoglobin concentration;
WBC = white blood cell; IT3, IT5, IT7 and IT9 = bed change interval of respectively 3, 5, 7 and 9 days.
Different letters indicate that there are significative differences according to the ANOVA ($p < 0.05$).

DISCUSSION

Reference values determined for biochemical tests and hemogram elements, as discussed and emphasized in specialized literature, may not represent precisely those of a certain population or animal species and should, therefore, be carefully interpreted[4,13], once there is a wide range of physiological variation. Besides, these variations are influenced by environmental conditions, gender, age, origin, breeding system, feeding and lineage, which also may interfere with the results[9,17,19] obtained in these tests. Therefore, the most adequate procedure would be to establish laboratory evaluation reference values for every animal facility.

Results obtained in biochemical analyses in Trial 1 male groups (Tab. 1) presented significative differences, in serum albumin, urea and ALT determinations. Among the MEV female groups, there were significative differences in relation to alkaline phosphatase and urea. Although these statistically significative differences have been noted, when these results are compared to the information found in specialized reports, they are considered to be inside the normal range of variation for the animal species and lineage[4,13,16]*.There is no biological reason for the variation to be clearly attributed to the management systems used in Trial 1. Alkaline phosphatase values observed in this trial were lower than the ones determined by Ringler; Dabich[19]. However, they were clearly higher for the male groups than for female ones, as stated by these authors.

When hematological values in Trial 1 are considered, there were significative differences between male FV1 and FV2 groups (Tab. 2), in relation to erythrocyte counts and hemoglobin concentration. When leukogram results are considered (Tab. 2), there were significative differences in the number of leukocytes and neutrophils, for both air speed levels in MEV, but not for the MEV and the GDV groups. In relation to female groups (Tab. 3), there were differences in the results for erythrocyte counts and hematocrit (FC2 X GDV; FV2 X FV1); hemoglobin values (FV1 X FV2) and CHCM (GDV X FV1; FV1 X FV2). There also was a significative difference for the relative number of eosinophils in animals of the GDV and FV1 (Tab. 3) groups. In spite of these evidence, values found were inside the range of physiological variation reported in the specialized literature[9,12,20]. No clear relation could be drawn from the differences found between the ventilation systems used (MEV and GDV).

When biochemical evaluation of the animals in Trial

* SÁ ROCHA, L.C. **Teste de toxicidade dérmica prolongada em ratos**. (Trabalho não publicado. Laboratório de Diagnóstico Toxicológico. FMVZ/USP. São Paulo, 1997).

2 is considered (Tab. 4), only alkaline phosphatase values for MEV groups IT7 and IT9 were significatively different from those of the GDV group. As already stated, these values were lower than the ones found by Ringler; Dabich[19]. However, this finding may be connected to physiological lineage variation, and environmental conditions, among other factors, for the values for alkaline phosphatase obtained were similar to those found by other authors[4,13,16].

In relation to the variation of erythrogram elements (Tab. 5), in Trial 2 there were significative differences for the number of erythrocytes (IT3 X IT9), for HCM ((GDV X IT3; IT3 X IT9) and for platelet counts (GDV X IT9 and IT5 X IT9). However, values found in literature also place these results inside the normal range of variation[5,19]. Leukogram evaluation (Tab. 5) showed significative differences for the number of leukocytes and lymphocytes, when results for the GDV group and MEV groups with the smaller bed change interval (IT3 and IT5) were compared. These groups presented the lowest values for these counts. The similarity between the results for these counts in GDV animals and MEV groups with larger intervals for bed change (IT7 and IT9) may suggest a lower stress level in a more comfortable situation. It should be emphasized that IT3 and IT5 results were inside the normal range of variation for the species found in specialized reports[4].

Using the same animals of Trial 2, Carissimi[6] studied ponderal development and feed intake of animals kept under MEV and GDV, and demonstrated that there was no significative difference for ponderal development in animals kept in both systems. In relation to feed intake, rats submitted to MEV ingested a statistically higher quantity than the ones submitted to GDV, no matter the bed change interval used. However, this fact did not produce any differences in erythrogram or total protein and albumin variations, in the comparison of the results for both groups. Therefore, intake observed may be related to higher energy consumption for body temperature maintenance in animals submitted to MEV.

It was noted that statistical differences observed occurred in a disperse way, and none of the systems studied was favored. Each of the items analyzed seem to point out for one of the ventilation systems, when they are analyzed individually. However, when all the items of each biochemical / hematological parameter are evaluated as a group, no correlation is found. It may be concluded that the differences observed are result of casual variability.

CONCLUSION

Results obtained in the present research trial demonstrate that the use of the MEV system does not produce significative alterations on biochemical or hematological parameters studied. This fact is significative and extremely important, for researchers should always be concerned with the standardization of laboratory animals, because they will influence one of the basic principles in research: result reproducibility. The need for determining reference values for different laboratory exams in every animal colony should be emphasized, because of the different and countless influence factors to which they are submitted in animal facilities. Reproductive, sanitary and bed change interval advantages of the MEV system, besides the data obtained in this trial and the possibility of higher control of microenvironmental variables suggest that this ventilation system should be used in the atmospheric control of animal facilities.

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RESUMO

Em estudos anteriores, demonstrou-se que ratos mantidos em sistema de Ventilação Microambiental (VMA) apresentaram parâmetros de produtividade e padrão sanitário melhores do que aqueles mantidos em sistema de Ventilação Geral Diluidora (VGD). Outra etapa dos experimentos foi determinar os parâmetros fisiológicos destes animais. O presente estudo foi realizado para avaliar os perfis hematológico e bioquímico de ratos mantidos sob o sistema de VMA. Para tanto, foram realizados dois experimentos diferentes, com ratos mantidos em VMA, quais sejam: Experimento 1 (E1), no qual foi avaliado o desempenho reprodutivo de machos e fêmeas, sob duas faixas de velocidade de ar (FV1 - de 0,03 a 0,26 m/s, e FV2 - de 0,27 a 0,80 m/s); Experimento 2 (E2), no qual foram avaliados diferentes intervalos de troca de cama (3, 5, 7 e 9 dias), para ratos machos mantidos a uma velocidade de ar constante de 0,5 m/s. Os valores do hemograma e de parâmetros bioquímicos destes animais foram comparados com os valores encontrados em ratos mantidos sob VGD. Os resultados obtidos demonstraram diferenças estatísticas em alguns dos parâmetros observados, tanto entre os sistemas VGD e VMA, como entre os diferentes grupos de VMA. Contudo, os valores encontrados em todos os parâmetros avaliados encontram-se dentro de faixas de variação normal para a espécie estudada, como é descrito na literatura. Isto indica que o emprego do sistema de VMA não induz alterações relevantes nos parâmetros fisiológicos estudados.

UNITERMOS: Animais de laboratório; Ratos; Hematologia; Bioquímica; Ventilação.

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REFERENCES

1- ALSCHULER, J.H. Air treatment for research animal housing. **Laboratory Animal Care**, v.13, n.3, p.321-31, 1963.

2- BARBOSA, J.A.R. **Estudo sobre a influência dos intervalos de trocas de cama na manutenção de ratos (*Rattus norvegicus*) acasalados em sistema de ventilação microambiental**. São Paulo, 1999. 74p. Dissertação (Mestrado) – Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo.

3- BESCH, E.L. Definition of laboratory animal environmental conditions. *In*: MONBERG, G.P. **Animal stress**. Bethesda : American Physiological Society, 1985. p.297-315.

4- BIHUN, C. Basic anatomy, physiology, husbandry, and clinical techniques, part II : anatomic and physiologic features. *In*: HILLYER, E.V.; QUEENSBERRY, K.E. **Ferrets, rabbits, and rodents: clinical medicine and surgery**. Philadelphia: W.B. Saunders Company, 1997. p.295-306.

5- BIRGEL JR, E.H.; BENESI, F.J.; BIRGEL, E.H. Estudo das variações do quadro hemático de ratos (*Rattus norvegicus*). *In*: CONFERÊNCIA ANUAL DA SOCIEDADE PAULISTA DE MEDICINA VETERINÁRIA, 41. **Anais**. São Paulo, 1986.

6- CARISSIMI, A.S. **Manutenção de ratos (*Rattus norvegicus*) em sistema de ventilação microambiental com diferentes intervalos de trocas de cama: aspectos sanitários e econômicos**. São Paulo, 1998. 89p. Tese (Doutorado) – Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo.

7- CARISSIMI, A.S.; CHAGURI, L.C.A.G.; TEIXEIRA, M.A.; MORI, C.M.C.; MACCHIONE, M.; GUIMARÃES-SANT'ANNA, E.T.; SALDIVA, P.H.N.; SOUZA, N.L.; MERUSSE, J.L.B. Effects of two ventilation system for animal facilities and of bedding change frequency on humidity level in bedding, ammonia concentration and respiratory tract epithelium of rats (*Rattus norvegicus*). **Animal Technology**. (Submetido a publicação).

8- CASSELL, G.H.; LINDSEY, J.R.; DAVIS, J.K. Respiratory and genital mycoplasmosis of laboratory rodents: implications for biomedical research. **Israel Journal of Medical Sciences**, v.17, n.7, p.548-54, 1981.

9- CCAC. Canadian Council on Animal Care. **Guide to the care and use of experimental animals**. 2.ed. Ottawa, 1993. v.1, p.37-48.

10- CHAGURI, L.C.A.G. **Ventilação microambiental para biotérios: estudo experimental em ratos (*Rattus norvegicus*)**. São Paulo, 1997. 83p. Dissertação (Mestrado) – Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo.

11- CLOUGH, G. The immediate environment of the laboratory animal. *In*: McSHEEHY, T. **Control of the animal house environment**. London: Laboratory Animals, 1976. p.77-94.

12- HARKNESS, J.E.; WAGNER, J.E. **Biologia e clínica de coelhos e roedores**. São Paulo : Roca, 1993. p.238.

13- HRAPKIEWICZ, K.; MEDINA, L.; HOLMES, D.D. **Clinical laboratory animal medicine an introduction**. 2.ed. Ames : Iowa State University Press, 1998. 277p.

14- ILAR. Institute for Laboratory Animal Resources – National Research Council. **Guide for care and use of laboratory animals**. Washington : National Academy Press, 1996. 125p.

15- ILAR NEWS. **Long-term holding of laboratory rodents**, v.19, n.4, p.L7, 1976.

16- KANEKO, J.J. **Clinical biochemistry of domestic animals**. 4.ed. London : Academic Press, 1989. 932p.

17- LOEB, W.F. Clinical biochesmistry of laboratory rodents and rabbits. *In*: KANEKO, J.J. **Clinical biochemistry of domestic animals**. 4.ed. London : Academic Press, 1989. p.866-75.

18- MERUSSE, J.L.B. Equipamento para criação e manutenção de animais utilizados em experimentação biomédica: respectivo processo de distribuição unidirecional do ar. **Revista de Propriedade Industrial**, n.1262, p.28, 07/02/95 (P.I. 9302341-3).

19- RINGLER, D.H.; DABICH, L. Hematology and clinical biochemistry. *In*: BAKER, H.J.; LINDSEY, J.R.; WEISBROTH, S.H. **The laboratory rat**. New York : Academic Press, 1979. p.105-18.

20- SANDERSON, J.H.; PHILIPS, C.E. **An atlas of laboratory animal haematology**. New York : Oxford University Press, 1981. 473p.

21- SILVA, R.B. **Ventilação**. São Paulo: Grêmio Politécnico da USP, 1967. p.1-16.

22- TEIXEIRA, M.A. **Ventilação microambiental para biotérios: estudo experimental em camundongos (*mus musculus*)**. São Paulo, 1995. 97p. Dissertação (Mestrado) – Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo.

23- TEIXEIRA, M.A.; SINHORINI, I.L.; SOUZA, N.L.; MERUSSE, J.L.B. Redução do nível atmosférico de amônia e da incidência de lesões pulmonares em camundongos pelo sistema de ventilação microambiental (VMA) para biotérios. *In*: CONGRESSO PANAMERICANO DE CIÊNCIAS VETERINÁRIAS, 15., Campo Grande, 1996. **Resumos**. Campo Grande, 1996. p.183.

24- TEIXEIRA, M.A.; SINHORINI, I.L.; SOUZA, N.L.; MERUSSE, J.L.B. Microenvironmental ventilation system for laboratory animals facilities with air distribution by means of plenum chambers. **Animal Technology**, v.50, n.3, p.187-94, 1999.

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