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## **RENIN - ANGIOTENSIN - ALDOSTERONE SYSTEM VERSUS OSMOTIC PRESSURE OF BLOOD PLASMA IN CALVES IN THE NEONATAL PERIOD**

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### **ABSTRACT**

The aim of this work was to examine the influence of changes in plasma renin activity and aldosterone concentration on osmotic pressure of blood plasma in calves in the neonatal period. The examination was carried out on 11 calves of black – white breed directly after birth and in the 2<sup>nd</sup>, 3<sup>rd</sup>, 7<sup>th</sup> and 30<sup>th</sup> day of life. Plasma renin activity and aldosterone concentration were examined by means of radioimmunological methods, while the osmotic pressure – by means of the cryoscopic method. The decrease of plasma renin activity to the value of 1,55 ng/ml/h was proved in the first week of life, and it remained at this level till the end of the first month of calves' life. The aldosterone concentration was high after birth (61 pmol/l) and decreased rapidly during the first 24 hours. Gradual increase of concentration of this hormone (to 85 pmol/l) was observed from the 2<sup>nd</sup> to the 7<sup>th</sup>

day, and its decrease – till the end of the first month of life. The molality of calves blood plasma showed a downward tendency in the first month of their life.

The conducted examination indicates that in the first week of calves' postnatal life the efficiency of renin – angiotensin – aldosterone system is low despite its high intensity, which is proved by the lowering of blood plasma molality.

**Key words:** calves, neonatal period, plasma renin activity, aldosterone, osmotic pressure

## INTRODUCTION

The first period of life of a newborn requires a quick adaptation of most of its organs to extrauterine life. It concerns, among others, kidneys – an organ mainly responsible for regulating the internal environment stability. Calves are included in the group of animals of high somatic maturity at the moment of birth. Yet, it is well known that the kidney of calves shows lower functional efficiency in comparison to adult animals. The blood flow through kidneys is lower as well as plasma filtration in glomerules, and the processes of resorption and secretion in renal tubules – particularly of water and electrolytes - are also less efficient. It is well known that the plasma molality depends on the water – electrolyte balance regulated by kidneys. This regulation is under control of the endocrine system. A newborn is characterised by a specific water distribution in its organism. It was proved that in the first days of life the content of total water is stabile, but from the 3<sup>rd</sup> – 4<sup>th</sup> day of life it is significantly reduced, particularly at the cost of extracellular space [20]. Mainly the renin – angiotensin – aldosterone system is involved in regulating the renal saving of water and electrolytes, i.e. keeping proper plasma molality. It gave a reason to undertake research on the influence of this system on osmotic pressure, and also on water – electrolyte homeostasis of the organism of calves in the neonatal period.

## MATERIAL AND METHODS

The examination was carried out on 11 calves of black – white breed in the winter period (January – March).

The births took place at the stands without medical – veterinary assistance, with supervision of staff. During the first two days the calves were fed with mothers' colostrum 4 – 5 times a day, and from the 3<sup>rd</sup> to 7<sup>th</sup> day of life – with full milk in three portions, in the amount of 6 litres every 24 hours. During the examination period the animals were in good shape and did not have a disease.

Blood taken from external cervical vein, directly after birth, after 24 and 72 hours, and in the 7<sup>th</sup> and 30<sup>th</sup> day of life constituted the material for examination.

The blood was protected before clotting by use of heparin (250 i.u.) or EDTA (2 mg/ml of blood), depending on the requirements of analytical methods. Directly after collecting, the blood was centrifuged, and the obtained plasma was frozen (-20 °C) until the time of carrying out the analyses.

The following were determined in the collected blood samples:

- aldosterone level (by means of radioimmunological method, using aldosterone <sup>125</sup>I RIA Kit, code 12254, BIODATA - Italy),
- plasma renin activity, on the basis of measurement of angiotensin I level (by means of radioimmunological method, using Angiotensin <sup>125</sup>I RIA Kit, code 12964, BIODATA - Italy),
- plasma molality (by means of cryoscopic method, osmometer - Knauer).

The mean values and standard deviation were calculated on the basis of detailed results. In order to evaluate the significance of observed differences, the obtained results were subject to statistic calculations, by means of variance analysis applying the multiple gap test of D – Duncan. The correlation coefficients between selected indexes were also calculated. The results were collected in [Tables](#) (1-3).

## RESULTS

The highest plasma renin activity was observed directly after birth (4.31 ng/ml/h). In the first 24 hours of life plasma renin activity significantly ( $p < 0.01$ ) decreased to the value of 2.30 ng/ml/h. From the third day of life, further statistically important ( $p < 0.05$ ) drop of ARO was observed, which reached the value of 1.55 ng/ml/h in the 7<sup>th</sup> day and remained at this level till the end of the first month of calves' life ([Table 1](#)).

**Table 1. Mean plasma renin activity in calves (ng/ml/h)**

	Time after birth				
	a	b	c	d	e
Day, hour	0	24 <sup>h</sup>	72 <sup>h</sup>	14	30
x	4.31	2.30	2.19	1.55	1.53
SD	2.57	1.41	0.57	0.50	0.65

  

** P < 0.01	* P < 0.05
a → b, c, d, e	c → d, e

The examination showed statistically important changes in aldosterone concentration in blood plasma in calves. In newborn calves the aldosterone concentration amounted to 61.29 pmol/l, and after 24 hours it decreased to the level of 27.16 pmol/l. These changes were highly significant statistically ( $p < 0.01$ ). In the subsequent days of the first week of life, significant ( $p < 0.01$ ) increase of aldosterone concentration was observed to the value of 88.07 pmol/l noted in the 7<sup>th</sup> day. The lowest concentration of this hormone was observed in the 30<sup>th</sup> day of life (24.12 pmol/l) ([Table 2](#)).

**Table 2. Mean aldosterone level in blood plasma in calves (pmol/l)**

	Time after birth				
	a	b	c	d	e
Day, hour	0	24 <sup>h</sup>	72 <sup>h</sup>	7	30
x	61.29	27.16	52.05	88.07	24.12
SD	34.75	13.27	35.00	33.93	14.35

  

** P < 0.01	* P < 0.05
a → b, e	b → e
b → d	c → d
d → e	

The molality of blood plasma in calves demonstrated a downward tendency in the first month of their life. The highest osmotic pressure was observed directly after birth (262.22 mmol/kg

H<sub>2</sub>O), while the lowest one – in the 30<sup>th</sup> day of life (250.22 mmol/kg H<sub>2</sub>O). These changes were statistically significant (p<0.01) (Table 3).

**Table 3. Mean osmolality of blood plasma in calves (mmol/kg H<sub>2</sub>O)**

	Time after birth				
	a	b	c	d	e
Hours, days	0	24 <sup>h</sup>	72 <sup>h</sup>	7	30
x	262.22	257.56	257.56	253.00	250.22
SD	7.54	8.72	8.72	7.02	7.05

  

** P< 0.01	* P< 0.05
a → e	a → d

## DISCUSSION

The experiment showed that the renin activity of blood plasma in calves in the first month of life was high (particularly directly after birth). A significant (p<0.01) decrease of renin activity of blood plasma takes place in the first 24 hours of calves' life probably in relation to high volume of total water (particularly of extracellular fluid) in newborns, and also as a response to the increase of blood pressure in afferent arteriola (as a result of decrease of renal vessels resistance). A downward tendency of ARO was present during the whole neonatal period. It seems that one of the important factors inhibiting the renin release might have been high vasopressin concentration in blood. Other authors also proved high renin activity of blood plasma in the postnatal period in calves [10,12,16,14], lambs [19], puppies [8] and children [6, 18]. Safwate [16] informs that plasma renin activity in the period from the 3<sup>rd</sup> to the 10<sup>th</sup> day of life is at the level of  $2.9 \pm 2.1$  ng/ml/h. Riad et al. [12] stated that in 10-day old calves ARO amounts to 4.8 pmol/ml/h. Itoh et al. [10] also indicate the changes in renin activity of blood plasma in calves. These authors observed the decrease of ARO in the first 12 hours of life from 1.23 ng/ml/h to 0.97 ng/ml/h and the increase to the value of 1.47 ng/ml/h in the third 24-hour period. Amadiou et al. (2) stated that the renin activity of blood plasma in 4-day old calves is at the level of 2.2-2.4 ng/ml/h.

Significant (p<0.01) aldosterone decrease was observed in the experiment in the first 24 hours of calves' life, probably as a result of using-up the "reserves" of mineralocorticoids from intrauterine life. It seems that the increase of aldosterone concentration observed during the experiment from the 2<sup>nd</sup> to the 7<sup>th</sup> day of life was a result of increased synthesis and (or) hormone releasing from adrenal glands as a response to the decrease of water volume in the organism and the lowering of sodium concentration in blood. For the reason of accompanying ARO decrease it is difficult to state unambiguously what stimuli caused the observed increase of aldosterone concentration in this period of life. It might have been connected with the increase of the number or sensitivity of receptors for angiotensin II in adrenal glands (AT<sub>2</sub>) or with the influence of other factors, e.g. angiotensin IV, whose release is independent of renin [4], adrenocorticotrophic hormone (ACTH) or bradykinin [1, 11, 17]. High aldosterone concentration in blood after birth and dynamic changes in the neonatal period were observed

in calves [10,12,15,14], lambs [13,19] and children [3,6,18]. Riad et al. [12] observed that aldosterone concentration in 10-day old calves amounted to 80 pmol/l. Itoh et al. [10] provide the information that the concentration of this hormone in calves after birth is at the level of 166.3 pg/ml, after 14 hours it increases to the value of 173.6 pg/ml, and in the 7<sup>th</sup> day of life it amounts to 67.0 pg/ml. In the first 24 hours of life the authors observed positive correlation between aldosterone concentration and plasma renin activity. A similar dependence was demonstrated in the presented experiment. Safwate [14] observed that aldosterone concentration decreased in healthy newborn calves from 150 pg/ml at the moment of birth to 50 pg/ml 12 hours later. In the 48<sup>th</sup> and 72<sup>nd</sup> hour after birth aldosterone concentration amounted to 75 pg/ml, and decreased gradually to the 7<sup>th</sup> day of life to the level of 15 pg/ml. Amadiou et al. [2] stated that in 4-day old calves aldosterone concentration in blood plasma amounted to 60-70 pg/ml.

The changes in blood plasma molality in calves observed during the experiment were probably a result of changes taking place in kidneys activity and increased water loss mainly from the extracellular space in this period of life, which was observed also by other authors. The stimulation of osmoreceptors and volume receptors contribute to the increased release of aldosterone from adrenal glands, and probably of vasopressin from hypophysis. Yet, the obtained results indicate that the activity of these main factors – antidiuretic and antinatriuretic was surpassed by factors acting diuretically and natriuretically. Therefore, it seems that the necessity to lose water is a major aim of mechanisms securing the water-electrolyte balance of calves' organism in the postnatal period.

## CONCLUSIONS

1. In the first week of calves' postnatal life the efficiency of renin-angiotensin-aldosterone system is low, which is shown by the decrease of blood plasma molality despite high plasma renin activity and increasing aldosterone concentration.

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