

# Blood Sugar Values and Intestine Mucosa Integrity in Suckling Pigs in Relation to their Nutritional Status

Olga Rada<sup>1</sup>, Horea Sărăndan<sup>1</sup>, Liliana Vasile<sup>2</sup>, Diana Argherie<sup>1</sup>

<sup>1</sup> Banat University of Agricultural Sciences and Veterinary Medicine, Faculty of Veterinary Medicine, 119 Aradului Alley, 300645, Timișoara, Romania

<sup>2</sup> Victor Babes University of Medicine and Pharmacy, 2 Square Eftimie Murgu, 300041, Timișoara, Romania

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## Abstract

The experiment included 106 healthy piglets aged 1-14 days and 38 piglets suffering from diarrhoea, aged 1-7 days. The blood sugar was measured with the help of Accu-chek Go (Roche Diagnostics GMBH, Germany) halfway between two sucklings.

Segments with duodenum, jejunum and ileum were harvested from the diarrhoea suffering piglets and coloured HE preparations were examined under a stereoscopic magnifying glass and the microscope.

With healthy piglets, the average blood sugar was of  $61.55 \pm 10.2$  mg %, and after a 12 hour life the blood sugar increased to  $96.5 \pm 15.50$  mg %, with piglets aged 1-7 days, the average blood sugar was of  $93.08 \pm 3.67$  mg %. In piglets suffering from diarrhoea, during their first 12 hours of life, the blood sugar decreased by 22 %, and between 1 and 7 days it decreased by 18.55 % compared to healthy piglets of the same age ( $p < 0,05$  for days 2, 3 and 5).

Morphologically, in piglets suffering from diarrhoea, the examination of the small intestine mucosa resulted in: areas of mucosa denudation with villi disappearance, central edema of villi of the jejunum, vascular lesion resulting in the formation of edema in villi and in lamina propria.

**Keywords:** blood sugar, diarrhoea, suckling pigs.

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## 1. Introduction

Beside osmotic and secretory diarrhoea [1, 2, 3, 4], parturition hypoxia [5] and malnutrition produced by various causes lead to diarrhoea because of an energetic and plastic intake insufficient for maintaining the morphological and functional integrity of the small intestine mucosa. That is why the blood sugar and the metabolic usage of glucose decrease.<sup>1</sup>

In this context, knowledge about the metabolic status of the piglets can contribute to finding solutions to a metabolic balance and for recovering the hypoxic piglets at birth and the ones suffering from malnutrition in the first days of life.

The purpose of this paper is to establish a physiologic average of blood sugar in healthy

piglets in relation to their age, and the blood sugar average in piglets suffering from diarrhoea as referred to the morphological integrity of the intestine mucosa.

## 2. Materials and methods

The experiment was carried out with 106 healthy suckling pigs ranging from newborns to 14 days of age and 38 suckling pigs suffering from diarrhoea, between 1 and 7 days of age.

The blood sugar was measured with the Accu-cjek equipment. The blood sample was taken by auricular vein puncture in all examined piglets. We did not take blood samples from stressed piglets, because stress causes high blood sugar. Thus, we believe that the measured values are the exact reflection of the real piglet blood sugar. What is more, the measurements were undertaken halfway between two sucklings. All examined piglets were weighed and their average body

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\*Olga Rada, 00 (+40) 256-277456, radaolga10@yahoo.com.

weight was calculated referring to the average blood sugar.

In relation to the age, the average blood sugar of healthy piglets was compared to that of piglets suffering from diarrhoea.

Duodenum, jejunum and ileum samples were harvested from piglets suffering from diarrhoea and were put in saline solution for the stereoscopic magnifying glass examination and in 80° alcohol for the histopathologic examination.

For the villi examination under the stereoscopic magnifying glass, the intestine segments were sectioned longitudinally and immersed into saline solution, in Petri plates. The examination was carried out with a resolution of 10x5x4.5, photographing the most defining aspects.

For the histopathologic exam, the intestine samples kept in 80° ethyl alcohol, were prepared for paraffin inclusion, undergoing all classic preparation steps; the preparations were coloured using the tri-chromic colouring and were examined under an optical microscope.

### 3. Results and discussion

It has been noticed that, at birth, the average blood sugar value was of  $61.55 \pm 10.20$  mg %; 12 hours after birth it increases to  $96.5 \pm 15.50$  mg %. During the next seven days, the blood sugar decreases to 93.08 mg % every day bringing a slight variation. After seven days, the blood sugar tends to stabilise at an average of  $85 \pm 3.88$  mg %.

It was established that, in some calving groups, diarrhoea comes up at less than 24 hours after birth. Not all piglets in a group get diarrhoea, only the ones suffering from malnutrition. Thus, suckling pigs suffering from diarrhoea at less than a day's life showed a blood sugar of  $75.28 \pm 21.96$  mg %, quite high variations, in relation to the malnutrition degree. The blood sugar of ill piglets represents 78.01 % of the healthy piglets' blood sugar average at a 12 hour age. Up to the age of 7 days, in relation to the number of days of the illness period (diarrhoea), at the moment of the measurement, low blood sugar was determined, at an average of  $75.81 \pm 2.31$  mg % with slight variations for different ages. This blood sugar average of piglets suffering from diarrhoea represents 81.45 % of the blood sugar value of healthy piglets (Table 1). Taking into account the fact that 66% of the piglet blood sugar is metabolically stimulated and only 34 % is

stimulated by the milk they take in, we can assume the fact that the blood sugar deficit of piglets suffering from diarrhoea is, in fact, the milk intake difference.

Since the intestine mucosa is the greatest energy consumer for the allometric growth, reconstruction and change of the type of small intestine epithelial cells and since the intestine mucosa is a priority in the body's energy saving, it is sure to encounter an energetic deficit. This leads to intestine mucosa disturbances.

The examination of intestine mucosa in piglets suffering from diarrhoea, under stereoscopic magnifying glass, shows denudation areas with mucosa villi disappearance in the duodenum of the four days old piglets; this proves that the worst destruction happens within the duodenum, respectively in the area greatest energy deficit, in the area with the greatest energy and substance consume for the mucosa reconstruction, especially of the epithelium.

Inside the jejunum, the villi edema was noticed in the central part, as a sign of suffering and vascular permeability alteration (Figure 1).

In the ileum, an uneven atrophy of the villi was noticed, highlighted in some mucosa areas by villi reduction (Figure 2).

The histopathologic examination of the small intestine segments mucosa: duodenum, jejunum and ileum, confirms the above observations.

Thus, a newborn piglet having a weight of 1060 g, and reduced vitality, suffering from malnutrition, after 24 hours from birth showed a weight of 920 g, and after 46 hours, weighed 830 g, when it was sacrificed. Severe malnutrition at the level of the intestine mucosa manifested itself through morphologic changes. Focal villi atrophies and the dilatation of the lymphatic chyliferous vessel in the conjunctive axe of some villi (Figure 3) were noticed in the duodenum; At the villi base, in the lamina propria and periglandularly, there have been edema areas as a result of vascular permeability alteration.

In the jejunum, we observed a local villi atrophy, vein-capillary and lymphatic dilatation in some villi axes, as well in the submucosa. In the ileum mucosa, a periglandular edema in the villi and perivascular axe was observed.

As a whole, changes in the small intestine mucosa determined by malnutrition start with changes in the mucosa vascular permeability, a fact that leads to local edema and intestine villi atrophy. These

changes will be followed by the intestine villi necrosis (Figure 4), caliciform cell hyperplasia and vascular thrombosis in the conjunctive axe vessel circulation.

Parturition hypoxia affects the intestine mucosa as well, since it determines an adrenaline discharge; this produces low blood sugar and vasoconstriction in the intestine mucosa vessels. A piglet, 4 hour old when sacrificed, weighing 1520 g at birth, coming from a sow that had 3 live piglets and 6 dead ones during an average period between expulsions of 25 minutes, had a blood sugar of 188 mg %. In the jejunum, we noticed

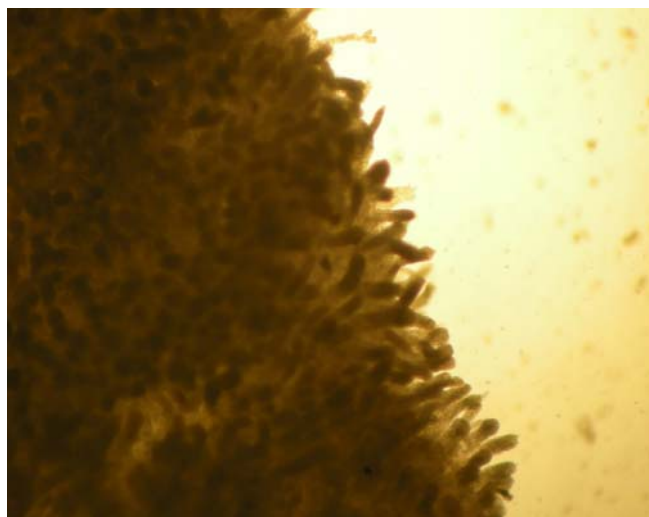
mucosa necrobiosis, villi agglutination and capillary-vein hyperaemia in lamina propria and in the villi axe.

We can appreciate that in piglets with parturition hypoxia and malnutrition in the first days of life, the blocking of nutrient intake in the small intestine mucosa increases during the first step the malnutrition stat of the mucosa. This leads to edema of the mucosa and submucosa, vascular permeabilization with liquid influx in the intestine lumen, villi atrophy and enterocyte necrosis.

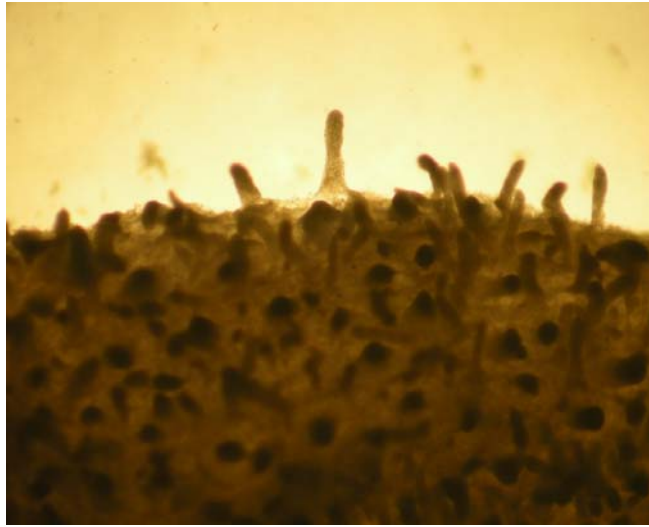
**Table 1.** Comparative blood sugar values in healthy piglets suffering from diarrhoea in their first seven days of life

Age (days)	Blood sugar (mg %)		Diarrhoea piglets (% of healthy piglets blood sugar)
	Healthy piglets	Diarrhoea piglets	
At birth	61.55± 10.20		
< 24 hours	96.5±15.50	75.28±21.96	78.01
1	85.8±8.00	78.40±5.28	91.37
2	91.6±12.00	73.55±12.37	80.29*
3	95.3±4.16	74.80±5.44	78.49*
4	89.0±10.16	71	79.77
5	103.7±11.78	78.62±7.22	75.81*
6	99.7±13.10	76.30±6.43	76.53
7	86.5±7.05	78	90.17
X	93.08±3.67	75.81±2.31	81.45

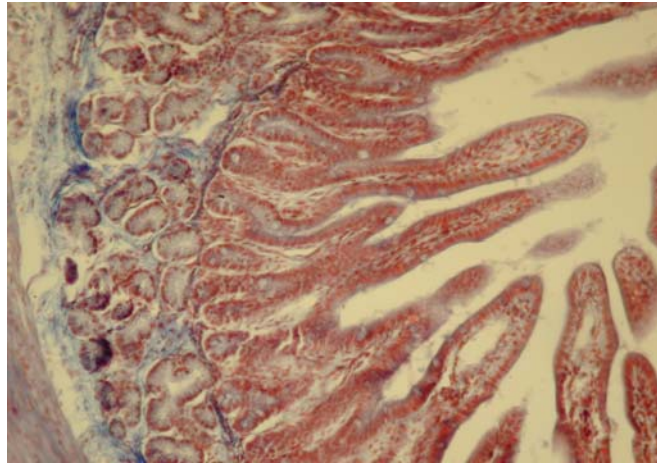
\* p<0,05 (Mann Whitney U Test)



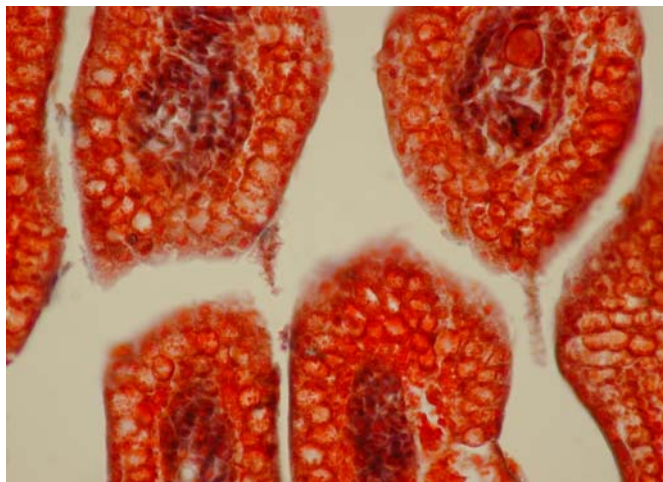
**Figure 1.** Jejunum mucosa. Uneven villi and edema in the central area (stereoscopic magnifying glass, resolution 10x5x4.5, original)



**Figure 2.** Ileum mucosa. Uneven villi, in various atrophy stages. (stereoscopic magnifying glass, resolution 10x5x4.5, original)



**Figure 3.** Duodenum mucosa and submucosa of a 46 hours old piglet suffering from malnutrition. Villi focal atrophy and dilatation of the lymphatic chyloferous vessel in the conjunctive axe of some villi, edema in lamina propria at villi base and periglandular. Tri-chromic colouration x100, original.



**Figure 4.** Jejunum mucosa from a 46 hours old piglet suffering from malnutrition. Intestine villi necrobiosis, microcirculation of conjunctive axe vessels with vascular thromboses, caliciform cell hyperplasia (aspect pseudo-colon aspect of villi epithelium). Tri-chromic colouring x 400, original.

#### 4. Conclusions

1. At birth, the average piglet blood sugar was of  $61.55 \pm 10.20$  mg %. After 12 hours from birth the blood sugar increases to  $96.5 \pm 15.50$  mg %.
2. The normal blood sugar in piglets aged 1-7 days was an average of  $93.08 \pm 3.67$  mg %.
3. Blood sugar of piglets suffering from diarrhoea in the first 12 hours of life decreases by 22 % compared to healthy piglets blood sugar. Piglets suffering from diarrhoea, aged 1-7 days have an 18.55 % smaller blood sugar than healthy piglets of the same age ( $p < 0,05$  for days 2, 3 and 5).
4. In the first life week, the duodenum of piglets suffering from diarrhoea displays areas of mucosa denudation with villi disappearance; the jejunum shows central villi edema.
5. The histopathologic exam of the intestine mucosa in piglets showing parturition hypoxia, revealed vascular lesions and vessel permeabilization, as well as the first installation of villi edema and of lamina propria. As a consequence, villi atrophy and intestinal epithelium necrosis develops. Piglets suffering from diarrhoea in the first days of life show the same histopathologic aspects.

6. Since the primary cause of these lesions is the deficit in energy necessary for the mucosa material and energetic metabolism, we believe to be entitled to characterise the digestive disorders as „postpartum nutritional diarrhoea”.

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