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Changes in Selected Blood Metabolites Associated with Melatonin Administration in Dairy Goats

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In order to examine the effect of exogenous melatonin on selected blood indices, dairy goats were given pineal gland hormone at a dose of 0.1 mg/kg body weight. Next, one and four hours after the melatonin had been administered, blood samples were collected from the goats in the control and treated groups in order to determine the levels of glucose, total cholesterol, triacyloglycerides, free fatty acids, as well as alanine and aspartate aminotransferase. The pineal gland hormone caused a significant increase in the levels of glucose, total cholesterol, triacyloglycerides and the activity of alanine aminotransferase. After melatonin administration a significant decrease in the FFA:TAG and FFA:Cholesterol blood ratios was observed. Moreover, no changes in the free fatty acid concentrations and the activity of aspartate aminotransferase were observed.

Key words: Dairy goats, melatonin, blood indices.

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Melatonin – N-acetyl-5methoxytryptamin – a biologically active indole derivative, is one of the neurohormones produced by the pineal gland (SKOTNICKA & HŁYNCZAK 2001). Melatonin is secreted rhythmically depending on the lighting conditions and changes nycthemerally (MAĆKOWIAK *et al*. 1999 a,b). The action of the pineal gland hormone requires the activity of specific receptors located primarily in the brain, as well as in the peripheral tissues (VENECEK 1998). Thus, the hormone may act directly or indirectly on many processes influencing the metabolism of the entire body. The most important role of melatonin in mammals is the regulation of seasonal rhythms. In many species, it has been shown to regulate the seasonal cycles of reproduction, fasting, thermoregulation and hibernation (VENECEK 1998; SKOTNICKA & HŁYNCZAK 2001). There are reports concerning the effect of the pineal gland hormone on carbohydrate-lipid metabolism (MAĆKOWIAK *et al*. 1999b; HOYS *et al*. 2000), as well as the endocrine system (MAĆKOWIAK *et al*. 1999a; ESQUIFINO *et al*. 1999; FABIŚ *et al*. 2002). However, most concern small animals, such as rats, hamsters, mice and birds.

Studies conducted so far on small ruminants have analyzed the effect of melatonin on reproduction in sheep and goats (CHEMINEAU *et al*. 1988; DELGADILLO *et al*. 2001; WULIJI *et al*. 2003b), on the level of prolactin (MOLIK & CIURYK 2003) and cashmere production in goats (WULIJI *et al*. 2003a). Hardly any information exists on the effect of pineal gland indolamine on the indices of carbohydrate – lipid metabolic processes in small ruminants.

The presents study aims at determining whether melatonin has any effect on carbohydrate – lipid metabolic indices in dairy goats.

Material and Methods

The experiments were conducted on dairy goats of the White improved breed, aged from 3 to 6 years and with an average milk yield of 900 l/year. Animals in their 100th day of lactation were included in the experiment, and were divided into two groups, i.e. control (C) and treated (T) with 10 animals each, compiled using the analog method.

Goats from the treated group in the morning hours received melatonin (SIGMA-ALDRICH, Poland) intravenously in the amount of 0.1 mg/kg body weight. Melatonin was first dissolved in absolute alcohol (0.1 mg/1 ml) and this solution was diluted before administration with physiological saline to a final alcohol concentration of 11 %

(v/v). The control group was fully untreated. Blood was collected from all animals three times, i.e. immediately before, an hour and four hours after the hormone was administered. In the collected samples the following parameters were determined: the levels of glucose, total cholesterol, triacyloglycerides (TAG) – with the use of the enzymatic colorimetric method using biochemical assays by DIALAB, the levels of alanine aminotransferase (ALP) and aspartate aminotransferase (ASP) – with the kinetic, decreasing reaction modified by the International Federation of Clinical Chemistry – using biochemical assays by DIALAB, along with the levels of free fatty acids (FFA) with the use of the colorimetric method by DUNCOMBE (1964).

The obtained data were analyzed statistically using the SAS software package with a one-way analysis of variance. Statistically significant differences were determined at the $P \leq 0.01$ and $P<0.05$ levels of significance.

Results

The administration of melatonin induced an increase in glucose levels, which was statistically significant in comparison to the control animals 1 hour after administration. At the same time, some changes in the triacyloglycerides and cholesterol concentrations were observed. Concentrations of these lipids increased in the melatonin-treated goats. Simultaneously, the injection of pineal gland hormone caused a slight reduction in the free fatty acid level by approx. 16 %. However, the observed tendency was not statistically significant. A large reduction of the FFA:TAG (approx. 38%) and FFA:Cholesterol (approx. 28 %) blood ratios in comparison to those of the control animals was observed as well. The obtained data indicate that melatonin caused an increase in the activity of alanine aminotransferase, but did not influence the activity of aspartate aminotransferase in the treated goats.

The effect of melatonin on lipid metabolism is still poorly understood. The obtained results again indicate that the pineal gland hormone is not only involved in controlling biological rhythms. Melatonin can also play the role of a factor controlling lipid turnover in the organism, in goats as well. The results indicate that melatonin can significantly change triacyloglyceride content. Along with an increase in levels of triacyloglycerides, a decrease in the level of free fatty acids was found in the experimental animals. Both MAĆKOWIAK *et al*. (1999b) and MORI *et al*. (1989) observed an increase in the TAG contents in the blood of rats. At the same time, MAĆKOWIAK *et al*. (1999b) reported a decrease in the concentration of free fatty acids (FFAs). Similarly, an increase in the TAG concentration was observed in previous studies along with a simultaneous decrease in the free fatty acid concentrations in cows after the administration of pineal gland indolamine (DARUL & KRUCZYŃSKA 2004). However, JOHN *et al*. (1990) showed a significant increase in the FFA level in pigeons and a dependence between the

Table 1

Biochemical blood indices of dairy goats

Index	Group	Time of collection of blood samples		
		0 h	1 h	4 h
Glucose mmol/l	C	3.33 (0.083)	3.21 (0.070)	3.20 (0 069)
	T	3.20 (0.176)	3.52 (0.086) $_{A\,a}$	3.31 (0.100)
Cholesterol mmol/l	C	1.98 (0.103)	1.89 (0.109)	1.96 (0.095)
	T	2.03 (0.068)	2.18 (0.084) $_{A}$	1.99 (0.075)
TAG mmol/l	C	0.25 (0.017)	0.26 (0.016)	0.27 (0.017)
	T	0.23 (0.007)	0.31 (0.004) $_{A\,a}$	0.30 (0.015) $_{a}$
FFA mmol/l	C	0.12 (0.009)	0.12 (0.010)	0.11 (0.010)
	T	0.13 (0.011)	0.10 (0.003)	0.11 (0.010)
FFA:TAG l/l	C	0.51 (0.003)	0.50 (0.070)	0.41 (0.040)
	T	0.54 (0.060)	0.34 (0.013) $_{A\,a}$	0.37 (0.050) $_{a}$
FFA:Cholesterol l/l	C	0.06 (0.006)	0.07 (0.009)	0.06 (0.006)
	T	0.06 (0.005)	0.05 (0.003) $_{A}$	0.05 (0.003)
ALT U/l	C	20.33 (1.223)	17.00 (0.913)	15.00 (0.943)
	T	19.55 (1.143)	18.88 (2.280)	18.00 (2.460) $_{a}$
AST U/l	C	39.00 (2.267)	39.11 (2.340)	36.55 (2.467)
	T	42.67 (1.870)	40.89 (2.100)	39.22 (1.560)

Results are expressed as means and SEM. The statistically significant differences ($P<0.05$) between the experimental and control groups are marked with "a", and statistically significant differences ($P<0.01$) between the experimental and control groups are marked with "A".

dose of melatonin, the time of administration (day/night) and the obtained effects.

Changes in the cholesterol levels observed in this study in melatonin-treated goats are similar to changes caused by hormone injection in dairy cows (DARUL & KRUCZYŃSKA 2004), although they contradict some of the data published previously. In studies on rats fed a high cholesterol diet, melatonin lowered the level of this index, at the same time not causing any changes in rats fed a normal diet (MORI *et al*. 1989; HOYS *et al*. 2000). Melatonin might affect lipid metabolism through its effect on the level of hormones. Insulin is known to be a very important factor regulating anabolic processes. Many authors have indicated the substantial role played by insulin in lipid synthesis, also in ruminants. It stimulates this process in the liver (HAAGSMANN *et al*. 1981; CARDONIGRA-VALINO *et al*. 1997). The influence of pineal gland hormone on the level of insulin had been observed earlier by PESCHKE *et al*. (1997). Also, MAĆKOWIAK *et al*. (1999a) and FABIŚ *et al*. (2002) showed an increase in the levels of insulin in rats along with a simultaneous increase in the level of glucose after the administration of exogenous melatonin. Although in the experiment described in this study the concentration of insulin was not determined, the action of pineal gland indolamine on this hormone can not be excluded in relation with the observed increase in glucose concentration after injection. However, it can not be ruled out that melatonin acts directly on other aspects of lipid metabolism. The action of pineal gland hormone on lipid metabolism in goats is also evidenced by the decrease in the FFA:TAG and FFA:Cholesterol ratios.

Moreover, melatonin affected the activity of alanine aminotransferase, but had no effect on the activity of aspartate aminotransferase. Moreover, DARUL and KRUCZYŃSKA (2004) did not find any changes in the activity of liver enzymes in dairy cows. HOYS *et al*. (2000) also did not observe any changes in the level of aminotransferases in rats with hypercholesterolemia. Simultaneously, CALVO *et al*. (2001) reported a therapeutic effect of pineal gland hormone in rats with liver diseases by reducing the activity of liver enzymes.

The obtained results suggest that melatonin has an effect on carbohydrate-lipid metabolism in goats. For this reason, it seems advisable to conduct further research to investigate in detail the effect of pineal gland hormone on metabolism in connection with the reproductive performance of dairy goats.

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