Changes in melatonin, prolactin and growth hormone concentrations in Olkuska sheep, Polish Mountain Sheep and their crosses during lactation

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An important element of improving sheep production profitability in mountain areas is to increase efficiency by improving prolificacy and milk yield of mountain sheep. These parameters can be improved using the indigenous breed of prolific Olkuska sheep. The study was carried out with 90 lactating sheep. Lambs were reared with mothers until 56 days when they were weaned and the mothers were assigned for milking. Sheep were milked twice daily from May to the end of August using an Alfa Laval Agri milking machine. Each animal was recorded for milk yield at 10-day intervals. During the experiment blood was drawn from 6 sheep of each breed group. Blood was collected from sunset over a period of 6 hours at 60-minute intervals. Collected blood was centrifuged and the plasma obtained was stored at −20°C until analysis. Melatonin, prolactin and growth hormone concentrations were determined by radioimmunoassay at the Institute of Animal Physiology and Nutrition of the Polish Academy of Sciences in Jabłonna. The study revealed a 15% increase in milk yield in F₁ crosses. Analysis of changes in the hormone profile showed that as lactation progressed, prolactin level decreased and growth hormone and melatonin concentrations increased.

KEY WORDS: sheep / melatonin / prolactin / growth hormone / lactation

Because harsh climatic and soil conditions of the Polish mountains make it impossible to keep high-producing animals, the mountain landscape has for centuries been dominated by Polish Mountain Sheep. Pastoralism in the Carpathian Mountains is evidence that the region’s traditions and customs have been maintained, which enabled the region to preserve its identity on a European scale [14]. The change of productive
orientation from wool to dairy and the increased interest in sheep’s milk products offer a real chance to make the breeding of these ruminants more profitable. An important element of improving sheep production profitability in the mountain areas is to increase efficiency by improving prolificacy and milk yield of mountain sheep. These two parameters can be improved using the indigenous breed of Olkuska sheep [1, 3, 16].

Until today, it was believed that the level of milk production in mammals is determined by genetic and environmental factors; however, light has recently been shown to modulate prolactin levels (PRL). Molik et al. [15] demonstrated that in sheep entering lactation under different day lengths, the concentration of hormones responsible for the initiation and maintenance of lactation depended on photoperiod, and synthesis of the hormone melatonin was determined by day length. Like in other mammals, melatonin in sheep is synthesized at night. Because secretory activity of the pineal gland is lower during the day, the highest concentration of melatonin, known as the darkness hormone, is observed during the night [10, 19, 20].

The endocrine mechanism controlling initiation and maintenance of lactation in sheep is not fully understood, but it is known that it requires the action of many hormones [7, 9, 18]. One of these hormones, which determines both the initiation and maintenance of lactation, is prolactin. According to Misztal et al. [12, 13], the highest prolactin concentration in sheep blood occurs during long days and is the lowest during decreasing photoperiod, when melatonin concentration is the highest. Seasonal changes in prolactin and growth hormone (GH) secretion during lactation have a definite effect on the amount of milk produced. Therefore, the aim of this study was to characterize the profile of melatonin, prolactin and growth hormone in lactating Olkuska sheep, Polish Mountain Sheep and their crosses.

Material and methods

The study was carried out with 90 sheep, i.e. Olkuska sheep (n=30), Polish Mountain Sheep (n=30) and their F₁ crosses (n=30). All sheep groups were mated between 15 and 30 September and lambed in the second half of February. To determine milk production parameters of the sheep based on weight gains of lambs, they were weighed at 2 and 28 days of age in the first period of lactation. Milk production of the ewes was then calculated using a conversion factor of 4.5 kg milk = 1 kg weight gain of the lamb. Lambs were reared with mothers until 56 days when they were weaned and the mothers were assigned for milking. Sheep were milked twice daily from May to the end of August using an Alfa Laval Agri milking machine. Each animal was recorded for milk yield at 10-day intervals using specially constructed containers, which enabled milk yield to be estimated for the whole milking period. During the study, the sheep were fed conventionally according to standards [17].

During the experiment, blood was drawn from 6 sheep of each group. Blood was collected since sunset over a period of 6 hours at 60-minute intervals. The collected blood was centrifuged and the plasma obtained was stored at −20°C until analysis. Melatonin, prolactin and growth hormone concentrations were determined by radioim-
munoassay (RIA) at the Institute of Animal Physiology and Nutrition of the Polish Academy of Sciences in Jabłonna. Melatonin concentration was determined in 500 μl of whole plasma using the method described by Fraser et al. [8] and modified by Misztal et al. [12]. Plasma prolactin was determined at the Department of Endocrinology of the Institute of Animal Physiology and Nutrition of the Polish Academy of Sciences in Jabłonna using the RIA method described by Kokot and Stupnicki [11]. Growth hormone was determined as described by Dvorak et al. [5]. The results obtained as arithmetic means ± standard deviation were analysed statistically by SAS software using one-way analysis of variance and Scheffe’s test.

**Results and discussion**

When analyzing lactation profile of the ewes based on test-day yields, it was found that mean daily milk yield in May was the highest in Olkuska sheep (0.63 ±0.02 l), followed by Polish Mountain Sheep (0.4 ±0.04 l) and F₁ crosses (0.38 ±0.01 l), with statistically significant differences (P≤0.01) (Figure 1). Also in June and July, the highest milk yield was found in Olkuska sheep (0.57 ±0.03 l and 0.36 ±0.01 l, respectively) and significantly (P≤0.01) the lowest in Polish Mountain Sheep (0.32 ±0.02 l and 0.23 ±0.06 l, respectively). As lactation progressed and day length shortened, the milk yield decreased.
yield decreased in all the groups studied. The results obtained showed that during the milking period, Olkuska sheep were characterized by the highest milk yield (47.0 ± 8.7 l), which was significantly (P≤0.01) higher than in F1 crosses (31.2 ± 7.6 l). The lowest milk production was found in Polish Mountain Sheep, which produced just 27.1 ± 5.9 l during the whole milking period, with significant differences (P≤0.01). Such different milk production levels could be due to differences in the concentration of lactotropic hormones, especially prolactin and growth hormone, whose profile is modulated by changes in day length.

The present study showed that during the long photoperiod (May), melatonin concentration in all the groups was the lowest (Fig. 2). In the second month of milking (June), the highest melatonin level was found in F1 crosses (114.6 ± 9.4 pg/ml) followed by Olkuska sheep (70.9 ± 5.04 pg/ml) and Polish Mountain Sheep (54.3 ± 4.1 pg/ml), with statistically significant differences (P≤0.05). As lactation proceeded and dark phase increased with decreasing day length, melatonin concentration increased. In the last month of milking (August), melatonin level was the highest in F1 crosses (129.4 ± 9.3 pg/ml), lower in Olkuska sheep (81.8 ± 9.9 pg/ml) and the lowest in Polish Mountain Sheep (77.7 ± 6.6 pg/ml), with significant differences (P≤0.05).

Fig. 2. Changes in melatonin concentrations in Olkuska sheep, Polish Mountain Sheep and their crosses.

A, B, C – means with the same letters differ significantly in different months at P≤0.01 - średnie oznaczone tymi samymi literami w poszczególnych miesiącach różnią się istotnie przy P≤0.01
a, b – means with the same letters differ significantly in different months at P≤0.05 - średnie oznaczone tymi samymi literami w poszczególnych miesiącach różnią się istotnie przy P≤0.05

Fig. 2. Changes in melatonin concentrations in Olkuska sheep, Polish Mountain Sheep and their crosses.
The results obtained for changes in PRL concentration in lactating sheep showed that during the first collection in May, the highest prolactin level was found in Polish Mountain Sheep (212.8 ±6.6 ng/ml), followed by Olkuska sheep (200.3 ±5.6 ng/ml) and F1 crosses (199.2 ±6.9 ng/ml) (Figure 3). In the second month of milking (June), prolactin concentration increased in all sheep groups studied. The highest level was found in F1 crosses (314.1 ±7.9 ng/ml) followed by Polish Mountain Sheep (306.8 ±3.2 ng/ml) and Olkuska sheep (274.1 ±9.04 ng/ml). In July, the highest PRL level was characteristic of Polish Mountain Sheep (258.4 ±5.7 ng/ml), followed by F1 crosses (252.6 ±7.3 ng/ml) and Olkuska sheep (235.2 ±9.3 ng/ml). In August, with advancing lactation, prolactin level was the highest in Polish Mountain Sheep (128.4 ±3.7 ng/ml), significantly lower in F1 crosses (94.4 ±6.2 ng/ml), and the lowest in Olkuska sheep (65.7 ±3.7 ng/ml), with significant differences (P<0.01).

At the first sampling in May, the highest growth hormone (GH) concentration was characteristic of F1 crosses (7.54 ±3.2 ng/ml) and the lowest of Olkuska sheep (4.3 ±1.5 ng/ml); the differences were statistically significant at P<0.01 (Figure 4). In Polish Mountain Sheep, GH concentration in May was 6.9 ±2.3 ng/ml with significant (P<0.01) differences in relation to GH concentration in Olkuska sheep. In June, GH concentration was the lowest in Olkuska sheep (4.95 ±1.2 ng/ml) and significantly
higher in F1 crosses (6.38 ± 1.7 ng/ml) and in Polish Mountain Sheep (5.85 ± 1.3 ng/ml), with significant differences (P<0.01). In July, GH levels in the sheep groups studied decreased considerably; the highest GH concentration was found in Polish Mountain Sheep (5.5 ± 2.4 ng/ml) and the lowest in Olkuska sheep (3.5 ± 1.3 ng/ml). In F1 crosses, GH concentration was 4.69 ± 1.9 ng/ml with significant differences (P<0.01). During the last month of milking, the highest GH concentration was found in Polish Mountain Sheep (7.54 ± 2.4 ng/ml), lower in F1 crosses (6.61 ± 2.9 ng/ml) and the lowest in Olkuska sheep (5.0 ± 2.4 ng/ml), with significant differences (P<0.01).

The present study demonstrated that Olkuska sheep were characterized by the highest milk production and F1 crosses had higher milk yield than Polish Mountain Sheep. The use of Olkuska rams in the commercial crossing with Polish Mountain Sheep was found to improve the milk production parameters of F1 ewes and enabled them to be used in mountain and submontane regions. Likewise, Ciuruś [2] and Drożdż [4] showed that the use of prolific breeds (East Friesian rams) in single-stage crossing improves the productive parameters of mountain sheep. Recent research has shown that milk production in sheep is determined also by photoperiod length [15]. The melatonin secretion profile observed in our study had the characteristics of the annual rhythm described by Misztal et al. [12]. During the long photoperiod, melatonin concentration decreased while prolactin secretion and milk yield increased. During decreasing photo-
period, the increase in melatonin concentration reduced the level of prolactin, which contributed to a decrease in the milk yield of the sheep group investigated.

One of the main hormones responsible for the initiation and maintenance of lactation is prolactin, but an equally important role in this process is played by the growth hormone (GH). Until now, research on the role of GH in regulating prolactin secretion and, indirectly, milk yield has been focused on cattle. According to Etherton et al. [6], the growth hormone has an effect on milk yield and chemical composition in ruminants. In seasonal sheep, the role of growth hormone in regulating lactation is not entirely understood. However, the present study showed that growth hormone concentration depended on day length. When comparing changes in the concentration of growth hormone and prolactin in different months, it was found that during the long photoperiod, when sheep had a high milk yield, the level of prolactin increased while the growth hormone concentration decreased. During decreasing photoperiod, when milk yield of sheep decreased, prolactin concentration also decreased while growth hormone concentration increased. Due to their low reproductive parameters and level of milk production, Polish Mountain Sheep have been the subject of discussion and research aimed at improving their productive traits. However, when analyzing the present findings, the account must be taken of the profile of lactotropic hormones in this breed. During the period between May and July, there were no significant differences in prolactin concentration in the analysed groups of sheep and milk yield was significantly lower in Polish Mountain Sheep. Our findings lead us to conclude that responsible and conscientious breeding may also improve productive traits because the profile of lactotropic hormones (PRL, GH) suggests that Polish Mountain Sheep have a potential to increase milk production.

REFERENCES


