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Short Communication

GROWTH DINAMICS ON THE SKIN AND THE COAT IN NORMANDIAN AND SIMMENTAL CATTLE DURING ADAPTATION TO THE FARMING TECHNOLOGY IN SOUTHWESTERN PART OF BULGARIA

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ABSTRACT

The aim of the present study was to identify the adaptability of Normandy cows raised in a loose system to the climatic and technological conditions and to compare their adaptability with already acclimatized Simmental cows in one farm in Southwestern Bulgaria. Total of 20 cows at same age (II – IV lactation) and same body weight (630-660 kg) from both breeds were classified into 2 groups (each having 10 cows) and subjected to skin thickness measurement, fibers total weight determination and fiber categorization during the winter and summer season. The results have shown that during the winter season, the Normandy breed had significantly higher skin thickness at the elbow compared to the Simmental breed, whereas no differences were observed in the skin thickness between both breeds either at the neck or at the middle of the last rib. During the summer season, the differences on the skin thickness compared to the Simmental breed were observed at the neck ($p<0.05$), whilst at the elbow and at the middle of the last rib no differences were recorded ($p>0.05$). During the winter seasons, the coat of Normandy cows contained more soft fibers in comparison to the Simmentals cows. Furthermore, the changes in the observed parameters, influenced by climatic conditions showed similar pattern in both breeds. It can be concluded that the two breeds have emphasized their genetic potential and have a good adaptability to the temperate continental climate of the region.

Key words: cattle, coat, skin, environment, adaptation

INTRODUCTION

The wide variety of specific natural and climatic conditions in Bulgaria, as well as the sufficient size of farming land, meadows and pastures create favorable conditions for the development of specialized dairy farming (1, 2).

The skin of animals and human skin attracted the attention of scientists for a long time as a study subject. The cattle have the thickest skin compared to all other farm animal species, measuring up to 1.01 cm. The sweat glands are branched. The epidermis and papillary layer are relatively thin. The hairs are characterized by a small thickness and a thin medulla with smooth edges (3).

According to Pozdniakova (4), the skin thickness, the structure and the coat peculiarities in cattle are important parts in their adaptation to lower or higher temperatures. Many researchers have found interbreeding, seasonal and age differences in cows' skin thickness and hair structure (4, 5, 6). During one calendar year, the thickness of the skin and coat in cattle undergoes significant changes that could be identified and controlled by morphological methods and thus allowing analysis of their acclimatization abilities (7, 8, 9, 10, 11, 12).

According to Carabano et al. (13), new breeding strategies in cattle breeding are focused

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on improvement of tolerance to climatic stress, which have a significant impact on the technology of the production systems. This problem shall be addressed, developed and expanded in the future cattle breeding programs.

The Simmental cattle is an old, combined, long-acclimatized and tested breed that is important for the balance of dairy cattle breeding in Bulgaria. Normandy cattle is a breed recently imported to Bulgaria with a relatively high milk yield, varying between 6500-6700 kg, with dietary qualities of the milk. In any modern technology in cattle breeding, natural and climatic conditions are of primary importance (12). Kresna municipality is located in Southwestern Bulgaria. The valley of the river Struma divides the region into two parts - Pirin and Maleshevska. The altitude is 232 m. The climate is transitional Mediterranean. The winter is mild, late and snowless (the average temperature in January is +2 °C). Spring begins in March. The summer is dry and hot (the average temperature in July is +27 °C), and in July and August, the temperature reaches 40-42 °C. Autumn is long and warm. Precipitation is 700 mm/m², and is mainly in the months of November and December. The winds usually blow along the Struma River from the south (warm) and from the north (cold). The mountain-valley wind has an important, refreshing effect during the warm and long summer.

We hypothesized that the acclimatization of the Normandy cows raised on a loose system in Bulgaria will be different in comparison to already acclimatized Simmental cows. Therefore, the aim of the present study was to identify the adaptability of Normandy cows raised on a loose system to the climatic and technological conditions, and to compare the adaptability with already acclimatized Simmental cows in one farm located in the village of Slivovo, Kresna, Southwestern Bulgaria.

MATERIAL AND METHODS

The experiment was conducted during eight-month-period between the summer 2021 and winter 2022. The subject of our research were Normandy and Simmental breeds cows, in the farm „Katarino“, Slivovo village, Kresna municipality at 47° 72' N (N) longitude and 23°16' E (E) latitude. The cows from both breeds (n=20) have been selected and classified in 2 groups: Group 1 (n=10) cows from the Normandy breed and Group 2 (n=10) Simmental breed cows. All animals subjected to the study were at same age (II – IV lactation) and same body weight (630-660 kg). The Normandy cows were imported to Bulgaria from France, to the farm „Katarino“ in 2016. The cows were reared on a loose system, had free access to water and feed technologically balanced.

Skin thickness was measured at the neck, elbow and at the middle of the last rib by Cutometer digital (Hauptner-Herberholz, Germany) during the summer and winter seasons. In addition, a determination of the different hair (fibers) categories of the coat expressed in percentage, as well as their total weight during both seasons (winter and summer) have been done. The samples of the coat were taken manually using scissors from the upper end of the last rib with in an area of 1 cm² in both seasons. The evaluation of the fiber diameter was determined by micro projection using an MP3 Lana-meter (Polish Optical Plant, PZO). Metric (fiber length), morphological (skin thickness), and morphometric (fiber diameter) methods were used (4, 12). The Temperature and Humidity Index (THI) was calculated according to the following formula: THI=0.8 x dry bulb temperature of the air + (relative humidity x (dry bulb temperature of the air -14.4)/100+46.4 (14). A statistical analysis of the skin thickness and coat characteristics (weight, length and diameter) traits was performed using commercial statistical program (Statistica 10.0, StatSoft Inc. Tulsa, OK, USA), based on a linear model that included the effect of the breed and season, and the interaction between breed and season. All effects were compared by $\bar{x}\pm Sx$, with significance level set on $p<0.05$. The obtained results for each trait are presented in Tables.

RESULTS

The results of the present study have shown that the skin thickness differed between breeds as well as between seasons (Table 1).

During the winter season, the Normandy breed had significantly higher skin thickness at the elbow (0.79 mm) in comparison with the Simmental breed whereas no significant differences were observed in skin thickness between both breeds either at the neck or at the middle of the last rib (0.37 mm and 1.55 mm), respectively. During the summer season, the differences compared to the Simmental breed were observed at the neck (0.46 mm), whilst at the elbow (0.76 mm) and at the middle of the last rib (0.57 mm) no significant differences were recorded.

The coat characteristics were also different between the Normandy and Simmental cows (Table 2).

Table 1. Skin thickness in both breeds during the winter and summer seasons, mm, ($\bar{x} \pm Sx$)

Typical anatomical area for measuring the skin thickness	Normandy cows N=10 (Group 1)	Simmental cows N=10 (Group 2)
	Winter	
The neck	11.14±1.38	10.77±1.35
Top of the elbow	10.22±1.30*	9.43±1.02
Middle of the last rib	13.69±4.51	12.14±3.19
	Summer	
The neck	10.57±1.36*	10.11±1.83
Top of the elbow	9.65±1.92	8.89±1.04
Middle of the last rib	12.24±3.98	11.67±3.73

The asterix indicates significant difference between the measured values in the individual columns.
*p<0.05

Table 2. Coat characteristics during winter (January) and summer (August), ($\bar{x} \pm Sx$)

Indicator	Normandy cattle n=10 (Group I)	Simmental n=10 (Group II)
	Winter	
Weight per 1cm²(mg)	26.09±1.02	24.48±0.86
Length in cm		
- coarse fibers	7.21±0.68	6.80±0.42*
- transition fibers	5.21±0.34*	4.20±0.56
-soft fibers	3.12±0.38	3.06±0.46
Thickness, µm		
- coarse fibers (≥52µm)	79.90±0.24*	64.40±0.32
- transition fibers (31-51µm)	50.40 ±0.54*	44.80±0.74
- soft fibers (<31µm)	35.30±0.22*	29.20±0.31
Distribution by %		
- coarse fibers	12.2	15.3*
- transition fibers	33.7	32.1
- soft fibers	54.6*	52.6
	Summer	
Weight per 1cm² (mg)	20.57±1.42	19.01±1.11
Length in cm		
- coarse fibers	3.66±0.56	3.00±0.51
- transition fibers	2.80±0.65	1.68±0.38
- soft fibers	2.45±0.28*	1.30±0.42
Thickness, µm		
- coarse fibers (≥52µm)	74.90±0.36*	61.10±0.44
- transition fibers (31-51µm)	43.40 ±1.10*	41.30±0.89
- soft fibers (<31µm)	29.10±0.26*	24.10±0.24
Distribution by %		
- coarse fibers	21.9	22.1
- transition fibers	38.6	40.7
- soft fibers	39.5	37.2

p<0.05*

During the winter season, the coat of Normandy cows contains more soft fibers by 2.0% in comparison to the Simmentals, whereas the content of transitional fibers was almost the same in both breeds. However, when comparing the coarse fiber content, domination has been observed in the Simmental breed by 3.1%. During this season the Normandy cows also had significantly longer transition fibers than the Simmental breed. During the summer season, the soft fibers were more

Table 3. Temperature and humidity index - THI

Season	THI value (%)
Winter	58.6
Summer	69.0

abundant in Normandy breed by 2.3%, while the transitional and coarse fibers were dominant in the Simmental breed by 2.1 and 0.2%, respectively, but these differences were negligible. In addition, the thickness of the various fibers in the winter period was higher in the Normandy cows compared to the Simmental cows in the coarse fibers (15.5 μm), in the transition fibers (5.6 μm) and in the soft fibers by 6.1 μm. In the summer season the thickness of the Normandy breed fibers was dominated by 13.8 μm for the coarse fibers, 2.1 μm for transition fibers and 5.0 μm for soft fibers. Also, the length of the Normandy cows' summer soft fibers was significantly different than the Simmental breed. The distribution by percentage content for the different types of fibers were similar between the both breeds.

The asterix (*) indicates significant difference between the measured values in the individual columns. *$p<0.05$.

The environmental temperature and humidity index represents the degree of discomfort that the cattle organism experiences during the cold and warm weather. The percentage of THI index measured during the winter and summer is shown in Table 3. THI was calculated at a temperature of +4 °C and a humidity of 58% during the winter, and +27 °C and a humidity of 78% during the summer season.

DISCUSSION

The hypothesis of the present study was that the acclimatization of the Normandy cows raised on a loose system in Bulgaria would be different compared to already acclimatized Simmental cows. The results have shown that during the winter, compared to the summer season, the skin thickness of the studied areas was pronounced in all animals showing their breed characteristics. In the process of ontogenesis, the relative size of the endodermal and papillary layers of the skin in different breeds of cattle decreases, while reticular and subcutaneous tissue increase significantly (3). During the acclimatization, cows develop a protective mechanism of adaptation against exposure to cold, which can be assessed by the thickening of their skin. (4, 15). Our results have shown that the Normandy breed of cows have a thicker skin in both seasons compared to the Simmental breed, which is in agreement with the results reported by Pozdnyakova (4).

The coat is derived from the skin and is closely related to its structure and function. In the adaptation of cattle to low temperatures, especially in winter, the coat plays an important role in regulating heat exchange between the body and the environment, and during rainy and snowing days in protection of the animals from getting wet (8, 6). The adaptation of the cattle to lower temperatures during the winter season causes changes in the coat structure (Table 2). It was found that the coat weight, of a sample of 1 cm^2 obtained from the Normandy breed cows is 6.18% higher, in comparison to the Simmental (3). The Normandy breed express longer and thicker coat than their Simmental herd mates.

In our study, THI was calculated at a temperature of +4 °C and a humidity of 58% during the winter, and +27 °C and a humidity of 78% during the summer season. The calculated index during the winter season was not a cause for discomfort. These data are correspondent and are in accordance with those reported by others (12, 13, 16).

CONCLUSION

Changes in both parameters influenced by climatic conditions showed the same pattern in both breeds of cattle. The latter could be explained by the common genotypic basis on which they are subordinated. The ecogenesis of both breeds in Bulgaria was under quite different climatic conditions compared to the climatic conditions in its original environment in France. It can be concluded that both breeds have emphasized their genetic potential and have a good adaptability to the temperate continental climate of the region, which is characterized by mild winters and dry summers.

CONFLICT OF INTEREST

The authors declare that they have no potential conflict of interest with respect to the authorship and/or publication of this article.

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AUTHORS' CONTRIBUTIONS

NM and SS conceived the study, participated in its design and coordination and helped to draft the manuscript. TsB carried out the measurements, collected the data and drafted the manuscript. NA, IE, BA and LjM contributed to the design and implementation of the research, to the statistical analysis of the results and to the writing of the manuscript. All authors read and approved the final manuscript.

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