

CHARACTERISTICS OF GROWTH AND WEAR OF HOOVES OF COWS RAISED ON PASTURE AND INDOOR CONDITIONS IN THE CENTRAL BALKAN MOUNTAINS

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Abstract

The paper deals with the study on individuals of two groups of cows, of red-white, wide-faced Montbeliarde and Simmental cattle breeds approved in Bulgaria according the qualities of their hoof horn and the impact of exogenous and endogenous factors on this process. Visual, metric and anatomically-topographical methods were used. Five measurements were made of the following indicators: length, width, total width, height and hoof angle of the thoracic and pelvic limbs of the studied animals during the indoor and pasture periods. Support point in cm² and the ratio of 1 kg live weight to unit support point in cm² were calculated. Pasture-raised cows, in both breeds, showed a higher coefficient (ratio) of a unit of support point compared to live weight, respectively a coefficient of 1,7576 for Montbeliarde breed or by 8.2% more and a coefficient of 1,3946 for Simmental breed or by 9.1% more. Mobility of cows affected critically to their ongoing health, productivity and longevity. Uniform growth of the hoof horn was determined by the equal distribution of cows' body weight over the distal limbs. Hoof growth was subject to seasonal fluctuations.

Key words: breed, hoof horn, growth, pasture, length, width.

INTRODUCTION

Biomechanical laws are constant for each species. In the biomechanics of cattle hooves, must be accepted the fact that the weight of the animals' body is distributed proportionally on all limbs (Hernandez-Mendo et al. 2007; Veremey et al., 2010; Homin et al., 2017; Hamzaev, 2019).

Cement floors, as a part of the mass technological process, lead to a higher growth intensity of hoof horn, with reduced hoof angle due to increased wear. Farmers must consider the conditions in the rearing room and the comfort requirements of the cows to prevent problems that are result of arising from hoofs. The time spent on hoof care combined with proper balanced feeding give results in the long-term period (Mochamadia & Khaglani, 2013; Marinov, 2016; Fedoseeva & Kolekniv, 2016; Longova et al., 2020).

Skin covering of cows' toes has changed into a kind of horned slipper in the process of phylogenetic development of cattle as species. Their hoof is a keratinized epithelium formed on the distal part of the limb. The derived layer of the epidermis, continuously produces a horn

layer during the entire ontogenetic development of the individual (Muling & Creenongh, 2006; Kennedy et al., 2009; Rauibar et al., 2016).

Growth intensity of the hoof horn depends on various external and internal factors such as breed, sex, technology, sufficiency and dietetics of feeding, season of the year, physiological state, etc. (Cook et al., 2009; Kvochko et al., 2010; Shearer et al., 2013; Zemlyanukhina, 2016; Lomonov & Skorkina, 2020).

The objective of the present investigation was to study the growth and wear of hoof horn of cows of red-white, wide-faced Montbeliarde and Simmental cattle breeds during the pasture and indoor period in the region of Troyan in Central Balkan Mountains.

MATERIALS AND METHODS

The experiment was conducted from the end of May to the end of September in 2021, on the farm of Research Institute of Mountain Stockbreeding and Agriculture in Troyan, Bulgaria. By the method of analogues, two groups each of 10 cows were formed – 1st group of the Montbeliarde breed and 2nd group of Simmental breed. Cows were kept free-boxed in

a barn during the winter, as each cow was provided with a bed covered with dry sand and straw. In the summer, the animals were raised on a pasture complex sown with traditional grass. During the experiment, the cows were fed in the same way, at a specific feeding rate. During the barn period, the animals were kept in a steel-concrete room with a cement floor. Five measurements were made of length, width, total width, height and angle of the hooves of the thoracic and pelvic limbs of both groups of studied cows, at the beginning and end of the grazing period, and at the beginning and end of the barn period as well as using measuring

instruments: retractable tape measure, measuring tape, plumb line and a protractor according to the methodology of Peschkin (1976) for hooves characterization. Measurements were recorded in a protocol. Live weight of the studied animals was determined using an electronic scale with an accuracy of 0.01 kg. The support point in cm² and the ratio of 1 kg of live weight to a unit of support point in cm² were calculated. Visual, metric and anatomically-topographical methods were used. The data were processed by the methods of variation statistics using the program 'Statistica', version 10 and presented in Tables 1 and 2.

Table 1. Characteristics of the hoof horn, by breeds, cm

| Size | Period | | | |
|---------------------------------|------------------------------------|------------------------------|------------------------------------|------------------------------|
| | Pasture-raised | | Barn-raised | |
| | At the beginning of the experiment | At the end of the experiment | At the beginning of the experiment | At the end of the experiment |
| Montbeliarde | | | | |
| Front hooves of thoracic limbs | | | | |
| Length | 13.2±0.05 | 13.8±0.05 | 13.81±0.01 | 14.41±0.05 |
| Width | 6.2±0.05 | 6.7±0.05 | 7.4±0.05 | 7.6±0.05 |
| Total length | 13.2±0.05 | 13.5±0.05 | 13.47±0.05 | 14.67±0.05 |
| Height | 6.2±0.05 | 6.4±0.06 | 6.3±0.05 | 6.5±0.05 |
| Notched part angle | 45±0.25 | 45±0.30 | 45±0.30 | 45±0.30 |
| Back hooves of the pelvic limbs | | | | |
| Length | 13.22±0.04 | 13.56±0.07 | 13.72±0.23 | 14.52±0.03 |
| Width | 6.13±0.05 | 6.34±0.05 | 6.89±0.04 | 7.47±0.04 |
| Total width | 13.65±0.04 | 13.88±0.05 | 13.72±0.05 | 13.97±0.02 |
| Height | 6.5±0.04 | 6.7±0.02 | 6.6±0.01 | 6.9±0.03 |
| Notched part angle | 54±0.30 | 54±0.30 | 55±0.05 | 55±0.04 |
| Simmental | | | | |
| Front hooves of thoracic limbs | | | | |
| Length | 15.02±0.05 | 15.64±0.04 | 14.31±0.04 | 15.78±0.03 |
| Width | 7.9±0.04 | 8.11±0.04 | 8.5±0.05 | 8.84±0.05 |
| Total width | 14.87±0.04 | 14.53±0.02 | 15.1±0.05 | 15.32±0.05 |
| Height | 6.3±0.04 | 6.5±0.03 | 6.7±0.04 | 7±0.04 |
| Notched part angle | 44±0.01 | 44±0.02 | 44±0.04 | 44±0.05 |
| Back hooves of the pelvic limbs | | | | |
| Length | 14.12±0.04 | 14.64±0.04 | 14.31±0.05 | 14.78±0.05 |
| Width | 6.94±0.04 | 7.11±0.05 | 7.35±0.05 | 7.94±0.05 |
| Total width | 13.53±0.08 | 13.89±0.06 | 14.24±0.05 | 14.83±0.04 |
| Height | 6.5±0.03 | 6.8±0.04 | 6.6±0.02 | 6.9±0.05 |
| Notched part angle | 54±0.3 | 54±0.3 | 55±0.4 | 55±0.3 |

P<0.05*, P<0.01**, P<0.001***

Table 2. Live weight, support point and ratio between them

| Period of raising | Number (n) | Live weight, g | Support point, cm ² | Support point/live weight ratio, kg/cm ² |
|---------------------|------------|----------------|--------------------------------|---|
| Montbeliarde | | | | |
| Pasture-raised | 10 | 627.24±0.67 | 356.86 | 1.7576 |
| Barn-raised | 10 | 635.37±0.94 | 435.96 | 1.4574 |
| Simmental | | | | |
| Pasture-raised | 10 | 644.12±1.33 | 461.86 | 1.3946 |
| Barn-raised | 10 | 658.46±1.95 | 513.69 | 1.2818 |

(P<0.05*)

RESULTS AND DISCUSSIONS

In cattle, the anatomical-orthopedic features possess their own peculiarities. The hoof is modified skin of the limb forming a slipper around the third and fourth toe. It has a relatively thicker lateral wall compared to the medial one. In its notched part, the thickness of the wall is about 7 mm, and in the heel part, the same is about 5 mm (Marinov, 2016; Lomonov & Skorkina, 2020).

Growth and wear of the horn layer characterize the condition of the hoof horn in cows (Homin, 2017). Research has shown that the greatest rate of increase in hoof horn growth is observed during the grazing period in the order of 0.6 cm. According to experimental groups, hoof horn growth varies from 0.2 to 0.6 cm.

The studied cows from both groups demonstrated at the end of the pasture and barn period values of increase in hoof horn growth. The pasture-raised cows of Montbeliarde breed in the measurements of the hooves of the thoracic limbs showed an increase at the end of the experiment: length by 0.6 cm, the width by 0.5 cm, the total width by 0.3 cm, and these measurements for the same barn-raised animals showed an increase: 0.6 cm in length, 0.34 cm in width, 0.25 cm in total width. In pasture-raised Simmental an increase in hoof measurements of the thoracic limbs was observed: length by 0.23

cm, width by 0.21 cm, total width by 0.36 cm. These measurements taken on the same animals reared in a barn showed an increase: length 0.47 cm, width by 0.71 cm, total width by 0.59 cm ($P < 0.05$).

The situation with the pasture-raised Montbeliarde breed is as follows: in the measurements of the hooves of the pelvic limbs, an increase was demonstrated at the end of the experiment: length by 0.34 cm, width by 0.21 cm, total width by 0.23 cm, and these measurements, and for the same animals raised in a barn, the following increase is reported: length by 0.47 cm, width by 0.58 cm, total width by 0.25 cm. The measurements of the back hooves of the thoracic limbs of pasture-raised Simmental cows showed an increase at the end of the experiment: the length by 0.52 cm, the width by 0.17 cm, the total width by 0.36 cm, whereas these measurements, for the same barn-raised animals showed an increase: 0.47 cm in stature, 0.59 cm in width, 0.59 cm in total width ($P < 0.05$) (Figures 1-4).

The intensity of growth of the hoof horn depends on various external and internal factors, such as breed, sex, technology, sufficiency and dietetics of feeding, season of the year, physiological state, etc. (Cook et al., 2009; Kvochko et al., 2010; Shearer et al., 2013; Zemlyanukhina, 2016; Lomonov & Skorkina, 2020).

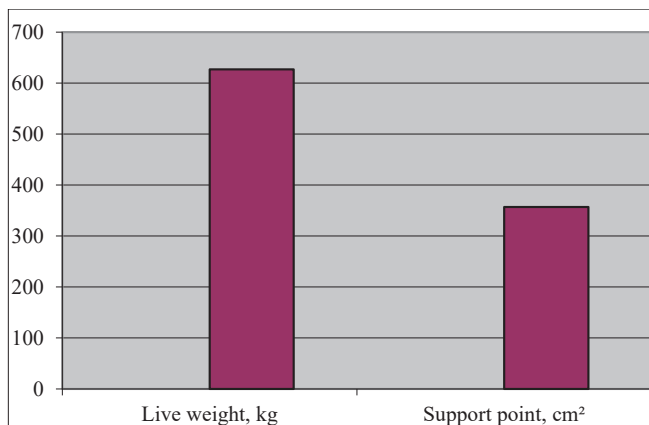


Figure 1. Pasture-raised Montbeliarde

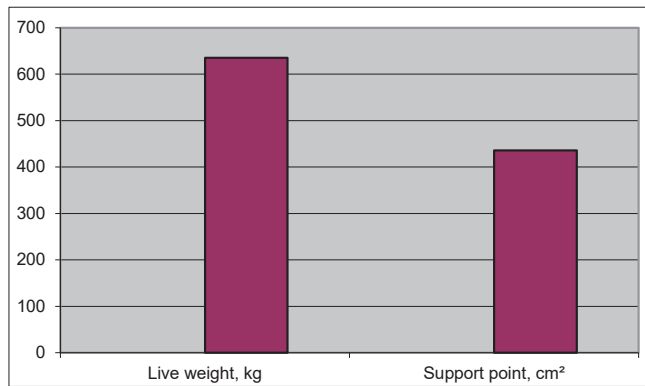


Figure 2. Barn-raised Montbeliarde

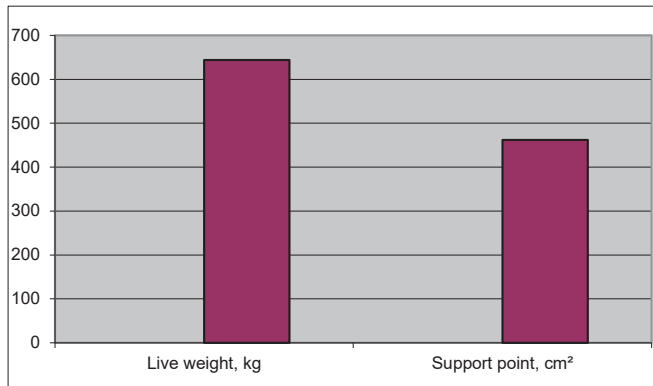


Figure 3. Pasture-raised Simmental

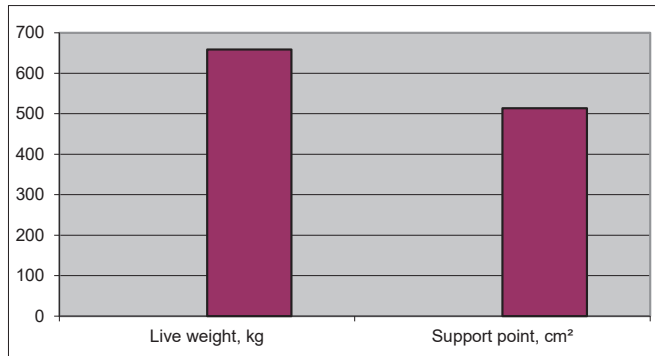


Figure 4. Barn-raised Simmental

CONCLUSIONS

Hoof height varies from 6.3 to 6.9 cm in Montbeliarde cows and 6.5 to 6.9 cm in Simmental cows, and the notched angle in both breeds shows acceptable values of 44° to 45° for thoracic limbs and 54° 56° for pelvic limbs (P<0.05).

The visual assessment, measurements and calculations of the support point of both groups of examined cows give us a description of their limbs and hooves (Veremei et al., 2010). They showed that in pasture-raised cows in both breeds, a higher coefficient (ratio) per unit of support point, relative to live weight (Table 2), was observed, respectively 1.7576 points for the

Montbeliarde breed or by 8.2% and 1.4869 points for the Simmental breed or by 9.1%. This is explained by the fact that pasture-raised cows show more hoof horn attrition.

The present results are similar to the results obtained by Homin et al. (2017), Longova et al. (2020) and Lemonov & Skorkina (2020), and in some cases complement them.

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