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EXPERIMENTS ON A HOLSTEIN-FRIESIAN LINE ON THE EFFECT OF SELECTION FOR ROBUSTNESS ON FEEDING BEHAVIOUR

Mugurel COLA, Florica COLA

University of Craiova , 13 A.I.Cuza str, , Craiova, Romania

Corresponding author email: colaflorica@yahoo.com

Abstract

The consumption behavior of fodder in kg dry substance (SU) per day was followed for the duration of the fodder consumption in minutes per day, and the duration of the rumination in minutes per day, at 6 first-calf heifers in each group for 3 consecutive days. During the stall period, the group 1 first-calf heifers had higher fodder consumption than the group 2 first-calf heifers. The SU consumption was 19.5 kg/day in the group 1 and 17.2 kg/day in the first group 2. The duration of fodder consumption was higher in group 1 (robust first-calf heifers) compared to the duration of fodder consumption in group 2 (256 vs. 236 minutes per day). The average time to consume one kg of SU was on average 13.12 minutes for group 1 of animals and 13.70 minutes for group 2 of animals. The ideal cow for pasturing systems is the cow that consumes large quantities of green mass and efficiently transforms it into high milk production per kg live weight. The first-calf heifers in group 2 are slightly more efficient in pasturing than the robust first-calf heifers. Grass consumption was, on average, 16.4 kg Dry Substance in group 2 of animals compared to group 1 of animals 14.2 kg SU. The difference between the two consumptions 22.2 kg SU is statistically significant ($p<0.05$).

Key words*: robustness, body conformation, productive longevity, heifer.*

INTRODUCTION

The exploitation of dairy cows is based on the following types of behaviour: ingestion, dietary, metabolic or trophic behaviour; excretion or feeding behaviour; social behaviour; comfort, rest and sleep behaviour; exploratory and orientation behaviour in the environment (Cola and Cola, 2019).

Ingestion behaviour (food) is the innate and learned action of the animal to nourish and drink water, an action based on nervous and humoral mechanisms. This behaviour comprises 3 phases: the search for food, the procurement and contact with the food and the consumption of food and manifests itself differently in the pasture and shelter (Georgescu et al., 2007).

Excretion behaviour involves two physiological processes, resulting from metabolism-defecation and urination.

Social behaviour represents the group manifestations through which the relationships between animals are established. In the extensive growth the social behaviour approaches the natural one, and in the semi-intensive and intensive one there are constraints in their manifestation.

Rest and sleep behaviour is the interruption of activities to restore the body's power. This behaviour is different in pasture and shelter.

Exploratory and orientation behaviour represent the actions of investigating the environment in order to know and orientate the cows in the environment in which they live.

The daily time of the behavioural activities was measured by establishing a "behavioural routine" (Table 1) that serves as a basis for the evaluation of the productive performance and the economic losses due to a faulty management. The time allocated to the behavioural activities in 24 hours represents the net response of each cow to its growth environment.

Table 1 Daily time allocated to behavioural activities in lactating cows *

Activity	Time allocated to the activity per day
Fodder consumption	3-5 hours (9-14 meals a day)
Rest behaviour	12 – 14 hours
Social behaviour	2-3 hours
Rumination	7-10 hours
Water consumption,	30 minutes
Exploratory behaviour (including milking)	2.5-3.5 hours
Other activities	30 minutes

* Adaptation after Grant and Albright (2000)

Albright (1993) measured the daily behaviour of the Beecher Arlinda Ellen cow during lactation in which she set the world milk production record by recording the following: 6.3 hours of fodder, 13.9 hours of rest and 8 hours of rumination, of which 7,5 hours lying down and 30 minutes standing.

Dairy cows need to perform daily behavioural activities and should not interfere with the management routine.

Satisfying basic behavioural needs lasts almost 21 hours daily. Given this absolutely necessary time, it is easy to see how managerial practices can disrupt the behavioural time span. A deprivation of 3.5 hours from the rest area, fodder or water will force the cows to give up other activities or shorten the time allocated to the activities. Often the rest time and the fodder time are reduced with negative consequences on the productivity of dairy cows.

Starting from these aspects, several experiments were conducted at SCDA Şimnic Craiova regarding the behaviour of the primipara resulted in the first generation from the basic herd subject to improving their robustness.

MATERIALS AND METHODS

From the total herd of dairy cows from SCDA Şimnic was selected a genealogical line of Holstein Friesian cows with common genes from the famous STARBUCK bull (Canada). The database includes information from cows born in 2015, 2016 and 2017 and from the pedigrees of 10 breeding bulls. New phenotypic values are recorded periodically. It was expected that by 2018 the base herd (50 cows) will produce 105 F_1 products, of which 52 females and 53 males. Each group of features is composed of indicators that in turn are complex phenotypes formed of physiological phenotypes. These experiments took place in 2018 at SCDA Şimnic Craiova Dolj.

The experiments lasted 68 days, of which 34 days during the maintenance period at the stable (May 1-June 3) and 34 days during the grazing period (June 4-July 8).

Two primipara groups were brought to the experiments, of which group 1 of robust primipara (PR) and group II control group primipara (PM), primipara contemporaries with PR but from mothers not included in this study within the research Biobase of dairy cows in Şimnic. Each group included 11 animals.

During the stall period, the primipara were housed in two separate boxes, free on straw bedding and fed with a ration comprising 60% concentrates and 40% volume fodder. The composition of the concentrated fodder provided consisted of maize 472 kg, sunflower seed 276 kg, wheat 175 kg, minerals 40 kg and vitamins 37 kg (all in kg of dry substance per ton of concentrated mixture). Volume fodders included alfalfa hay and maize silage. The ration adjustment was done with brewers' grains. An accommodation period of 20 days and a measurement period of 14 days were allocated. The milking of the animals was done twice daily: 5:30 - 6:30 in the morning and, respectively, 15:30 - 16:30 in the evening, in a milking room 2 x 5 De Laval type. Animal feeding was done twice daily. During the 14 days of measurements the fodder consumption per primipara group was calculated as the difference between the quantities of fodder ingredients administered the day before and the quantities of fodder ingredients that were not consumed. The quantity consumed multiplied by 1.1 represents the quantity offered to the cows the next day.

During the grazing period the animals grazed a surface of Lolium perenne. An amount of approximately 18 kg of Dry Substance of green mass calculated at a cutting height of 4 cm was allocated daily. This allocation was made daily by measuring 4 quarts of 0.25 m^2 grass surface cut to a height of 4 cm from the ground with the sickle and chosen randomly.

The amount of grass in each quarter was weighed and samples were taken to determine the dry substance content (S.U.).

The height of the grass before grazing and after grazing was determined daily. The crude protein, acid detergent fibre, detergent fibre, raw energy and starch content and water soluble carbohydrate content were analyzed in the laboratory in the main fodders offered in the two experimental periods.

The consumption behaviour of the fodder in kg of Dry Substance per day was followed for the duration of fodder consumption during the day, and the duration of the rumination in minutes per day, at 6 primipara in each group for 3 consecutive days.

The data from the experiments was statistically private with MC Excel 2010.

RESULTS AND DISCUSSIONS

The content of Dry Substance of crude protein (PB), neutral detergent fibber (NDF), acid detergent fibre (ADF), starch, water soluble carbohydrates and raw energy of the fodders offered during an experimental period is presented in Table 2. The concentrates had an average content of Dry Substance of 854 g/kg, 236 g/kg of Dry Substance crude protein and 16.2 MJ/kg Dry Substance raw energy during the stall period and 864 g Dry Substance/kg, 220 kg/Dry Substance crude protein and 16.4 kg MJ/kg of raw energy respectively during the grazing period. The maze silage offered had a Dry Substance content of 334 g/kg and a starch content of 260 g/kg of Dry Substance.
The green mass (*Lolium perenne*) offered had a Dry Substance content of 182 g/Kg, crude protein of 195 g/kg of Dry Substance and raw energy of 11 MJ/kg of Dry Substance.
Before grazing, the height of the grass was on average 9.7 cm in the plot offered to the animals in group 1 and 10.4 cm in the plot offered to the animals in group 2.
During the stall period, the group 1 primipara had a higher fodder consumption than the group 2 primipara (Table 2.)
The consumption of Dry Substance was 19.5 kg/day in group 1 and 17.2 kg/day in group 2. It is worth mentioning that the difference in live weight between the two groups was 40 kg in favour of group 1. The duration of fodder consumption was higher in group 1 (robust primipara) compared to the duration of fodder consumption in group 2 (256 vs. 236 minutes per day).
The average time to consume one kg of Dry Substance was on average 13.12 minutes for group 1 animals and 13.70 minutes for group 2 animals.
During grazing, grass consumption was higher in group 2 animals compared to group 1 animals (16.4 kg Dry Substance vs. 14.7 kg Dry Substance). The grazing time was higher in group 2 compared to group 1 (582 vs. 530 minutes/day), and the duration of rumination was on average 366 minutes in group 2 animals and 350 minutes in group 1 animals.

Table 2 Chemical composition of the main fodders offered during the experiments

Specification	Period of stall				Grazing period			
	Concentrates		Silo maze		Concentrates		Green mass	
	$\dot{X}$	±ds*	$\dot{X}$	±ds*	$\dot{X}$	± ds*	$\dot{X}$	± ds*
SU g/Kg	854	20.2	334	10.8	864	14.2	182	20.5
Crude protein g/Kg SU	236	22.8	84	20.9	220	14.0	195	32.3
NDF g/kg SU	94	20.2	548	22	90	20.4	510	14.8
ADF g/kg SU	189	14.1	278	20.8	170	18.2	240	8.5
Starch g/kg SU	250	2.3	160	24.2	-	-	-	-
Water soluble carbohydrates g/Kg SU	-	-	-	-	-	-	70	40.2
Raw energy MJ / Kg SU	16.2	2.2	18.8	9.9	18.8	2.4	11.0	0.38

* standard deviation; SU = dry substance; NDF = neutral detergent fibre; ADF = acid detergent fibre

The difference between the two fodder consumption was 2.3 kg Dry Substance per day and per cow. The difference in weight and, implicitly, the metabolic weight of the robust primipara resulted in a higher consumption of Dry Substance during the stall period. There were no restrictions on access to fodder or water to the two groups of animals.

The ideal cow for grazing systems is the cow that consumes large quantities of green mass and efficiently transforms it into high milk production per kg live weight. As shown in (Table 3), the group 2 primipara are somewhat more efficient at grazing than the robust primiparae (figure 1).

Table 3 Food behaviour during the stall and grazing period

Specification	Group 1 primipara	Group 2 of primipara	Standard error of difference	Signifi-cance
Period of stall				
Total Dry Substance consumed (kg/day)	19.5	17.2	0.67	*
Total feeding time (min/day)	256	236	0.005	
Time per kg of Dry Substance consumed (minutes)	13/12	13.7	18.2	
Duration of rumination (minutes/day)	466	490	28.2	*
Grazing period				
Total Dry Substance consumed (kg/day)	14.2	16.4	0.68	*
Total feeding time (min/day)	19	17.6	0.68	
Time per kg of Dry Substance consumed (minutes)	530	582	18.2	**
Duration of rumination (minutes/day)	350	366	21.0	

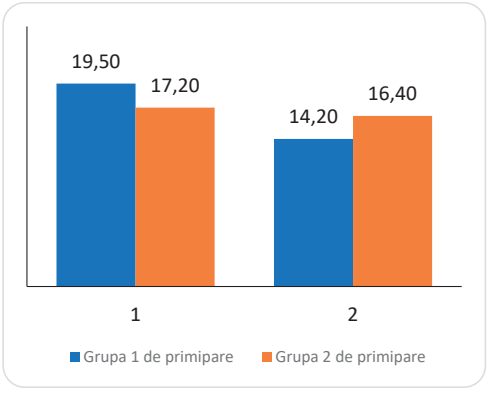

Figure 1. Dry Substance consumption during the year

Grass consumption was, on average, 16.4 kg Dry Substance in group 2 animals compared to group 1 animals 14.2 kg Dry Substance.

The difference between the two consumptions of 22.2 kg Dry Substance is statistically significant ($p<0.05$). The consumption of green mass at grazing is based on the length of time the pasture multiplied by the number of bowls swallowed by grass and the amount of grass per bowl swallowed by the animal. In most studies, the effects of environmental factors on grazing and less the genotypes of animals are examined. The duration of grazing was greater in group 2 of primipara (582 minutes/day) compared to group 1 of primipara (530 minutes/day). The same tendency was also observed regarding the duration of the rumination, 366 minutes for group 2 and 350 minutes for group 1 animals.

The higher fodder consumption in the robust primipara (group 1) observed in this study suggests a higher consumption capacity compared to the primipara in group 2, under feeding conditions in the stall. The selection for a higher weight at maturity results in a greater increase of the capacity of the rumen, which usually represents 0.022 of the body weight. Not the same thing was observed during the grazing period. This confirms that Holstein Friesian animals with large body growth do not behave as well as Holstein Friesian animals with lower body growth in terms of grazing. Further research is needed to clarify this aspect in terms of productive performance.

The results of this study suggest that the body weight and, in particular, the fodder consumption capacity are features with positive economic value. These features become even more important as the volume of fodder in the daily ration of cows is increasing. The use of concentrated fodder should not increase due to their costs and problems related to their consumption. The features related to the fodder efficiency of the cows should also be taken into account. The inclusion of features related to the efficiency of the dairy cow in the selection objectives makes possible the efficient use of fodder resources. For this purpose, the optimum body size of the dairy cow should be defined for the circumstances of a milk production system so that the use of volume fodder can be maximized. From this study it results that improving for body weight and greater ruminal capacity can further increase the profitability of a Holstein-Friesian cow.

The important interactions between breeding, nutrition, health and reproduction can be properly transposed into farm-level economic considerations.

The consumption capacity of dairy cows depends on three factors: fodder, management and animal. The factors related to fodder are

those related to composition and physical form. The management factors are those related to the restricted feeding strategy compared to the feeding at discretion, and the animal related factors are those related to the level of production, body size, age, physiological stage and genetic merit for the consumption of fodder. The ruminal capacity was defined as follows: maximum loading of the rumen with Dry Substance at any time. The dynamic model of digestion estimates the consumption capacity based on a coefficient of 0.021 multiplied by body weight. There are also some adjustments that take into account the level of production and the month of gestation.

The actual performance of a cow also depends on the feeding strategy. In this analysis it is assumed that cows have unlimited access to the consumption of volume fodder (alfalfa hay, green meal, corn silage) and limited for the consumption of concentrated fodder.

The concentrated fodder was allocated in a ratio of 1 kg concentrated fodder to 2.7 kg of milk.

CONCLUSIONS

The more robust primipara tend to consume larger quantities of fodder in the conditions of feeding at the stall. Their greater body growth results in greater gastrointestinal capacity in these animals.

Primipara with lower body development behave much better under grazing conditions, which suggests the creation of genotypes suitable for grazing systems.

Further research in other grazing seasons would also clarify these aspects in terms of productive performance.

The results of this study offer important information regarding the type of features to be considered within the objectives of genetic improvement in cattle specialized for milk production.

This study clearly shows the importance of the features related to the survival of the animals in the herd and the features related to the conception rate, both types of features are features related to the robustness of the dairy cows.

The robustness of dairy cows is a multi-character trait and reflects the combined success of several features (fertility, energy balance, longevity, docility, health, mobility, fitness). The economic value of these features is mainly determined by indirect effects, such as: reducing the percentage of replacement (and the costs of replacing animals in the basic herd); changes regarding the distribution of cows in age classes or changes in the number of reproductive days versus productive days.

During the life of a cow, managerial practices can disrupt the duration of behavioural times. A shortening by 3.5 hours of rest time, feeding or water consumption will force cows to give up other activities or shorten the time allocated to the above activities. Dairy cows need to perform daily behavioural activities and should not interfere with the management routine. Often the resting time and the feeding time are reduced with negative consequences on the productivity of dairy cows.

There is a sensitivity of economic values to changes in the price of milk components and the price of fodder. Changes of ± 20% as compared to the original values were taken into account in three situations: fixed herd, inputs with fixed concentrated fodder and total fixed milk production. The changes were made one at a time, keeping the other parameters to the original values.

The economic values have also been recalculated for all the characters assuming a change in the feeding strategy.

This strategy was selected on the basis of a study in which feeding strategies were compared on the basis of their efficiency to fully meet the nutritional needs of cows in a wider range of their productive status.

The strategy with the worst performance was selected for the recalculation of the economic values taking into consideration the assessment with fixed herd of livestock. In this case the cows were fed with fixed quantities of 6, 4 and 2 kg of concentrated fodder during the first 0-100 days, 101-200 and, respectively, over 200 days of lactation. Cows also consumed volume fodder without restrictions.

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