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SEÇKİN SALAR

OĞUZ ÇALIŞICI

DUYGU ÇALIŞICI

İDİL BAŞTAN

AYHAN BAŞTAN

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Effect of utilization of a controlled-release intraruminal monensin device on dry matter intake, milk yield, and some reproductive parameters in dairy cows

Seçkin SALAR[1,*], Oğuz ÇALIŞICI[2], Duygu ÇALIŞICI[2], İdil BAŞTAN[3], Ayhan BAŞTAN[1]

[1]Department of Obstetrics and Gynecology, Faculty of Veterinary Medicine, Ankara University, Ankara, Turkey

[2]Süt Kardeşler Co., İzmir, Turkey

[3]Department of Internal Medicine, Faculty of Veterinary Medicine, Ankara University, Ankara, Turkey

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Abstract: The aim of this study was to examine the effect of the prepartal administration of the monensin release capsule on dry matter intake (DMI), milk yield, and some reproductive parameters of dairy cows. The cows were divided into study (n = 35) and control (n = 41) groups. The study group cows were administered the intraruminal-monensin releasing capsules at 21 ± 3 days before expected calving and the control group cows were not subjected to treatment. Monthly mean DMI; cumulative milk yield at 30, 45, and 60 days in milk (DIM); peak milk yield; days of 1st AI; days open; and culling rate were measured. Monensin delivery prepartum decreased DMI postpartum (P < 0.001) but did not alter cumulative milk yield at 30, 45, and 60 DIM; peak milk yield; days of 1st AI; days open; or culling rate (P > 0.05). In conclusion, monensin-releasing capsule administration in the prepartum period did not affect performance reproductive parameters postpartum. However, it may contribute to the economics of production efficiency.

Key words: Dairy cow, dry matter intake, milk yield, monensin, reproductive performance

1. Introduction

A negative energy balance is formed in high-yielding dairy cows due to the lack of energy meeting the requirements for the milk yield. This depends on insufficiencies of dry matter intake (DMI) and feed efficiency in the late pregnancy period and early lactation (1). Important metabolic alterations happen in the subsequent lactation period when in a state of negative energy balance (2). Some researchers (2–5) specified that these metabolic changes negatively affect productivity and lead to different disorders.

Monensin is a polyether carboxylic ionophore that leads to alterations in the bacteria and fermentation balance of the rumen due to an increase in the amount of propionate and glucose precursors (6). An increase in the amount of propionate in the rumen increases the use of glucose for energy production (7). Even though there are various studies about rumen fermentation and ketosis, there are limited numbers of studies conducted on reproductive efficiency and health (8).

Disorders related to calving and metabolic problems in the early postpartum period affect milk yield and reproductive performance, and hence the economic profits of dairy farms (7,9,10). The hypothesis of our study is that the administration of a capsule releasing monensin over a long term regulates the negative energy balance, decreases the incidence of ketosis, and thus can affect the days in milk (DMI) in the postpartum period and positively influence the milk yield and reproductive parameters. The aim of this study was to examine the effect of the prepartal administration of the monensin-releasing capsule on DMI, milk yield, and some reproductive parameters in the postpartum period.

2. Materials and methods

2.1. Cows and herd management

This study was conducted on a commercial dairy farm located in the vicinity of İzmir, Turkey, with approximately 1500 lactating Holstein cows. The average milk yield of the animals was approximately 10,800 kg/305 days. Data of the cows (ear tag number, age, lactation number, etc.), milk yield records, diseases, treatments, reproduction, and feeding were regularly recorded with herd management software (Alpro Windows, Version 6.93; DeLaval, Tumba, Sweden). After parturition, all cows were immediately separated from their calves, moved to a fresh pen, and fed a fresh ration until 30 days postpartum. At 30 DIM the cows were moved to a high-producing free-stall barn

* Correspondence: ssalar@ankara.edu.tr

and fed a high-producing ration (Table 1). The total mixed ration (TMR) was prepared according to standard National Research Council recommendations and the cows were fed three times per day. The averages of lactation number and age were 1.46 ± 0.09 and 1.44 ± 0.08 lactations and 43.59 ± 1.32 and 44.98 ± 1.22 months in the study and control groups, respectively ($P > 0.05$).

When the cows were moved from the fresh pen to the high-producing barn, all cows were examined using transrectal ultrasonography for uterine involution and cyclicity. Reproductive health examinations were performed regularly once a week to check cyclicity and estrus. The results of these routine examinations and of activity meters were recorded until the end of the voluntary waiting period (VWP). The first inseminations were conducted using Ovsynch-56 after the VWP. Nonpregnant cows were again inseminated depending on the determination of the estrus cycles established from estrus observations, results of examinations, and activity meters. In the event that the estrus cycle could not be determined, insemination was repeated using the Ovsynch-56 program. All cows were inseminated by the same staff and were checked for pregnancy diagnosis using transrectal ultrasonography (7.5 MHz linear-array transducer, KAI XIN KX5100, Xuzhou Kaixin Electronic Instrument Co., Ltd., China) on days 27–30 following insemination.

2.2. Experiment design

The study was conducted as a controlled and randomized clinical trial between January and April 2015. In the study, 76 cows were randomly assigned to one of two groups: a study group (n = 35) and a control group (n = 41). All cows in each group were housed together in separate barns, each group being fed the same TMR ration under the same conditions. The study group orally received a cylindrical device (Kexxtone, ELANCO Animal Health, Guelph, ON, Canada), which remained in the rumen and continuously released 32.4 g of monensin (equivalent to 35.2 g of monensin sodium), at 21 ± 3 days prior to expected calving. The control group received no treatment.

2.3. Data collection

Data on feeding were collected by technical staff using Microsoft Excel software and on-farm data sheets; data on milk yield and reproduction were collected using computerized software records. Alpro Windows (Version 6.93; DeLaval, Tumba, Sweden), herd management software, was used to retrieve and verify the milk yield and reproductive outcomes. The peak milk yield and total

Table 1. Ingredient levels in rations (%, dry matter basis) of precalvers[a], fresh cows[b], and high-yielding cows[c].

Levels (%; DM basis)	DM (%)	Precalvers[a]	Fresh cows[b]	High-yielding cows[c]
Corn silage	33	34.32	19.44	22
Alfalfa hay	89	-	21.02	14.46
Wheat straw	92	36.06	1.02	1.15
Commercial compound 1	87	6.96	12.17	13.78
Commercial compound 2	88.93	4.27	16.37	18.53
Corn flake	88.80	-	12.42	14.06
Corn gluten	90.8	3.63	2.79	-
Wet brewers grain	26	14.56	6.7	7.58
Soy hulls	87.5	-	4.83	5.47
Bypass fat fract.	99	-	1.82	2.06
Premix	99.5	0.4	-	-
Sodium bicarbonate	99.5	-	0.61	-
Rumen buffer	95	-	0.42	0.48
NitroShure	99.5	-	-	0.58
Bypass choline	98	-	0.36	-

[a] In the last 3 weeks of pregnancy; [b] from calving to DIM 30; [c] grouping according to milk yield after DIM 30.
DM: Dry matter; NitroShure is an encapsulated urea supplement (Balchem Corp., New Hampton, NY, USA).

milk yield at 30, 45, and 60 days postpartum were obtained using the herd management software.

Reproductive variables were the interval from calving to first service, conception rates, days from calving to pregnancy, days of 1st AI (defined as calving-to-first AI interval), and days open (defined as calving-to-conception interval). Cows that had not become pregnant after >250 DIM were culled.

The quantity of total TMR was determined according to the number of animals and daily feed consumption. The orts were measured. Mixtures of TMR and orts were obtained by using a randomized sampling method. The dry matter analysis of the mixtures was separately conducted by using a moisture analyzer (Shimadzu MOC63u, Shimadzu, Kyoto, Japan) and the findings were recorded. The mean daily DMI per cow was calculated according to the following formulas and recorded:

TMR feed (kg) × dry matter of TMR (%) – ort (kg) × dry matter of the ort (%) = consumed dry matter (kg)

Consumed dry matter (kg) / number of animals = mean DMI per animal

2.4. Statistical analysis

The Kolmogorov–Smirnov test was used to determine whether or not the data of the study were normally distributed. We used the Mann–Whitney U test in order to evaluate the data (number of lactations and age) not normally distributed. When data were normally distributed (total milk yield at 30, 45, and 60 DIM; peak milk yield; days of 1st AI; days open), the Student t-test was used. The chi-square test was used to analyze the categorical variable (culling rate). Monthly DMIs of the study and the control group cows were analyzed by general linear models with Bonferroni adjustment. All statistical analyses were performed using SPSS for Windows, and $P < 0.05$ was the significance cut-off.

3. Results

3.1. Dry matter intake

The monthly mean DMI was lower for the study group than for the control group in the postpartum 1st, 2nd, and 3rd months ($P < 0.001$; Table 2).

3.2. Milk yield

Peak milk yield and total milk yield at 30, 45, and 60 DIM for the study and the control group were similar ($P > 0.05$; Table 3).

3.3. Reproductive parameters

Day of 1st AI and days open for the study group (86.31 ± 2.36 days and 109.44 ± 5.23 days, respectively) were not different ($P > 0.05$) from those for the control group (80.37 ± 2.93 days and 108.38 ± 8.83 days, respectively). Additionally, the reproductive culling rate was also similar between the groups ($P > 0.05$; Table 4).

4. Discussion

There are different views about the effect of monensin on milk yield. Melendez et al. (11) determined that cows receiving monensin supplementation have higher milk production. However, it was also found that monensin administration did not affect the mature equivalent 305-day milk yield. It was claimed that the positive effects of monensin on milk yield can be associated with the body condition score (BCS) values at parturition. Similarly, Duffield (12) detected that the administration of monensin

Table 2. Comparison of average DMI (mean ± SEM; kg).

	1st month	2nd month	3rd month	Estimated marginal means
Study group	9.58 ± 0.98	13.12 ± 0.67	16.57 ± 0.68	17.85 ± 0.35
Control group	14.99 ± 0.85	17.38 ± 0.58	21.18 ± 0.59	13.09 ± 0.4
Estimated marginal means	12.29 ± 0.65	15.25 ± 0.44	18.87 ± 0.45	-

Group: $P < 0.001$; time: $P < 0.001$; group × time: $P = 0.751$.

Table 3. Comparison of milk yield between the groups (mean ± SEM).

	Study group	Control group	P-value
Peak milk yield	46.04 ± 0.95	44.91 ± 0.72	>0.05
30 DIM total milk	888.13 ± 35.91	933.88 ± 20.74	
45 DIM total milk	1491.21 ± 43.53	1533.06 ± 26.06	
60 DIM total milk	2087.59 ± 55.18	2173.42 ± 34.88	

Table 4. Comparison of reproductive parameters in the groups (mean ± SEM).

	Study group	Control group	P-value
Days of 1st AI (days)	86.31 ± 2.36	80.37 ± 2.93	>0.05
Days open (days)	109.44 ± 5.23	108.38 ± 8.83	
Reproductive culls (%; n/N)	22.9 (8/35)	36.6 (15/41)	

markedly increased the milk yield in cows with high BCS at 3 weeks before calving. They also found that the effect of monensin was related to the BCS in the prepartum period. Interestingly, Melendez et al. (7) showed that there was an increase in dystocia rates in cows treated with monensin. The researchers claimed that this was due to the following reasons: long-term monensin administration can increase the BCS and thus the pelvic adiposity at calving, or it can lead to delivery of calves with higher body weight depending on the increase in the glucose metabolism in the dam. In another similar study (13), it was found that monensin led to increases in the milk yield only in multiparous cows that had placental retention. High BCS at parturition causes an increase in dystocia rates and complications in the early postpartum period. This can negatively affect the milk yield. In our study, monensin administration did not affect the milk yield. We were not expecting such a result, so we did not evaluate the BCS and early postpartum disorders. However, various researchers have specified that some other factors such as herd (14) and the genetic merit of cows (15) can also affect milk yield.

Duffield et al. (8) conducted a metaanalysis study and determined that conception rate in the first insemination was not affected by monensin administration. Gallardo et al. (16) stated that the monensin-releasing capsule increased the pregnancy rate in the first service. However, previous studies (17,18) showed that it did not affect the reproductive performance. It is known that the energy balance in the postpartum period is closely related to fertility and the method of nutrition directly affects the energy balance.

There are conflicting results related to the effects of monensin on DMI. In some studies (19–21), it was shown that monensin did not affect the DMI, whereas others (22,23) showed opposite results. Peterson-Wolfe et al. (24) determined that cows administered monensin were more prone to consume dry matter compared to those that did not receive it. Interestingly, even though Zahra et al. (25) claimed that there was a relationship between the monensin-releasing capsule use and high BCS values, they also stated that the DMI was not affected in cows with normal or high BCS. According to the metaanalysis studies of Duffield et al. (26), it was specified that monensin administration decreased the DMI by as much as 2%. Even though these results were similar to our findings, those researchers evaluated together different studies in terms of feeding type (pasture or TMR) and type of monensin (top-dress, TMR, or CRC). In our opinion, the difference in feed type and type of monensin administration can lead to different outcomes. Similarly, some researchers (20,27) claimed that the effect of monensin can be changed according to feeding type. For instance, Duffield et al. (28) showed that monensin had better effects on the reduction of BHBA levels in pasture-based cows. On the other hand, Oba and Allen (29) stated that the effects of monensin on DMI depended on increased propionate needs and the glucose needs of the mammary gland for milk production.

The lacking effect of prepartal monensin administration on reproductive performance is in agreement with the literature. Unlike previous studies, we did not evaluate the BCS and reproductive disease history of the cows. Duffield et al. (30) determined that the monensin-releasing capsule did not affect the conception rate in the first insemination. There are also other studies (7,13) with similar findings. In one of these studies (7), it was shown that the monensin-releasing capsule did not affect the conception rate in the first service, pregnancy rate, or the calving-to-conception interval. However, it was stated that the administration of the capsule positively affected the conception rate in the first insemination and the calving-conception interval in cows with BCS of ≥2.75. The other study (13) stated that the conception rate in the first insemination did not change, whereas the placental retention history affected the outcome. It was reported that BCS (7) and placental retention (13) history can change the efficiency of the monensin-releasing capsule.

In conclusion, monensin-releasing capsule administration in the prepartum period decreased the DMI in the postpartum 1st, 2nd, and 3rd months. Furthermore, it did not have any effect on total milk yield, peak milk yield, days of 1st AI, days open, or culling rate. Further studies should consider carry-over effects of BCS and monensin interaction.

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