Eurasian Journal
of Veterinary Sciences

www.eurasianjvetsci.org

RESEARCH ARTICLE

The effect of different quality bedding materials used in dairy cows on milk yield

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Received:27.07.2020, Accepted: 30.11.2020
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Sağmal ineklerde kullanılan farklı kalitedeki yatak malzemelerinin süt verimine etkisi

Eurasian J Vet Sci, 2020, 36, 4, 347-354
DOI: 10.15312/EurasianJVetSci.2020.318

Öz

Amaç: Bu araştırma, farklı kalitedeki yatak malzemelerinin kullanımının sağmal ineklerin süt verimleri üzerine olan etkisinin değerlendirilmesi amacıyla yapılmıştır.

Gereç ve Yöntem: Araştırmanın materyalini, farklı yaşlarda bulunan 92 baş Holstein ırkı sağmal inek, bu ineklere ait 365 gün süreyle alınan süt ve görüntü kayıtları oluşturmuştur. Çalışmada 3 farklı tip yatak malzemesi kullanılmıştır. Bunlar 1. tip (mattress), 2. tip (mat) ve 3. tip (lastik paspas) olarak gruplandırılmıştır. Her grupta minimum 30 inek bulunmaktadır.

Bulgular: Araştırma sonucunda; serbest duraklı ahırlarda yetiştiriciliği yapılan ineklerin mattress yatak malzemesinde süt verimleri daha yüksek bulunurken mat yatak malzemesinde ise yatma sürelerinin daha fazla olduğu bulunmuştur.

Öneri: İşletmeler yatak malzemesi olarak birçok farklı ürün (sap, saman, beton, kum, mat, matress, vb.) kullanmaktadır. Hayvanlar dinlenmek ve yatmak için daha yumuşak, kuru ve konforlu alanları tercih ederler. Dinlenme ve yatma sürelerinin artması süt verimini olumlu yönde etkileyerek verimin artmasını sağlar. Dolayısıyla işletmelerin hayvanlara konforlu ve rahat bir alan sağlaması verimlilik açısından önem arz etmektedir. Tüm bunlar dikkate alındığında işletmelerde mattress yatakların kullanılması önerilmektedir.

Anahtar kelimeler: İnek yatağı, süt verimi, konfor, mattress

Abstract

Aim: This research was carried out to evaluate the effect of using different quality bedding materials on milk yields of dairy cows.

Materials and Methods: The study material consisted of 92 head Holstein breed dairy cows of different ages and milk and video recordings of these cows for 365 days. In the study, 3 different types of bedding materials were used. These are grouped as type 1 (mattress), type 2 (mat) and type 3 (rubber mat). There is a minimum of 30 cows in each group.

Results: As a result of the research; It was found that milk yield was higher in mattress bed material of cows raised in free stall barns, while lying time was longer in mat bedding material.

Conclusion: It uses many different products (straw, straw, concrete, sand, mat, matress, etc.) as bedding material in animal husbandry enterprises. Animals prefer softer, dry and comfortable areas to rest and lie down. Increasing rest and lying times affects milk yield positively and increases yield. Therefore, it is important in terms of productivity that enterprises provide animals with a comfortable and comfortable space. Considering all these, it is recommended to use mattress beds in enterprises.

Keywords: Cow beds, milk yield, comfort, mattress

Introduction

Recently, cow beds that are common in the world have been increasingly used in dairy cow businesses in Turkey. Thanks to this increase, the level of welfare and comfort conditions offered by businesses to cows increase as well. The cows spend more time lying on the comfortable areas offered to them, and their stress levels decrease due to increased welfare. Decreased stress and prolonged bedtime also affect the yield of cows positively. There are many different types of bedding materials (mattress, mat, sand, compost, straw, sawdust, concrete, etc.) used in the free stalls of dairy cows (Tucker et al 2003, Fulwider and Palmer 2004, Calamari et al 2009, Ferraz et al 2020, Leso et al 2020). It is desirable that the bedding materials to be used are economical, provide a comfortable lying area, tolerate moisture, keep the animals clean, fulfill the task of bedding and reduce the labor force (Boone et al 2009, Ruud et al 2010, Mitev et al 2012). There are a number of factors to be considered in the use of these beds. These include encouraging cows to lie down, good thermal insulation, the potential of low maintenance requirements and low bacterial growth (Boone et al 2009). If the selection of the ideal bed material for the cows is taken into consideration when designing the stalls, the problems that may be encountered later will be easy to solve. Materials such as straw, sawdust, sand, etc. used as bedding material in the stalls, accumulate at the stall and prepare the environment for bacterial growth, foot diseases and mastitis, as a result can reduce milk yield (Greenough 2007). The effect of different bedding materials on the general behavior of cows is of interest to researchers (Fregonesi et al 2007, Sutherland et al 2013, Sinha et al 2017, Tullo 2019, Liu et al 2020).

It is known that cows' lying time in a relaxing and comfortable area will affect milk yield. This effect is attributed to the increased blood flow to the udders when the cows lie down. It is reported that the blood flow to the udders of the lying cows is 28% higher than the standing ones (Metcalf et al 1992, Oord 2019). In addition, there is 5 liters of blood flow per minute to the udders of the lying cows, while 3 liters of blood flow per minute to the udders of the standing cows. It is stated that cows increase their bedtime in the stalls with a soft surface between 1.8 and 4.0 hours per day compared to concrete surfaces and that soft surface stalls have higher milk yield (Fregonesi et al 2007, Temple et al 2016).

Decrease in cows' lying times is associated with stress (Ladewig and Smidt 1989, Nordlund et al 2019). In addition, it is reported that too much reduction in bedtime may be caused by differences in the circulatory system (Munksgaard and Løvendahl 1993). These differences may lead to a decrease in milk production, especially for young and growing ones (Hart et al 1978).

The cows' lying behavior is related to their preference for bedding material. They make this choice by turning their heads left and right in a way that their noses are close to the ground. In addition, dairy cows spend less time on head turning behavior on surfaces where they lie more and have a higher total lying time (Tucker et al 2003, Schütz et al 2019).

The beds used in dairy cow enterprises have been the subject of various preference tests. In the studies on this subject, bedding materials have been compared in different ways (Haley et al 2000, Fulwider and Palmer 2004, Drissler et al 2005, Kara et al 2015). The common result of the studies has been that dairy cows preferred "soft" surfaces more (Chaplin et al 2000, Manninen et al 2002).

Calegari et al. (2012), stated that cows may have higher milk yields in beds with sand compared to those without sand.

Herlin (1997) examined three different bedding materials (concrete floor, conventional rubber mat and a soft rubber mat) and concluded that cows preferred beds that were more comfortable (a soft rubber mat) to lie than the others.

Researchers in other study, compared four different bedding materials. While the stalls where the beds were covered with sawdust were mostly preferred by the cows to lie, the paper-covered concrete stalls were least preferred ones (O'Connell and Meaney 1997).

Gebremedhin et al (1985) stated that cows are more likely to lie as a result of using more bedding material at the stalls.

It is stated that similar results have been reached in the studies by different researchers and that cows prefer soft-surface stalls more (Herlin 1997, Smid 2019).

In summary, stall usage results show that cows spend more time lying in comfortable and soft stalls. However, the long-term effects of the issues such as health, production and stall management need to be known in order to make conscious decisions about stall design (Tucker and Weary 2001).

In this study, it was aimed to determine the most suitable bedding material by examining the effects of different quality bedding materials on milk yield of dairy cows.

Material and Methods

The study was conducted in a private dairy cow enterprise located in Karapınar district of Konya. The data was began to be examined on 01.1.2018 and finalized on 31.12.2018. Dairy cows in the same section of the enterprise were divided into 3 groups. The number n of each group in free stalls was arranged to be at least 30. In total, the number of cows used

was 92. As feed material, the groups were fed adlibitum with ration containing feed raw materials at the same rate (Table 1). The water needs of the cows were met individually from the automatic waterers.

Table 1. Ratio of raw materials used in ration

Nutrients	Kg
Straw	1.00
Clover	4.00
Clover silage	7.00
Cottonseed	1.50
Barley	1.50
Soy	1.75
Corn silage	17.00

Different quality bedding materials were mounted to the free stalls in the barn and 3 different quality stall floors were obtained. The bedding materials mounted in the stalls were taken from a commercial company in Konya.

The 1st bed type has 3 layers, a thickness of 3,2 ± 0,2 cm and a weight of 50 - 55 kg (Figure 1). There is a bondex sponge as the third layer between the rubber layers at the top and bottom of this bed. Thanks to the sponge, it is aimed to provide a softer and more comfortable area.

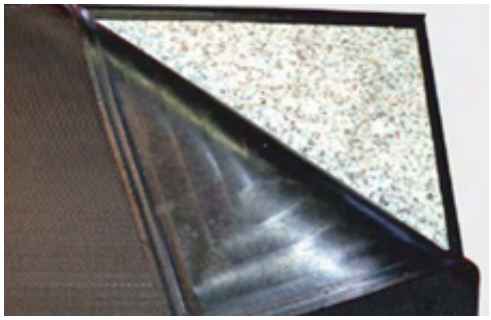

Figure 1. Photo of type 1 bed

The 2nd bed Type has a structure with a single layer. The bed has a thickness of 2.2 ± 0.2 cm and a weight of 30-32 kg (Figure 2).

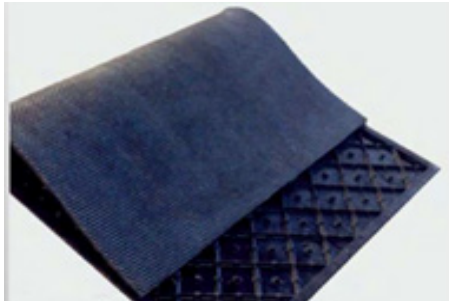

Figure 2. Photo of type 2 bed

The 3rd bed type has 1 layer like the 2nd bed type. It has a thickness of 10-12 mm and a weight of 10 kg (Figure 3).

Figure 3. Photo of type 3 bed

The research was carried out in three stages: determination of cow behavior and observation methods, establishment of live imaging system and measurement of values, and recording observations. In previous studies, it was stated that dairy cows in early lactation period had more health problems. Therefore, in this study, the evaluation was carried out by excluding the early lactation period of dairy cows (Ingvarsten 2006, Steensels et al 2012).

The individual milk yields of the cows in the study were taken on a certain day of each week from the herd management program used by the farm. Calculations were made by excluding the milk yields of the cows taken during the first 40 days after birth called as fresh period. In the study, there were cows with a longer or shorter lactation period than 305 days. Therefore, the standard lactation period was evaluated as 305 days, lactation milk yields were calculated by applying correction factor according to 305 days (Table 2) (Kendrick 1955). In this calculation, the milk yields of cows with lactation period less than 305 days and the milk yields of cows that automatically went dry were considered as 305-day milk yield (Alpan and Aksoy 1990). Milk yields of cows removed from the groups before 305 days due to reasons such as reformation, disability, disease, compulsory slaughter and death and the milk yields of the cows that went dry were evaluated using factors of correction according to 305 days (McDaniel et al 1965). In addition, since the daily milking number was 2 and 3 in the study groups, the factors of converting 3 milking yield per day to 2 milking were applied in order to standardize the milking number (Table 3). Another correction factor was the application of correction factors to the milk yield of cows in different ages according to the adult age (Table 4) (Alpan and Aksoy 1990). Some researchers (Schneeberger 1980) stated that the effect of age of dairy cows on milk yield was statistically significant, while others (Vanlı et al 1993) stated that it was insignificant (Özbeyaz et al 1996). It is suggested that the effect of seasons on milk yields is significant (Ray et al 1992). The data were analyzed using SPSS 25 package program.

Table 2. Conversion coefficients to 305-day yield

Day	Coefficients	Day	Coefficients
305-308	1.00	337-340	0.92
309-312	0.99	341-344	0.91
313-316	0.98	345-348	0.90
317-320	0.97	349-352	0.89
321-324	0.96	353-356	0.88
325-328	0.95	357-360	0.87
329-332	0.94	361-364	0.86
333-336	0.93	365	0.85

Table 3. Milking correction coefficients

Number of days milking 3 times	3-4 years old cows	Cows 4 years and older
-45	0.98	0.98
46-65	0.97	0.97
66-85	0.95	0.96
86-105	0.94	0.95
106-125	0.93	0.94
126-145	0.93	0.93
146-165	0.92	0.93
166-185	0.91	0.92
186-205	0.90	0.91
206-225	0.89	0.90
226-245	0.88	0.89
246-265	0.87	0.88
266-285	0.86	0.88
286-305	0.85	0.87

The "Least Squares Method" was used for all of the yield parameters examined in the data. For the evaluated milk yield parameters;

A sum model such as $Y_{ijkl} = \mu + a_i + b_j + c_k + d_l + e_{ijkl}$ was used.

In this model; Y_{ijkl} = Dependent variables, μ = Expected population average, a_i = The effect of yield year (i = 1,2,... 8; 1987,1988...., 2018,2019 years), b_j = The effect of the number of lactations (j = 1., 2., ... 7, 8. Lactation), c_k = The effect of age (k = 2,3,..., 8,9 and older) , d_l = The effect of the season (l = 1,2,3,4; winter, spring, summer, autumn) e_{ijkl} = Error (Özbeyaz et al 1996).

Statistical analysis

SPPS 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) statistical package program was used to evaluate the data. Average ± standard deviation, Median (Maximum-Minimum) percentage and frequency values were used in the variables. The suitability of the data for the analysis of variance in factorial order was evaluated with multivariate normal distribution and the Homogeneity Test of Box-M Variances. Variance analysis in factorial order was used for comparisons of means. If the parametric tests (variance analysis in factorial order) do not meet the prerequisites, the data was recovered with box cox data transformation and the variance analysis in the factorial order was used with the converted data obtained. Multiple comparisons were made with the Corrected Bonferroni Test. The relationship between the two variables is evaluated with the Pearson Correlation Coefficient and the Spearman Correlation Coefficient when it does not meet the prerequisites for parametric test. For the significance level of the tests, ($p < 0.05$) important, ($p < 0.01$) very important, ($p < 0.001$) very very important value was accepted.

Table 4. Correction coefficients according to adult age

Age (Year- Month)	Coefficient	Age (Year-Month)	Coefficient
2-0	1.27	6-0	0.97
2-3	1.22	6-3	0.97
2-6	1.19	6-6	0.97
2-9	1.16	6-9	0.97
3-0	1.13	7-0	0.97
3-3	1.09	7-3	0.97
3-6	1.07	7-6	0.97
3-9	1.05	7-9	0.97
4-0	1.03	8-0	0.98
4-3	1.02	8-3	0.98
4-6	1.00	8-6	0.98
4-9	0.99	8-9	0.99
5-0	0.99	9-0	0.99
5-3	0.98	9-3	0.99
5-6	0.97	9-6	1.00
5-9	0.97	9-9	1.01

Table 5. Analysis of the values obtained according to the data

					95% Confidence Interval for Mean			
		n	Mean	Std. Deviation	Lower bound	Upper bound	Min.	Max.
Milk yield (lt)	1. Type	365	18,36	0,17	18,03	18,70	10,700	28,28
	2. Type	365	17,69	0,18	17,35	18,04	9,96	26,43
	3. Type	365	14,93	0,14	14,65	15,20	7,51	21,81
	Total	1095	16,99	0,10	16,79	17,20	7,51	28,28

ANOVA Analysis		Sum of squares	df	Mean square	F	Sig.
Milk yield	Between groups	2426,83	2	1213,42	123,74	0,001
	Within groups	10708,57	1092	9,81		
	Total	13135,40	1094			

Bonferroni						95% Confidence Interval for Mean	
Dependent varible			Mean difference	Std. Deviation	Mean	Lower bound	Upper bound
Milk yield	1. Type	2. Type	,66984*	0,23	0,012	0,11	1,23
		3. Type	3,43923*	0,23	0,001	2,88	4,00
	2. Type	3. Type	2,76940*	0,23	0,001	2,21	3,33

* The mean difference is significant at the 0.05 level

Results

Each animal in the study was photographed and videotaped. Thanks to these records, an excel sheet was created for each cow, milk yield and bedtime were added. The length of the bed was calculated daily, and then the total duration was calculated. Milk yields were taken daily from the herd management program used by the enterprise. The statistical analysis results made with the data obtained at the end of the study are presented in the table.

In terms of milk yield, statistically highly significant differences ($p < 0.001$) were found between the groups of bed types. There was a statistically significant difference between the 1st, 2nd and 3rd type of beds (Table 5).

There was a statistically significant difference between the 1st and 2nd, 1st and 3rd bed types and 2nd and 3rd bed types (Table 5).
In the corrected data, the highest milk yield in the group averages (per animal) was determined in the cows in the 1st bed type during the observation period (365 days). This was followed by cows in the 2nd bed type and cows in the 3rd bed type. Average yields of cows in the 1st bed type increased by 3.43 liters compared to cows in the 3rd bed type and by 0.67 liters compared to cows in the 2nd bed type.

According to the findings obtained with the corrected data, it was determined that the animals lying in type 2 bed had the highest bedtime with an annual average value of 11 272 minutes. The bedtime of the cows with other beds; It was found to be 9 851 minutes in cows in type 1 beds and 6 063 minutes in cows in type 3 beds.

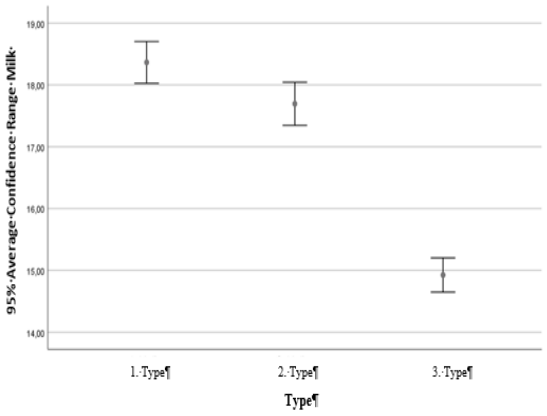

Figure 1. Relationship between milk yields and bed types

Discussion

The fact that milk yield of cows varies according to bed types differs from the previous studies. Chaplin et al (2000) found that the average daily milk yield of cows lying on two different mattresses was 25.3 liters and 28.7 liters, while those l lying on two different mat beds were found to be 24.8 liters and 30.8 liters. Although the researchers found the milk yield of cows lying on mat beds to be partially higher, the milk yield of cows lying on mattress beds was higher in our study. Norberg (2012) found that the average daily milk yield of cows lying on the rubber bed was 32.2 liters. In our study, the daily average milk yield of cows lying on mattress bed (type 1) was found to be the highest value with 18.36 liters in the corrected data. The average daily milk yield of cows lying on mat bed (type 2) was found to be 17.69 liters, the average daily milk yield of the cows lying on rubber mat (type 3) was found to be 14.93 liters (Graphic 1). In other studies, it was stated that bed quality was not the only factor in these differences (Algers et al 2009). Shelter management, shelter planning, location of stalls within shelter and climatic conditions are also effective in these differences. In previous studies, it was reported that cows lying on beds with soft surfaces had higher milk yield than cows lying on beds with hard ground (Greenough 2007, Rauw et al 1998). The results of this study are similar to these statements. Significance value between bedding types and milk yield in all beds was statistically highly significant ($p < 0.001$).

When these kinds of studies were examined, it was seen that the animals were not observed continuously, the video recordings were intermittent, the number of animals was low, and the group value was calculated based on a few animals while evaluating. In this study we conducted, animals were constantly observed, video recording was taken, the number of animals was kept high, the values of each animal in the study were calculated and the group average was found.

Conclusion

When the milk yields were examined in the corrected data obtained as a result of the research, the highest value was found in cows in the 1st bed type with 18.36 liters. This was followed by 17.69 liters in the 2nd bed type and 14.93 liters in the 3rd bed type. The fact that the highest milk yield average was found in cows the 1st bed type is consistent with the idea that, as other researchers stated, soft surface beds increase the comfort level and provide higher milk yields.

It uses many different products (straw, straw, concrete, sand, mat, matress, etc.) as bedding material in animal husbandry enterprises. Animals prefer softer, dry and comfortable areas to rest and lie down. Increasing rest and lying times affects milk yield positively and increases yield. Therefore, it is important in terms of productivity that enterprises provide animals with a comfortable and comfortable space.

Acknowledgement

This article has been prepared by the doctoral theseis of the first author.

Conflict of Interest

The authors did not report any conflict of interest or financial support.

Funding

This work was supported by Scientific Research Projects Coordination Selcuk University (Project number: 17102022).

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Ethical Approval

Approval of the study was obtained from institutional ethics board of the Veterinary Faculty Selcuk University (No: 2017/50).

CITE THIS ATRICLE: *Erzurum O, Yılmaz A, 2020. The effect of different quality bedding materials used in dairy cows on milk yield. Eurasian J Vet Sci, 36,4 347-354*