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EFFECTS OF SEASONAL BEDDING MATERIALS CHANGE ON DAIRY PRODUCTION

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ABSTRACT

The aim of this research was to answer the question if the seasonal cow's bedding changes are indifferent to dairy production. The research was held in two different Wielkopolska farms which had very high milk productivity. In one of the farms, the cow's beddings, were located indoor, and in the second one outdoor under the roof. The autumn's change from sand into straw and spring's from straw into sand are either indifferent to milk productivity or they have positive influence.

Introduction

Most frequently straw functions as bedding in a free-stall daily cowshed. Sand or other materials such as sawdust and shavings, scrap paper or paper mass, including granulated, straw with hydratyzed lime, compost, rubber mats etc. and even very expensive water mattresses are used as a substitution (Bedding options for dairy cows). Recently, information on harmful use of sawdust, which causes mastitis disease in relation to presence of a considerable number of intestinal bacteria *Klebsielli*, have been reported (Neja, 2013). Sand may come from a mine or be obtained from crushed rocks. In such form it is sharper. Diameter of its grains should be up to 3 mm. According to American recommendations a layer of sand in stalls should be 6-8 inches thick (approx. 15-20 cm) (Gooch and Inglis). Non-organic bedding, containing lower number of pathogens is less responsible for mastitis. According to Zdanowicz's research (2002) the number of bacteria cells occurring in the end of tits is related to their number in the bedding. Coefficients of correlation for the straw bedding are within +0.47 to 0.60 and for sand are slightly lower and are within +0.35 and + 0.40. A stall, which ensures welfare, influences long rest of a cow. Due to this, blood flow through an udder increases by 20-30%, which raises milk secretion (Osborne, 2012). According to Adamski and Zabłocka (2003) when a cow remains in a standing position for a long time, pressure in its cloven hooves increases, which reduces blood flow and leads to lameness. Sand beddings are slippery, therefore it results in a lower number of injuries and swelling of ankle joints and wrists in case of cattle occur very rarely (Rodenburg, 2000).

Moreover, sand helps to heal cloves faster (Norring et al., 2008). Dutch farmers pay attention to advantages of the mixture of cut straw and sand, which they use to cover stalls in cowsheds equipped with milking machines, which ensures a good condition of cows' limbs (Jonckers, 2011). Kaczor et al. (2011) stated that based on the research, the number of somatic cells in milk of cows, which rest on straw-lime beddings is lower in spring and summer, however, on sand it is lower in autumn and winter. Rodenburg (2000) also pays attention to a lower number of somatic cells in milk of cows maintained on sand. The advantage of sand beddings is that in summer their temperature is almost by 2ºC lower than the temperature of air, which advantageously influences thermal comfort of animals. It is confirmed by Gooch and Inglis. Cook claims that a cow should stay in a stall 12 hours a day. This time is shortened by a prolonged milking, which lasts over 3 hours. Cows prefer to rest in straw stalls than in the sand stalls. Moreover, sand has its disadvantages, because it damages machines by rubbing their working elements and when it is not used carefully it clogs up drain system (Gooch and Inglis). The joint paper written by Buli et al. (2010) is a valuable piece of literature on the knowledge of bedding and laying cowsheds. These authors carried out detailed literature studies and they included 113 mainly English publications from around the world.

The objective and the scope of the study

A temporary shortage of bedding straw is a milk producers' problem. It may be easily replaced with sand, but production outcomes of seasonal replacement have not been well recognized in Poland. Thus, the objective of the research was verification of the hypothesis that in high-performance cowsheds with stalls for cows, located indoor as well as outdoor, a seasonal replacement of sand bedding with straw and reversely is neutral for animals and does not cause any changes in their milk productivity. A cow farm with outdoor stalls was in the centre of special interest, the sense of which was to protect cattle against the effects of heat stress (Chaberski et al., 2012).

Methods

The research was carried out in two farms of dairy cows: in the end of April 2012 and in the end of autumn and beginning of winter 2012 and in two first days of 2013. Both farms are located in Wielkopolska, they belong to one, big farm and are managed by the same person. In farm B with inside stalls, usually ca. 360 dairy cows were maintained. In farm S, with outdoor stalls, there were ca. 240 cows. Including dry cows, heifers and calves, the number of cattle in the entire farm was in total 1400. Annual productivity of cows was high and reached 11, 000 kilo of milk, which places the farm at a high position on the list of the best milk producers in the country (Ocena wartości użytkowej ...., 2013).

Farm B and S differ considerably since in farm B stalls for cows are located inside cowsheds, and in farm S outside under the roofs. Thus, microclimate conditions are not identical. Lairs in farm B are of the following dimensions 112x245 cm at the threshold height of 17 cm and in farm S it is respectively 120x230 and 12 cm. In both farms stalls are laid alternatively with straw or sand, relatively to the season. At the beginning of April, straw is

removed and laid with fossil sand. In December, sand is removed and replaced with straw. Photo 1. presents stalls for cows in farm S during spring replacement of straw with sand.

Figure 1. Spring bedding change in farm S (end of April, 2012)

For analyses of the impact of bedding change on the milk production a collected documentation was used. Figure data referring to a daily milk production in farm was calculated into average daily milk production from 1 milked head. Thus, disturbances which were frequently caused by a changing number of milked cows, resulting from their physiological preconditions were eliminated (birth, drying, culling etc.). For statistical calculations everyday data were applied (10 days before and 10 days after the bedding change) and weekly data including milk production 4 weeks before and 4 weeks after the change. The process of change of bedding lasted relatively to a farm – 9 or 10 days. Milk productivity of cows in transitory periods was not the subject of interest.

Daily productivity of cows in time before and after the replacement of straw with sand in stalls and reversely was statistically compared by means of analysis of variance. The authors' software was applied basing on the method described by Ruszczyc (1981). Test F was used for assessment of the significance of statistical differences between the investigated groups.

Moreover, climatic conditions in the time of analyses were checked. For this purpose meteorological data available in the Internet from a near station of permanent control in Krzyżowka, located approximately 20 km from both farms were used (Air control for Wielkopolska region).

Based on farm documentation average consumption of bedding - straw and sand were determined. Results were referred to a single stall.

As a part of the research, a single, random assessment of correctness of cow feeding was carried out on account of a proper balancing of components of TMR fodder performed by mixing fodder machines. Feeding in a farm is mono-diet and stable as to the mixture. Results of analysis of collective milk, including the content of fat, protein and urea were compared with normative data quoted in Fleszar's (2012) and Lipiński's and Winnicki's (2013) works. Chemical analyses were carried out by the Polish Federation of Cattled Breeders and Milk Producers.

Results

During decades subsequent to and following the periods of bedding change, the cows' milkability was partially varied. Table 1 contains results of statistical calculations. Weather was typical with no extremities. Average daily speed of winds was in spring within 0.2 to 2.9 $m \cdot s^{-1}$ and in late autumn and in winter within 0.4 to 2.7 $m \cdot s^{-1}$.

Table 1
The impact of seasonal bedding change on dairy production in 10 days before and after

Stall bedding change	Parameters	Farms	
		B (inside stalls)	S (outside stalls)
Straw replaced with sand (spring)	Before the bedding change		
	- average daily cows' milkability (1)	30.4	33.1
	- standard deviation (1)	0.7	0.5
	After the bedding change		
	- average daily cows' milkability (1)	32.2	33.1
	- standard deviation (1)	0.7	0.6
	Value of coefficient F	34.5 **	0.03
Sand replaced with straw (autumn/winter)	Before the bedding change		
	- average daily cows' milkability (1)	30.2	33.9
	- standard deviation (1)	0.6	0.4
	After the bedding change		
	- average daily cows' milkability (1)	30.3	34.8
	- standard deviation (1)	0.6	0.8
	Value of coefficient F	0.03	10.5 **

In the spring time, it was reported that in farm B with inside stalls, transfer from straw to sand is advantageous and the increase of cows' milkability is noticeable. Before the change during 10 days, at the average 30.4 l of milk daily was obtained from a cow and

after – 32.2 l. This difference is statistically highly significant. This phenomena may be justified by more advantageous thermal conditions (inter alia with slightly cooler stalls), since dairy cows prefer lower temperatures (Chaberski et al., 2012; Rodenburg, 2000). In farm B autumn-winter change of sand does not result in the change of cows' milkability. In case of farm S the situation is different. There, after the change of sand into straw, a daily milk production increased from 33.9 to 34.8 l from a statistical cow. Differences are also statistically considerably significant. However, there are no differences in spring, where sand replaces straw in stalls. Laying of outside stalls with straw in autumn may improve general conditions of the animals' rest and as a result cause increase in milk production.

Consideration of production effects of bedding change in longer, monthly time horizons brings similar results. In farm B before a spring bedding change of straw into sand, an average daily milk production in a month was 30.3 l and after the change – 31.3 l. However, these differences are not statistically significant ($F_{calc.}$=3.29, is lower than the table one, which is $F_{tab.}$=5.12). The source of insignificance of differences is obviously a small number of freedom degree. Almost the same is at the replacement of sand with straw, when average milk production before the change is 30.0 and after – 30.7 l of milk at the average from a cow. Bedding change in farm S with outisde stalls from sand into straw (autumn/winter) is obviously advantageous. Milkability increases from 34.1 to 35.0 l of milk from cow daily, differences are statistically highly significant (F=18.15).

In the light of the above, a hypothesis placed in the objective of this paper, partially was not confirmed. Changes in cows' milkability occur after seasonal bedding change: sand - straw, straw- sand and what is the most important they may be advantageous for milk producers. Milk secretion in cattle herds increases or does not change. Possibility of almost neutral for cattle, alternative use of both bedding materials allows more rational management of straw. Many years ago Gawarecki (1862) recommended: “maintaining cattle even in summer on richer green fodder and laying soil underneath in order to save straw for the whole year will considerably improve the national breed of cattle”.

In farms 600 kg of sand and 9 kg of straw is used for first bedding of a stall. Sand is later added in lairs every two weeks in portions 60-70 kilo. Straw is spread every day, consuming 1.5-2.0 kilo for one stall. Price of a tonne of sand is PLN 20 and straw PLN 250. Research carried out by Gaworski (2008) indicate possibility of using slightly bigger amount of sand: 6.6-28.2 kg·day^{-1} and 3-5 kg of straw per day. The American add sand in stalls every second day and they rinse the hall with water (Mirek and Pustuła, 2010). In the USA, according to Rodenburg (2000), costs of laying stalls with sand are 8-10 USD·tonne^{-1}, and with straw 40-50 USD·tonne^{-1}. When comparing costs incurred for beddings in our investigated farms and in American farms one may say that they are quite similar.

In case of feeding, one should pay attention that in both investigated farms (with TMR system), it was correctly balanced and had a mono-diet nature. Fodders were subject to laboratory assessment of quality. Chemical tests of cumulative milk were carried out in a farm systematically each month. Their exemplary results are included in table 2. A slight exception to requirements may be reported only once, in farm S, in the half of December 2012, where the content of urea in cumulative milk slightly exceeded the limit of 300 mg·l^{-1} (by approx. 5%). It is a signal that a feeding dose might have had a slight excess of protein and energy, although it is not completely sure. In literature among reasons for such phenomena a high dairy productivity of cows or insufficient consumption of water by animals is given (Nowak, 2009).

Table 2
The assessment of cows feed correctness in examined farms

Farm	Date of analyses	Content in milk			Relation of fat to protein	Assessment of feed
		fat (%)	Protein (%)	Urea ($mg \cdot l^{-1}$)		
B	14th Jan 2013	4.21	3.28	273	1.28	Correct
	11th Feb 2013	4.04	3.31	271	1.22	Correct
S	14th Dec 2012	3.91	3.46	315	1.13	Alert on the excess of protein And energy in fodder
	18th Jan 2013	3.81	3.37	234	1.13	Correct

Source: Authors' own assessment based on numerical data Obtained from the Polish Federation of Cattle Breeders and Milk Producers

Conclusions

1. In climatic conditions of Wielkopolska region, straw and sand may be alternatively used as stall bedding for dairy cows without the production risk. It concerns both inside as well as outside stalls.
2. Seasonal replacement of bedding in cow stalls with very high dairy productivity does not disturb milk secretion and is even advantageous.
3. In open cowsheds, with outisde stalls for cows, autumn-winter change of sand to straw ensures that animals have appropriate welfare ensured during the winter cold.

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WPŁYW SEZONOWYCH WYMIAN ŚCIÓŁEK LEGOWISKOWYCH NA MLECZNOŚĆ KRÓW

Streszczenie. Celem badań było sprawdzenie, czy sezonowe wymiany ściółek na legowiskach dla krów pozostają obojętne dla ich mleczności. Badania przeprowadzono w 2 różniących się miejscem umieszczenia legowisk wielkopolskich fermach o bardzo wysokiej produkcji mleka. Legowiska dla krów w jednej z ferm zlokalizowane są wewnątrz, a w drugiej na zewnątrz budynków, pod zadaszeniami. Badania wykazały, że jesienne wymiany ściółki piaskowej na słomę i wiosenne ze słomy na piasek są w zależności od umieszczenia legowisk albo obojętne dla produkcyjności krów lub działają korzystnie.

Słowa kluczowe: sezonowa wymiana ściółek, produkcja mleka w oborze