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Review article

Kamil SIATKA, Anna SAWA

DRY PERIOD LENGTH AND MILK YIELD IN THE NEXT LACTATION

DŁUGOŚĆ OKRESU ZASUSZENIA A WYDAJNOŚĆ MLEKA W NASTĘPNEJ LAKTACJI

Department of Cattle Breeding, University of Technology and Life Sciences in Bydgoszcz, Poland

Streszczenie. Celem pracy było omówienie wpływu długości okresu zasuszenia na wydajność krów w następnej laktacji. Okres zasuszenia charakteryzuje się radykalnymi zmianami anatomii, histologii i fizjologii gruczołu mlekowego, który przechodzi etap aktywnej inwolucji, fazę spoczynku oraz produkcji siary. 60-dniowy okres zasuszenia, uważany za optymalny, został przyjęty na początku dwudziestego wieku. Jednakże długość tego okresu wymaga rewizji ponieważ intensywna praca hodowlana, którą przeprowadzono w ostatnich 40 latach w połączeniu z poprawą warunków środowiskowych, spowodowała dwukrotny wzrost wydajności krów w wielu krajach. Wyższe wydajności mleka zwiększone poprzez zmiany w produkcyjności krów, między innymi wydłużenie laktacji, mogą wskazywać, że krowy są zdolne produkować mleko przez dłuższy czas, w związku z czym okres zasuszenia może być krótszy.

Key words: dry period, length, milk, yield.
Słowa kluczowe: długość, mleko, okres zasuszenia, wydajność.

The term dry period is commonly used to refer to the non-lactating stage in the cow's production cycle (Church et al. 2008). It is the time between the end of lactation, whether natural or forced, and calving (Kuczaj et al. 2009). During this period, the cow rests and its organism prepares for parturition and intensive production in the next production period. It is a period of radical changes in the anatomy, histology and physiology of the mammary gland (Dingwell et al. 2003; Łopuszańska-Rusek and Bilik 2007; Church et al. 2008).

In lactation, the primary function of the mammary gland is one of continuous production of milk, and during the dry period the udder goes through three stages: active involution, steady state involution, and colostrogenesis. The process of active involution is spontaneous and spread out over time. If lactation is not intentionally interrupted, it can continue until parturition or be ongoing in nature (Malinowski 2004). The mechanism of mammary involution suppresses milk production. Residual milk is phagocytized by histiocytes and circulated through lymphatic vessels. The increased autophagy is induced by hormones that maintain lactation (somatotropin, IGF-1), by increased expression of their receptors in the mammary gland, and by factors such as increased activity of apoptogenic factors (including TGF-β1), increased synthesis of sex steroids, and fetal competition for nutrients and bioactive substances (Kuczaj et al. 2009).

Corresponding author – Adres do korespondencji: Anna Sawa, Department of Cattle Breeding, University of Technology and Life Sciences in Bydgoszcz, Mazowiecka 28, 85-084 Bydgoszcz, Poland, e-mail: sawa@utp.edu.pl

The intramammary factors responsible for active involution are increased osmotic pressure in the mammary system as a result of milk accumulation in milk alveoli (Malinowski 2004; Kuczaj et al. 2009), IGF-binding proteins, and the protein known as a feedback inhibitor of lactation (FIL) (Kuczaj et al. 2009).

This process is accompanied by considerable changes in milk composition, with decreases in the synthesis of components synthesized by secretory epithelial cells (e.g. milk fat, casein, lactose, alpha-albumins, citrates), considerable increases in somatic cell concentration and components derived from blood (e.g. immunoglobulins, serum albumin) and increased pH (Malinowski 2004; Kuczaj et al. 2009). One characteristic change is a rapid increase in the content and activity of hydrolases and lactoferrin, which has the ability to bind iron (Malinowski 2004).

Involution is followed by the far-off dry period that is 2–3 weeks long (Malinowski 2004). During this period, mammary activity is arrested and no product is secreted. The duration of this period depends on the total dry period length and has an effect on maximum milk production in the next lactation. Milk yield is reduced if it is shortened to less than 2 weeks (Laven 2011).

The final stage lasts for two weeks prepartum. It is characterized by renewed proliferation and activity of mammary epithelium, leading to production of colostrum (Kuczaj et al. 2009; Laven 2011), and of milk after parturition (Malinowski 2004).

The optimum length of the non-lactating period in dairy cattle has been debated since the early 19th century (Annen et al. 2004). The 60-day dry period was adopted at the beginning of the 20th century. However, the duration of this period needs to be revised because intensive breeding work that has been carried out over the last 40 years coupled with improvements in environmental conditions caused the milk yield of cows to double in many countries. Higher milk yields increased changes in cow productivity, among others by extending lactations (Sawa and Bogucki 2009), which possibly indicates that cows are able to produce milk for a long time, as a result of which the dry period could be shorter.

Numerous studies have shown that dry period length has differential effects on the milk yield of cows. Many authors (Bachman and Schairer 2003; Monroe and Amaral-Philips 2005; Rastani et al. 2005; Church et al. 2008; Soleimani et al. 2010; Sawa et al. 2012) still consider a dry period of 40–60 days to be the most favourable for milk production in the subsequent lactation. Salamończyk and Guliński (2011) found that cows with a dry period of 46–60 days were characterized by the highest energy-corrected milk (ECM; the amount of milk produced in relation to the amount of feed consumed) per standard lactation and the lowest decrease in milk yield during lactation. The same dry period interval of 46–60 days was also shown as the most beneficial for the highest yield in the approaching lactation by the authors cited by Gulay et al. (2003b).

Considering the yield of milk and its components, shortening the dry period was shown to be less beneficial than extending it beyond the 40– to 60-day standard (Kuhn et al. 2005; Sawa et al. 2012). According to Sawa et al. (2012), prolongation of the dry period to 61–80 (or even 81–100) days contributes little (about 1 and 4%) to the decrease in milk yield, whereas greater losses (5%, 14% and 25%) were noted when this period was shortened to 21–40, 1–20 and 0 days, respectively. Grummer and Rastani (2004) suggest that extending

the lactation by shortening the dry period to less than 60 days may positively influence overall milk production. When shortening the non-lactating period, it should be noted that reduction to less than 30 days may limit milk yields in the next production period (Kuhn et al. 2005; Borkowska et al. 2006; Church et al. 2008; Węglarzy 2009; Sawa et al. 2012). Shortening the dry period to 30–40 days has an adverse impact on the productivity of first-calf heifers in the lactation following the dry period, but no such relationship was found for multiparous cows (Church et al. 2008). Other studies that compared the yields of cows after dry periods of 30–40 and 60 days showed that animals had the highest productivity in the lactation following the longer dry period (Annen et al. 2003b; Fernandez et al. 2003; Gulay et al. 2003a, b; Church et al. 2008). Some authors (Monroe and Amaral-Philips 2005; Berry and Hillerton 2007; Łopuszańska-Rusek and Bilik 2007; Waldner 2007) report that it contributes to optimum performance of cows. As opposed to the results cited above, Gulay et al. (2003b), who compared the effect of short (30 day) and normal (60 day) dry periods on feed consumption and productivity in the next lactation, found no evidence to indicate that shortening the non-lactating period has an effect on increasing or decreasing productivity in the following production period. A similar conclusion, based on analysis of the results obtained by other authors, was made by Soleimani et al. (2010). Also in their own study, the authors cited above reported that shortening the dry period to 30–35 days had no significant effect on milk yield in the subsequent lactation. Inconclusive results regarding the effects of shortening the traditional dry period to around 30 days were also reported, based on analysis of available literature, by Bachman and Schairer (2003); they found that reducing the number of non-lactating days may change subsequent milk production from a 10% decrease to a 1% increase. The same authors also showed that the results obtained can be influenced by the experimental approach: retrospective analysis of production data vs. planned trials. Not without significance is the random choice of experimental animals. Other important factors affecting the results are the genetic background of cows and management strategies in herds taking part in different experiments (Bachman and Schairer 2003; Annen et al. 2004; Soleimani et al. 2010).

Both omitted and excessively shortened dry periods interfere with the involution of the mammary gland (Waldner 2007) and reduce the number of secretory cells (Monroe and Amaral-Philips 2005), which has an adverse impact on milk production, causing it to decrease by 18–30% and even 40% (Annen et al. 2004; Monroe and Amaral-Philips 2005; Kuczaj et al. 2009; Sawa et al. 2012). Decreased milk yields in cows under continuous lactation are explained using four hypotheses: small body reserves in early lactation; changes in the endocrine profile; decreased number of mammary epithelial cells; and reduced secretory and mitotic potential (Kuczaj et al. 2009).

Reducing or omitting the dry period has a greater impact on the milk performance of first-calf heifers and cows between the first and second lactation compared to older cows (Annen et al. 2003a; Church et al. 2008). According to Kuhn et al. (2005), dry periods shorter than 40 days have a more negative effect on first-calf heifers compared to multiparous cows, which the authors attribute to differences in physiological maturity. Annen et al. (2004) hold that shortened or omitted dry periods may inhibit the development of the mammary gland in first-calf heifers, causing their milk yield to decrease in subsequent lactations.

Just like shortening the dry period to less than 30 days, extending it to more than 90 days compromises milk yield in the next lactation. Kuhn et al. (2006) recommend avoiding dry periods longer than 70 days due to reduced milk yield in the next lactation. According to Sawa et al. (2012), too long a dry period (beyond 100 days) may carry a risk of higher culling levels, shorter lactations, health disorders, and compromised reproductive performance. In light of the research findings, it is already unfavourable to extend the non-lactating period to more than 60–70 days (Monroe and Amaral-Philips 2005; Berry and Hillerton 2007; Waldner 2007). Waldner (2007) reports that each lactation day following a dry period shorter than 45 days and longer than 60 days causes a loss of 3 dollars per cow. For this reason, the objective is for 70–80% of animals in the herd to have a dry period of 40–70 days.

Kuczaj et al. (2009) report that dry period length has a significant effect on colostrum quality. Periods shorter than 40 days negatively affect the concentration of immunoglobulins and the nutrients they contain, which causes a deterioration in its quality.

In addition to its effects on milk production and milk composition, dry period length was also found to influence fertility in cows. The positive effect of a shorter dry period (34 days) on reproductive traits of multiparous cows was indicated by Watters et al. (2009). Sawa et al. (2012) found that increasing the dry period was paralleled by decreased cow fertility in the next reproductive cycle, and increasing the calving interval had a greater effect on prolonging the time to first oestrus than the interval from first to successful insemination. Meanwhile, Gallo et al. (2008) did not confirm the significant effect of dry period length on calving interval. Likewise, Annen et al. (2004) demonstrated that reproductive parameters (number and percentage of pregnant cows, services per conception, day of first oestrus, days open) did not differ statistically significantly in cows assigned to traditional or short dry periods or continuous lactation.

Other advantages of reducing the time when no milk is produced by the mammary gland can be seen in changes concerning herd nutrition. Extending lactation by reducing the dry period is associated with lower fatness, which reduces the risk of metabolic diseases in early lactation (Bachman and Schairer 2003). Shortening the non-lactating period to 30–40 days also makes it possible to limit the frequency of changes in feeding by eliminating the diet for cows during the far-off period, and thus to reduce the number of feeding groups (Gulay et al. 2003b). This limitation is beneficial as it reduces the management costs for non-income producing animals (Soleimani et al. 2010).

In the traditional approach, the dry period is an important time for the cow to replenish body condition before the next lactation, regenerate the mammary gland, prepare the body for the developing fetus, and attain good fertility and high milk yield postpartum (Salamończyk and Guliński 2011). Today, the first goal of drying off seems outdated, because this practice may harm animals by making them too fat. The dry period should not be the time to replenish body condition. The results of Pezeshki et al. (2007) provide evidence that multiparous cows and cows with higher body condition scores (BCS) can be dried off for shorter periods. Grummer and Rastani (2004) report that shortening or omitting the dry period reduces the energy deficit, typical of the periparturient period, which results from animals consuming inadequate amounts of energy. They suggest that shorter non-lactating periods have beneficial effects on the health status of animals by limiting the

mobilization of fatty acids from the adipose tissue. Such favourable changes in fat metabolism contribute to reducing the incidence of diseases characteristic of this period, such as ketosis, fatty liver, placental retention or displaced abomasum. Based on literature reports, Soleimani et al. (2010) state that shortening or omitting the dry period reduces the loss of body condition at the beginning of the next lactation. Meanwhile, the same authors' own results indicate that dry period length has no impact on body weight and body condition. Dry period length was also found to cause no differences in the negative energy balance postpartum. Similar conclusions were made by Gulay et al. (2003b), who observed no differences in the effect of non-lactating period length (60 vs 30 days) when cows were in adequate body condition before drying off (≥ 3.25 BCS). On the other hand, Rastani et al. (2005) found in their own experiment that a 28-day dry period is more favourable than a 56-day dry period in terms of the energy balance and mobilization of body reserves, when cows assigned the shorter dry period were fed a high-energy (lactation) diet.

In summary, it is difficult to conclusively establish the adequate length of the dry period for cows. Given that most studies conducted to date consider a 40– to 60-day non-lactating period as the most beneficial for achieving maximum productivity of animals in the subsequent lactation, its wide application in breeding practice seems justified. Nevertheless, the results of studies pointing to the lack of differences between the traditional and short (30– to 40-day) dry period, or those indicating an increase in animal productivity or a positive impact of the dry period on body condition do not allow for rejecting this solution completely. It seems appropriate to suggest shortening the dry period to 30–40 days, especially in multiparous cows and in cows with a BCS of about 3.5. Omitting or reducing the dry period should not involve cows after first calving.

The lack of a definitive answer to how long a cow should be dried off provides a very good basis for conducting further studies and analyses to clarify this issue.

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Abstract. The present review attempts to sum up the knowledge concerning the effect of dry period length on the milk yield of cows in the next lactation. The dry period is characterized by radical changes in the anatomy, histology and physiology of the mammary gland, which undergoes the stages of active involution, steady state, and colostrum production. The 60-day dry period, once considered optimal, was adopted at the beginning of the 20th century. However, the duration of this period needs to be revised because intensive breeding work that has been carried out over the last 40 years coupled with improvements in environmental conditions caused the milk yield of cows to double in many countries. Higher milk yields increased changes in cow productivity, among others by extending lactations, which possibly indicates that cows are able to produce milk for a long time, as a result of which the dry period could be shorter.