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REVIEW ARTICLE

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FEED ADDITIVES IN THE DIET OF HIGH-PRODUCING DAIRY COWS

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ABSTRACT

Improvement of the genetic value of cows, enabling increasingly high milk yield, requires increasingly modern feeding. Therefore, in addition to high-quality bulky feed and concentrate feed, specialized feed additives are being introduced to the diet of high-producing dairy cows. The available additives (rumen-protected essential ingredients, phytobiotics, probiotic, prebiotic and others) have a broad spectrum of activity, increasing production efficiency, protecting against metabolic disease, and improving the reproductive parameters and health of the herd. It should be borne in mind, however, that only rational use of feed additives in the diet of cows is conducive to their longevity, which is one of the most important factors improving the economic outcomes of milk production.

Key words: rumen-protected essential ingredients, phytobiotics, probiotic, prebiotic

INTRODUCTION

The increased genetic potential of dairy cows, enabling high milk yield, requires farmers to modify the feeding system. High-quality bulky and concentrate feeds are often insufficient for a balanced feed ration that meets the nutritional requirements of a high-producing cow. For this reason, feeding solutions are sought that will allow the production potential of the cow to be fully exploited while limiting the occurrence of metabolic disease and improving reproductive parameters [Čermáková et al. 2012, Prayitno et al. 2016, Mobeen et al. 2019, Callaway et al. 2019, Panchasara et al. 2019]. The most problematic period in the feeding of high-producing dairy cows is the perinatal period, which determines milk production throughout lactation. Feeding errors at this time affect not only subsequent milk yield, but above all the animals' health including calves [Stefańska et al. 2020]. The occurrence of acidosis, ketosis, or hypocalcaemia at the start of lactation often leads to early culling of the cow from the herd. Studies have shown that the rational use of feed additives in the diet of cows improves their longevity and reduces the use of energy and protein for milk production, which improves economic outcomes while also helping to protect the natural environment by reducing the excretion of undigested nutrients and the emission of harmful gases [Chung et al. 2007, Sirohi et al. 2010, Cannizzo et al. 2012, Pan et al. 2016, Veena et al. 2018, Mobeen et al. 2019]. The proper use of feed additives in the diet of high-producing cows is a challenge, due to their wide assortment and spectrum of activity.

The aim of the study was to present the importance of feed additives in the diet of high-producing dairy cows and their effect on the animals' productivity and health, which is largely reflected in the profits of the dairy farm.

Rumen-protected supplements

Rumen-protected supplements include amino acids, protein and fat. A characteristic feature of these products is that they resist degradation in the rumen but are very well degraded in the small intestine. Rumen-protected (bypass) protein may result from the effect of formaldehyde, extrusion, and xylose on soybean, rapeseed or sunflower seed meal [Carré et al. 2007]. Amino acids can be protected by coating with a mixture of fat and calcium, fat and protein, fat alone or by using heat and steer, reflux and ultrasound reaction at different times,

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temperatures and solvents [Schwab and Broderick 2017, Mazinani et al. 2019]. The most important benefits of by-pass protein are increased efficiency of feed conversion, increased milk yield, and improved milk parameters [Xu et al. 1998, Chen et al. 2011, Čermáková et al. 2012, Lee et al. 2012]. Čermáková et al. [2012] showed an increase in milk production and in the amount of protein and β-casein in the milk of cows whose feed was supplemented with rumen-protected methionine additives. Similarly, Lee et al. [2012] found that the addition of rumen-protected lysine, methionine and histidine to the feed ration of cows caused an increase in milk production of about 3.3 kg per day and an increase in protein of 0.13 kg per day. Furthermore, Xu et al. [1998] report that the use of rumen-protected amino acids absorbed in the small intestine reduced the calving interval by improving fertility in cows.

It is recommended that high-producing cows, which have an energy deficit during the early and mid-lactation, should be given rumen-protected fats, which help to prevent one of the most costly illnesses – ketosis [Duffield 2000, Lohrenz et al. 2010]. The most common form of fat protection are coated calcium soaps of fatty acids, resistant to the rumen environment and degraded in the duodenum [Włodarczyk and Budvytis 2011]. According to Lohrenz et al. [2010], the use of rumen-protected fat in the diet of dairy cows in the first stage of lactation, in addition to improving the energy balance and increasing milk yield (by about 0.9 kg per day), causes a decrease (by 0.1–0.3%) in the protein content of the milk. An increase in the yield of cows as well as the fat content in milk following supplementation with rumen-protected fat has also been demonstrated by Sirohi et al. [2010], Veena et al. [2018] and Mobeen et al. [2019]. Veena et al. [2018] reported increased milk production by 1.84 kg per day and an increase in milk fat content by 0.26 pp.

Reis et al. [2012] showed that the addition of calcium salts of polyunsaturated fatty acids to the diet of cows increased the level of progesterone in the blood, helping to maintain pregnancy in the first few days after insemination. Tyagi et al. [2010] reported that the addition of rumen-protected fat to the diet of cows at the start of lactation reduced the interval between calving and first oestrus.

According to literature, most of the methods used for protecting amino acids are physical methods. Although these products are not completely acceptable as their coated layers are still sensitive and could be damaged by chewing and physical or heat treatments used in diet preparation. On the other hand, most of the chemical methods could also be used for protecting amino acids as they do not have any physical layers so would not be damage by feed processing, therefore more work is needed to understand bioavailability of these products [Mazinani et al. 2019].

Propylene glycol

Propylene glycol is a glucose precursor administered in the form of daily drenching that increase glucose and insulin concentrations in the blood and improve reproductive parameters in cows [Miyoshi et al. 2001, Chung et al. 2007, Włodarczyk and Budvytis 2011]. Chung et al. [2007] found that the addition of 250 g per day of glycerine to the diet of cows from parturition to day 21 of lactation increased the blood glucose concentration and decreased the concentration of ketone bodies in the urine. The authors also observed an increase (52 kg per day in the experimental group vs 46 kg per day in the control) in milk production in the sixth week of lactation. Similarly, Włodarczyk and Budvytis [2011] suggest that administration of propylene glycol to cows is one way to prevent a negative energy balance in the final stage of the dry period and at the start of lactation. Miyoshi et al. [2001] reported that administration of propylene glycol to cows after calving accelerated the first ovulation by 13.2 days.

Fodder yeast

The most common feed yeasts supplements contain single-celled fungi *Saccharomyces* spp., *Kluyveromyces* spp., *Candida* spp., and some other (*Torula* spp. and *Pichia* spp.). The use of feed yeast in the diet of dairy cows has multiple benefits, including improved rumen function, increased milk yield, changes in the physicochemical parameters of milk, and a reduction in the somatic cell count [Dann et al. 2000, Czaplicka et al. 2014, Xiao et al. 2016, Nasiri et al. 2019, Chuang et al. 2020]. Dann et al. [2000], Yalcin et al. [2011], Xiao et al. 2016] and Nasiri et al. [2019] assessed the effectiveness of various preparations containing *Saccharomyces cerevisiae* yeast in the diet of cows and showed that they had a positive effect on daily milk yield, while the effect on the content of fat and protein in the milk was varied (Table 1).

Nasiri et al. [2019] showed that prepartum dry matter intake was greater in yeast-fed cows; however, this difference disappeared after parturition. Cows receiving yeast supplement (Probio-Sacc®) produced more milk and had greater concentrations of milk fat and total solid than those receiving no yeast. Loss of body condition score from calving to d 21 postpartum tended to be lower in yeast-fed cows than control cows.

Bruno et al. [2009] found that the addition of *Saccharomyces cerevisiae* yeast (30 g A-Max XTRA/day/cow) to the diet protects cows against a decline in milk production during hot weather. Thrune et al. [2009] showed that the use of *Saccharomyces cerevisiae* in the form of X-Mate Pro MX 300 increased the rumen pH from 6.80 to 7.01. This confirmed that these additives could be recommended to reduce the occurrence of subacute acidosis (SARA) in high-producing dairy cows, as demonstrated by Bach et al. [2007]. Beev et al. [2007] ob-

Table 1. Yield and milk composition in cows fed diets supplemented with *Saccharomyces cerevisiae* yeast

Tabela 1. Wydajność oraz skład mleka krów żywionych dietami uzupełnionymi *Saccharomyces cerevisiae*

Item Wyszczególnienie	Milk yield, kg per day Wydajność mleka, kg na dobę		Fat content, % Zawartość tłuszczu, %		Protein content, % Zawartość białka, %	
	control group grupa kontrolna	experimental group grupa doświadczalna	control group grupa kontrolna	experimental group grupa doświadczalna	control group grupa kontrolna	experimental group grupa doświadczalna
Dann et al. [2000]	23.49	24.97	2.96	3.14	3.66	3.63
Yalcin et al. [2011]	18.9	20.1	3.19	3.19	3.41	3.38
Xiao et al. [2016]	22.9	23.5	4.27	4.44	3.64	3.78
Nasiri et al. [2019]	42.3	43.7	3.16	3.41	2.44	2.46

served that the addition of live yeast cultures to the feed ration of dairy cows increased the number of cellulolytic bacteria in the rumen, which improved digestion of fibre and reducing the accumulation of lactates in the rumen fluid.

Yeast supplementation on ruminants has been shown to regulate rumen pH, microbial composition and fiber fermentation [Terre et al. 2015, Bach et al. 2018]. Recent studies suggest the supplementation of yeast may also influence immune function [Zanello et al. 2011, Nasiri et al. 2019, Gao et al. 2020]. Zanello et al. [2011] reported that yeast inhibit the *Escherichia coli* – induced expression of proinflammation transcripts and protein. Yuan et al. [2015] analyzed the effects of dietary yeast supplementation on uterine inflammatory and they found that although no treatment effect was detected for incidence of subclinical endometritis, supplementary yeast decreased uterine IL-6 mRNA abundance and improved neutrophil myeloperoxidase and neutrophil elastase expression on transition cow, as well as fecal IgA concentration, which indicating relieved uterine inflammation and strengthened immune function. Nasiri et al. [2019] reported that supplementation of 4 g a day of yeast (ProbioSacc®) fostered the lymphocyte proliferative response in transition dairy cows, which indicates an improved immune function.

Probiotics, prebiotics and synbiotics

Probiotics and prebiotics are used to protect the body against pathogens and to enhance the immune system of cows [Galus-Barchan et al. 2018]. Probiotics are live microorganisms, which confer a health benefit to the host when administered in adequate amounts (FAO-WHO 2008). The most important microorganisms used in the production of probiotics are the bacteria: *Bifidobacterium*, *Propionibacterium*, *Enterococcus*, and *Lactobacillus*; and yeasts: *Saccharomyces cerevisiae*, *Aspergillus oryzae*, and *Aspergillus niger* [Chiquette et al. 2008, Aikman et al. 2011, Uyeno et al. 2015, Callaway et al. 2019, Gao et al. 2020]. Prebiotics, on the other hand, contain nutritional compounds that serve as food for beneficial bacteria living in the digestive tract of animals [Uyeno et al. 2015]. Prebiotics are produced using mannooligosaccharides, fructooligosaccharides and galactooligosaccharides [Gaggìa et al. 2010, Ghosh and Mehla 2012].

The main purpose of administration of probiotics to cattle is to stabilize the population of microbes in the digestive tract and regulate the processes taking place in the rumen. It is particularly recommended to administer probiotics to cows in the perinatal period together with easily digestible, easily fermentable feedstuffs. Administration of large amounts of concentrate feeds increases production of volatile fatty acids and the lactic acid concentration in the rumen, thereby reducing the rumen pH. Reduced rumen pH creates unfavourable conditions for bacteria, resulting in ruminal acidosis [Krause and Oetzel 2006]. Ruminal acidosis in dairy cows at the start of lactation leads to a sharp decline in milk production and contributes to other metabolic diseases [Abdela 2016]. The proper functioning of this part of the cow's digestive system affects the functioning of the entire body. Studies show that probiotic preparations for cows may regulate rumen function, milk yield, milk parameters, health, and resistance to unfavourable conditions in dairy cows. Nocek and Kautz [2006] showed that supplementation of feed for dairy cows in the perinatal period with a preparation containing *Enterococcus faecium* strains increased uptake of dry matter, both before and after parturition, and positively affected its digestion in the rumen, resulting in increased milk production (by 2.3 kg per day). To reduce the concentration of lactic acid in the rumen, cows should be given probiotics containing bacteria that degrade it: *Megasphaera elsdenii*, *Selenomonas ruminantium*, and *Propionibacterium* spp. [Henning et al. 2010, Calsamiglia et al. 2012]. Aikman et al. [2011] reported that administration of *Megasphaera elsdenii* NCIMB 41125 bacteria to cows in the form of a probiotic stabilized the rumen pH, while the breakdown of lactic acid by these bacteria caused a change in the fermentation process, increasing production of propionate at the expense of acetate. A higher concentration of propionate has a positive effect on the energy balance and milk production in cows after calving. In an in vitro study by Luo et al. [2017], probiotic preparations containing *Propionibacterium* spp. accelerated the decrease in the lactic acid concentration in the rumen, preventing acidosis in cows. Supplements containing *Propionibacterium* spp. have also been found to have a beneficial effect, increasing milk production in cows [Stein et al. 2006]. Similarly, Sun et al. [2013] showed that a probiotic containing strains of *Bacillus subtilis natto* (isolated from fermented soybeans) added to the diet of cows in the amount of $0.5 \cdot 10^{11}$ and $1.0 \cdot 10^{11}$ CFU increased milk production by 2.2 and 3.2 kg per day, respectively, relative to the control group. An increase was also noted in daily production of protein, fat and lactose, as well as a decrease in the somatic cell count in the milk. Similar results were obtained by Peng et al. [2012] and Souza et al. [2017] following the use of a probiotic containing strains of *Bacillus subtilis* in the diet of cows. According to Xu et al. [2017], a diet supplemented with strains of *Lactobacillus* spp. (*Lactobacillus casei* and *Lactobacillus plantarum*) increases production of milk and the immune proteins contained in it, i.e. immunoglobulin, lactoferrin, lysozyme and lactoperoxidase, reducing the somatic cell count. Probiotics containing strains of *Prevotella bryantii* increase the fat content in the milk of cows and decrease the amount of lactic acid in the rumen [Chiquette et al. 2008].

The mechanism that probiotics exert beneficial effects on host health is closely associated with the capability to produce antagonistic substances, adhesion to host tissues and colonization to different sites of the host surfaces [Espeche et al. 2009]. Know is that intramammary LAB incubation restore balance in microbiota of the mammary gland and improve systemic immune function [Pellegrino et al. 2017]. On the other hand Gao et al. [2020] showed beneficial effects of dietary supplementation of LAB on mastitis and milk microorganisms of lactating cow.

Synbiotics are combinations of probiotics and prebiotics [Markowiak and Śliżewska 2018]. The combination of beneficial bacteria and oligosaccharides that serve as food for them significantly increases the effectiveness of these supplements [Malik et al. 2019]. Yosuda et al. [2007] found that cows whose feed was supplemented with a synbiotic (freeze-dried *Lactobacillus casei* $1.0 \cdot 10^7$ CFU + 5% dextran – a glucose polymer) in the amount of 10 g per cow per day showed increased resistance to high air temperature and humidity. Moreover, the use of the synbiotic improved milk yield, decreased the somatic cell count in the milk, and increased resistance to mastitis.

Phytobiotics

Phytobiotics, commonly known as herbal plant bioactive compounds, have been used in human and veterinary medicine to prevent diseases, enhance performance in stress-related syndromes, and increase resistance against infections [Rochfort et al. 2008]. Also Grela et al. [2013] claimed the term ‘phytobiotics’ refers to herbal preparations containing specific biologically active substances. They are used in the prevention and treatment of many diseases affecting farm animals. However, it is important to consider the effects that various substances contained in herbs can have on one another, so as to avoid antagonistic interactions [Budny et al. 2012]. The biologically active substances in these preparations include alkaloids, essential oils, glycosides, tannins, flavonoids, saponins, pectins, organic acids, mineral salts, and vitamins [Semeniuk et al. 2008]. According to Mohanty et al. [2014], herbs with galactagogue properties include goat’s rue, nettle, caraway, and common hops. Many studies [Grabowicz et al. 2004, Prayitno et al. 2016, Panchasara et al. 2019] indicate that the use of herbs in the diet of ruminants improves feed conversion and production results, beneficially modifies the bacterial microbiome of the rumen, and affects the immune system. The authors found that the administration of herb supplements to cows increased milk yield and improved the quality of the milk. Similarly, Kraszewski et al. [2008] demonstrated positive effects of a herb mixture (chamomile, yarrow, common agrimony, nettle, ribwort plantain, St. John’s wort, and hairy lady’s mantle) administered to cows. The authors noted an increase in the technological parameters of milk and a marked decrease (by 232,000 per cm^3) in the somatic cell count of the experimental cows. Moreover, they noted a decrease in the number of pathogens inducing mastitis. The frequency of *Staphylococcus aureus* decreased from 57.12% to 3.09%, and that of *Streptococcus agalactiae* from 14.14% to 2.23%. A significant decrease in the number of streptococci and *Escherichia coli* bacteria was also observed in the milk of cows receiving the herb mixture. On the other hand, Hosoda et al. [2006] found no changes in the somatic cell count or technological parameters of milk obtained from cows whose feed contained a 5% mint supplement. The inclusion of mint in the diet only increased the fat content in the milk. Węglarzy et al. [2010] found that the addition of fresh caraway and purple coneflower caused a significant increase in milk protein and fat. The use of phytobiotics also affects the health-promoting value of milk; Benchaar et al. [2007] demonstrated that the addition (2 g per day) of a mixture of natural essential oils (eugenol, thymol, guaiacol, limonene, and vanillin) to the diet of cows caused an increase in the concentration of conjugated linoleic acid (CLA) in the milk fat.

Klebaniuk et al. [2014] showed that a mixture of herbs (thyme, oregano, cinnamon and coneflower) in the diet of cows during the dry period has a beneficial effect on colostrum quality (increased content of immunoglobulins) in the first few hours after calving.

Grabowicz et al. [2004] reported that the use of milk thistle silage in the diet of cows in the final stage of the dry period and the start of lactation had a positive effect on enzyme activity in the blood serum.

Vitamins

High milk yield in cows requires that they receive an adequate amount of vitamins essential for the proper function of the body. The presence of microbes colonizing the rumen of cows makes it possible to meet the requirement for vitamin K and the B vitamins [Weiss and Gonzalo 2006, Castagnino et al. 2016]. But last reports show that high-producing cows it is likely that the demand for vitamin B increases with milk yield. The supplementation B vitamins need to be rumen-protected because ruminal microflora destroy them [Girard 2017]. All vitamins must be supplied in the form of vitamin supplements. The most important vitamins include fat-soluble vitamins A, D and E and water-soluble vitamins B_8 (biotin), PP (niacin) and B_4 (choline).

Vitamin A (retinol) and its pro-vitamin β-carotene are essential for a number of processes taking place in the body. According to Von Lintig and Vogt [2004], vitamin A enhances cellular resistance to pathogens, while β-carotene is a strong antioxidant, which increases the antibacterial activity of leukocytes. LeBlanc et al. [2004] demonstrated that administration of vitamin A or β-carotene to cows in the amount of 150,000–250,000 IU per day or 300–600 mg per day, respectively, in the final phase of the dry period reduces the incidence of mastitis in cows after calving. Yasar and Abdullah [2006] noted that an increased level of vitamin A during oestrus of cows has a beneficial effect on the quality of the embryo. The use of a β-carotene supplement at the start of lactation improves fertility parameters in cows: overt oestrus by day 60 after calving, a higher conception rate, and fewer diseases of the reproductive system, including ovarian cysts and placental retention [Kaewlamun et al. 2011].

The most important functions of vitamin D (cholecalciferol) include controlling the plasma concentrations of calcium and inorganic phosphate and influencing the cellular immune response and reproductive system. Hymøller et al. [2009] noted higher concentrations of vitamin D in the blood of cattle during the summer than in the winter, and much higher amounts in animals with access to sunny cattle runs relative to those kept indoors.

Vitamin E functions as a strong antioxidant, protecting cell membranes against the adverse effects of fatty acid oxidation products, but can also form a barrier against oxidation for other vitamins [Focant et al. 1998, Pottier et al. 2006]. The use of a vitamin E supplement in cow feed reduces the risk of postpartum retention of foetal membranes, has a beneficial effect on foetal growth, and reduces the calving-to-conception interval [Allison and Laven 2000, Bourne et al. 2007]. Horn et al. [2010] found that vitamin E has a beneficial effect on the immune system of cows through its role in antibody production, particularly class G immunoglobulins. According to Batra et al. [1992], vitamin E improves udder health, reducing the somatic cell count in milk.

Vitamin B_8 (biotin) is essential for the production of keratin, as well as substances cementing the cells of the hoof horn [Tomlinson et al. 2004]. Hedges et al. [2001] found that prophylactic use of vitamin B_8 (10–20 mg per day) in the diet of cows improves hoof condition and reduces the incidence of hoof diseases. According to Higuchi et al. [2004], the beneficial effect of biotin on hoof health is due to an increase in the fat concentration in the hoof horn. Kinal et al. [2011] demonstrated that supplementation of the diet of cows with 10 mg of biotin increased the amount of milk obtained (on average by 6.6 kg per day). The addition of biotin is particularly recommended for high-producing cows fed large amounts of concentrate feed, in which biotin synthesis in the rumen may be impaired, so that it is consumed by ruminal bacteria and does not reach the intestine [Tomlinson et al. 2004].

Vitamin PP (niacin) affects the development of protozoa colonizing the digestive tract of ruminants and alters lipid metabolism by decreasing the rate of lipolysis [Niehoff et al. 2009, Morey et al. 2011, Yuan et al. 2012]. According to Morey et al. [2011] and Yuan et al. [2012], the addition (12 g per day) of vitamin PP to the diet of cows has no effect on the physicochemical parameters of milk or the amount of milk produced during lactation.

Vitamin B_4 (choline) has a very broad application and effect on dairy cows. It is administered in rumen-protected form, as choline chloride. Baldi and Pinnotti [2006] showed that the addition of choline chloride to the feed ration caused a 7% increase in the milk yield of cows. Similarly, Mohsen et al. [2011] reported that supplementation of feed with choline chloride in the amount of 15 g per day and 30 g per day increased milk yield by 8.6% and 11.5%, respectively, and fat content in the milk by 3.5% and 5.3%. Jayaprakash et al. [2016] also confirmed that the use of vitamin B_4 improves health, increases milk yield, and alters the composition of milk. According to Pinnotti et al. [2005], choline improves lipid transport in the blood, thereby reducing the risk of fatty liver and subclinical ketosis. Suksombat et al. [2012] demonstrated that choline supplementation also reduces the incidence of mastitis and postpartum foetal membrane retention.

Dihydropyridine

Dihydropyridine (DHP) is a type of Ca^{2+} channel antagonist, which can inhibit Ca^{2+} influx into the cytoplasm and decrease the concentration of cytoplasmic Ca^{2+}. DHP has been used as an additive in animal diets due to its antioxidant ability to protect oil, vitamin A, beta-carotene from oxidation [Wu 2020]. Meanwhile, DHP can alter the levels of hormones in the serum, which is beneficial for the promotion of the growth of animals, enhancing reproductive ability, and increasing milking capacity. Yu et al. [2020] indicated the decrease in superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), catalase (CAT), and total antioxidation (T-AOC) levels and the increase in malondialdehyde (MDA) level during HS season, after supplementation DHP cow's diet. Meanwhile, antioxidant indexes (SOD, GSH-Px, and T-AOC) were positively correlated with milk yield, whereas MDA exhibited a significant negative correlation with milk yield. Dihydropyridine treatment significantly restored SOD and GSH-Px levels under heat stress. The findings indicated that the DHP altered ruminal bacterial community mainly composed Proteobacteria and Firmicutes in dairy cows under HS. Results confirm that dihydropyridine can enhance the antioxidant abilities of dairy cows with favorable effects on ruminal microbial communities under HS, further alleviating heat stress on dairy cows.

Anion salts

Inappropriate proportions of elements or inadequate supplementation, especially during the perinatal period, leads to metabolic disorders in dairy cows. One of these is milk fever, which results from a sharp decrease in the concentrations of calcium and phosphorus in the blood in the first few days after calving [Mulligan and Doherty 2008]. One means of preventing milk fever is to administer anion salts, which include chlorides, sulphates, and phosphates of magnesium, calcium and ammonium [Oetzel and Barmore 1993, Goff et al. 2004]. Administration of anion salts regulates the cation-anion balance in the circulatory system by mobilizing the release of Ca from the bones and increasing its absorption from the digestive tract of cows after parturition [Goff et al. 2004, Liesegang et al. 2007]. Maintaining a correct cation-anion balance by administering anion salts to dairy cows has a positive effect on feed consumption and yield [Razzaghi et al. 2012, Janocha et al. 2019].

CONCLUSIONS

At present, animals used in milk production have high genetic potential and thus require a balanced diet with high-quality feed enriched with specialized feed additives. These are not cheap, so their use is associated with profitable production. Protection against metabolic diseases, improvement in reproductive parameters, and improved health in the herd are only some of the benefits of including feed additives in the diet of cows. Their positive effect on the milk yield of cows and improvement in the physicochemical parameters of milk should be stressed as well. To sum up, even the most effective feed additives cannot be a means of eliminating all irregularities arising in feed production, feed preservation, and balancing of feed rations for high-producing dairy cows.

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DODATKI PASZOWE W ŻYWIENIU WYSOKOWYDAJNYCH KRÓW MLECZNYCH

STRESZCZENIE

Poprawa wartości genetycznej krów pozwalająca uzyskiwać coraz wyższe wydajności mleka wymaga coraz to bardziej nowoczesnego żywienia. W związku z tym, oprócz dobrej jakości pasz objętościowych uzupełnionych treściwymi do dawek pokarmowych wysokowydajnych krów mlecznych wprowadza się specjalistyczne dodatki paszowe. Oferowane dodatki (preparaty chronione, fitobiotyki, probiotyki, prebiotyki i inne) mają szerokie spektrum działania, bowiem korzystnie wpływają na efektywność produkcji, chronią przed chorobami metabolicznymi oraz poprawiają wskaźniki rozrodu i zdrowotność stada. Pamiętać jednak należy, że tylko racjonalne zastosowanie dodatków paszowych w dietach krów sprzyja ich długowieczności, która jest jednym z najważniejszych czynników poprawiających wynik ekonomiczny produkcji mleka.

Słowa kluczowe: preparaty chronione, fitobiotyki, probiotyki, prebiotyki

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