The Effect of Nutrients on the Reproductive Performance of Dairy Cows

Carabă Ion[1], Păcală Nicolae[1], Ștef Lavinia[1], Peț Ioan[1], Marcu Adela[1], Ștef Ducu[1], Dronca Dorel[1], Julean Călin[1]*

[1]Banats' University of Agricultural Sciences and Veterinary Medicine "King Michael the Ist of Romania" from Timisoara", Calea Aradului nr.119, Timisoara - 300645, Romania

Abstract
The aim of this paper is to review the effects of the quality of nutrients in the ration on the reproductive function of dairy cows. Protein supplementation is one of the most important nutrients in milk production. However, an excess of protein over the requirements of cows affects reproductive function. Protein is needed to meet the nitrogen requirements of rumen microorganisms, as well as a direct source of protein for lactating cows.
The excess of degradable proteins in the rumen also results in large amounts of ammonia in the blood of the dairy cow, when there is not enough energy to turn ammonia into microbial proteins. In addition, the ammonia excess conversion requires energy, which can lead to a negative energy balance. This ammonia excess and negative energy balance result in reduced reproductive performance in dairy cows.
Minerals and vitamins are the most important nutrients for breastfeeding women, which are needed in very small quantities, but play an important role in metabolism, milk production, reproductive function and even for microbial fermentation in the rumen. Shaking seeds from plants is normally responsible for the loss of many nutrients, so the remaining material, such as straw, is a poor source of food.

Keywords: proteins, energy, minerals, vitamins, reproductive performance, cows

Introduction

In recent decades, modern dairy farming has become widespread. There is a tendency for milk production to increase, mainly due to intensive selection and increased nutrition. However, a decrease in reproductive performance (PR) for these high-yielding cows is observed [1-3]. This decrease in reproductive performance consists in increasing the time until the first sowing, a weak manifestation of estrus, decreased the success rate of artificial insemination (AI) [4, 5].
There are several factors that contribute to decreased reproductive performance, including genetic factors, heat stress, and disease-related causes [6-9]. There is a negative correlation between milk production and reproduction, as high milk production is maintained to the detriment of reproductive health [10]. High nutritional intake by the breast system causes a decrease in reproductive function.
A high-yielding cow consumes a large amount of glucose and suffers from a negative energy balance (NEBAL) in the early postpartum period [11, 12].
In the postpartum period, severe NEBAL is manifested by clinical or subclinical metabolic diseases [13]. Therefore, the disease factor is the most common cause of decreased reproductive performance in dairy cows. In addition to the number of infectious diseases [14], milk fever, ketosis and other nutritional changes contribute to the decline of reproductive function [15]. Nutritional metabolic alterations in the postpartum

* Corresponding author: Caraba Valer, Email caraba_i@animalsci-tm.ro

period affect the development and dominance of follicles on the ovaries and later ovulation, while diseases of the reproductive tract can directly affect fertility, embryo / fetal development, implantation and placental development [9, 16].
Thus, maintaining reproductive efficiency is an obvious challenge, a longer recovery period after calving, silent estrus, lower conception rates and early gestational loss (within 60 days) [2, 4, 5]. These conditions and mechanical changes affect the body's three major regulatory systems: the nervous system, the endocrine system, and the circulatory and immune systems. About two-thirds of reproductive disorders occur in the first month postpartum. Collectively, these factors directly or indirectly affect the development of the follicles, embryo / fetus and placenta, which in turn affect the reproductive performance of cows [17-19].

Protein level in cow feeding on reproductive and reproductive performance

The effect of dietary protein on reproduction is complex. Inadequate prolonged protein intake has been reported to reduce reproductive performance. More recently, it has been found that reproductive performance can be impaired if it is fed a protein in quantities that far exceed the requirements of the cow. Studies have reported negative associations between high raw food protein and a number of fertility parameters, finding no or no effect on reproductive performance [20]. Excess protein can have negative effects on reproduction [21]. Protein overfeeding during the breeding season and early gestation, especially rumen, receive an inadequate energy supply, which can be associated with a decrease in fertility [22]. This decrease in fertility may result from a decrease in uterine pH during the luteal phase of the estrous cycle in cows fed high levels of degradable protein. Meza-Herrera [23] reported that high pre-conception protein concentrations resulted in decreased uterine pH and decreased fertility rate but did not affect luteal function 15 days after insemination.
Cows that are fed excess protein (more than 10-15% above requirements) indicated that they needed more services per conception and had longer calving intervals [24, 25]. Similarly, in the case of supplementation with 15-19% crude protein, the conception rate was lower, from 65 to 53% [26]. The negative effects of protein supplementation are associated with an increase in urea-N in the blood, which affects the development of the ovarian and embryo follicles [27].

The quality of dietary protein on reproductive performance

While limited studies have directly addressed the influence of dietary protein type on fertility parameters, a recent study by Waterman et al. [28, 29, 30] have reported improvements in breeding rates in cows fed high levels of non-degradable rumen protein. An increase in RUP may increase the supply of amino acids (AA) for intestinal absorption, or contribute to an essential AA such as methionine, which may improve ovarian function [31].
Ardalan & Titi [32,24] also reported that supplementation of rumen bypass methionine may improve the reproductive performance of dairy cows. Because AA and RUP degradation peptides are absorbed in the gut and are easily accessible to ruminants, excess RUP has been shown to stimulate the pancreas to increase insulin production [33]. Insulin affects the ovarian tissues by enhancing the synthesis of LH receptors and pituitary action through these receptors.

Fatty acids and uterine health after calving

The health of the uterus is an important risk factor for the introduction of the cow for breeding in lactating dairy cows. During the calving process, eicosanoids are products that play an important role in the preparation of the cow and the control of calving, and the expulsion of the placenta and uterine contents by opening the cervix and contractions of the uterus. Prostaglandin F2α is an important eicosanoid that regulates CL lifespan and may influence fetal membrane retention and subsequent uterine health. Uterine synthesis of PGF2α is partially regulated by the availability of the substrate and arachidonic acid (AA; C20: 4 n-6) which is a precursor to PGF2α synthesis, so it is plausible to suggest that increases in the AA content of endometrial tissue should intensify uterine secretion. PGF2α, which in turn can affect the health of the uterus.
Similar effects have been observed with lactating dairy cows fed increasing amounts of fishmeal or Ca-LCFA enriched in fish oil [34,35]. Due to the

incorporation of n-6 and n-3 FA primarily into the phospholipid component of endometrial tissue, it is possible that changes in the FA content of endometrial tissue may modulate endometrial PGF2α secretion in cows.

Feeding about 2% of the ration as fish oil rich in n-3 FA reduced peripheral blood concentrations of the metabolite PGF2α (PGFM) indicating a reduction in uterine secretion of PGF2α [36].

Feeding n-3 FA yielded conflicting results in terms of milk yield, with some studies reporting high yields [37, 38], while others found no effect [39, 40].

Reviewing the topic, [41] suggested that conflicting results may arise from different levels of fat intake and different degrees of rumen protection.

Also, Ariza et al. (2019) [42] suggested that, unlike high-fat rations, supplementing moderate amounts of PUFA (extruded flax seeds) could increase the energy density of the ration without reducing KAI or reducing fiber digestibility. Supplementation with saturated palm oil AF also gave contrasting results, again with some authors reporting increased milk yield [8,42], while others did not find no effect, which may reflect the basic diet characteristics of the composition or fat supplement. These reports highlight the dose-dependent effect of fat supplementation in cow's milk. At a lower dose, fat supplementation increases energy density and consequently milk yield, but above a certain level of supplementation, fat depresses food intake and milk production [43].

The root cause of reduced fertility can be seen in the likely additive effect of the combination of various physiological and management factors. NEB length is the main nutritional factor influencing the decrease in reproductive efficiency in dairy cows with low milk production. The appearance of NEB prolongs the period between calving and the first ovulation and increases the embryonic mortality and the risk of uterine diseases.

Macrominerals

Garg and Bhandari (2005) [44] reported a low level of milk production and reproductive performance that are affected by mineral deficiency and corrected these deficiencies by supplementing different minerals. The results of previous experiments have shown that six minerals are deficient.

Bengal, i.e. Ca, P, Cu, Zn, Co and Mn [45].

Calcium

Calcium deficiencies are often very common during calving or a few days after calving. Ca: P ratio, the alteration can affect the ovarian function by its blocking action on the pituitary gland. This results in prolongation of the first estrus and ovulation, delayed uterine involution, increased incidence of dystocia, placental retention, and uterine prolapse [46]. In addition, low levels of calcium in the blood are also associated with anestrus where excess calcium can affect the reproductive condition of the animal by affecting the absorption of phosphorus, manganese, zinc, copper and other elements in the gastrointestinal tract. Ratio (Ca: P) between 1.5: 1 and 2.5: 1 for lactating cows should not affect reproductive function.

Cows that are milked should always receive adequate amounts of calcium to increase milk production and reduce health problems. A major concern in mineral feeding of cows is the provision of optimal levels of calcium and phosphorus to reduce the occurrence of milk fever. Prevention of milk fever is an important aspect in increasing reproductive function.

Phosphorus

This mineral has been most commonly associated with decreased reproductive performance in dairy cows. Inactive ovaries have been reported to have delayed sexual maturity and low conception rates due to low phosphorus intake. In a field study when weeds received only 70-80% of their phosphorus requirements and serum phosphorus levels were low, fertility was affected (3.7 sowing index). The sowing rate dropped to 1.3 when the phosphorus content increased.

In another experiment, increasing the phosphorus supplementation from 0.4% to 0.6% of the ration had no effect on the days until the first estrus or sowing index.

Phosphorus is considered to be one of the most important elements of normal sexual behavior [46]. Low phosphorus intake leads to delayed puberty, silent or irregular estrus in heifers, estrus deficiency and long periods between calving calves and poorly expelled calves or even embryonic death [47]. On the contrary, excess phosphorus makes the endometrium susceptible to infection [47]. Reduced fertility and reduced or delayed conception are the main signs of phosphorus deficiency and this can be ameliorated by proper phosphorus supplementation. While moderate deficiency can lead to repeated seeding and poor conception rate [46].

Sodium and potassium

Both elements are indirectly related to reproductive function in animals such as sodium deficiency affecting reproductive function. Sodium deficiency can be prevented by using protein. Potassium deficiency is well known to cause muscle weakness and therefore affect the muscles of the female genital tract causing impaired reproductive function.

Research suggests that feeding on high levels of potassium (5%) may delay the onset of puberty, delay ovulation, impair the development of the corpus luteum and increase the incidence of anestrus in heifers. Lower fertility was observed in cows fed high potassium or rations in which the potassium-sodium ratio was too high.

Magnesium

Magnesium usually does not have a direct impact on the reproductive status of animals, as it remains almost antagonistic to calcium in the body, and any disorder in Ca-P-Mg homeostasis can affect reproduction. Moreover, magnesium deficiency has led to loss of appetite [46].

Copper

Copper is one of the most important minerals in terms of reproduction, so deficiency is reported to be responsible for early embryonic death and embryonic resorption, increased chances of placental retention and placental necrosis and low fertility associated with delayed estrus (Howell and Hall, 1970). Copper treatment is reported to improve conception, as copper-treated cows require sowing, and untreated cows require a sowing rate of 1.15 [48].

Molybdenum

Molybdenum deficiency causes reduced libido, spermatogenesis, male infertility, delayed puberty. Reproductive processes affected by molybdenum deficiency are decreased libido, spermatogenesis in males and delayed puberty, low conception rate and anestrus in females [46].

Zinc

Zinc is known to be essential for proper sexual maturity, reproductive capacity (gonadal cell development) in males and all reproductive events (estrus, gestation and lactation), specifically with the onset of estrus in females. In addition, zinc plays a critical role in the repair and maintenance of the uterine lining after calving and the faster recovery of the uterus and the appearance of estrus [48].

Selenium

Selenium is an essential oligomineral for optimal fertility in both males and females, the selenium requirement is generally very low 0.1-0.3 ppm for most species. It occurs in inorganic and organic forms in nature. The inorganic form found in the form of selenite (Se4 +), selenate (Se6 +) and selenide (Se2−) and these forms are mainly selenite or selenite are obtained from plants in the soil to synthesize amino acids. If the soil is deficient in Se it leads to a decrease in the level of Se in plants.

Microminerals

Cows require 10 microminerals. Seven of the 10 microminerals have established requirements, including iron, manganese, copper, zinc, selenium, cobalt and iodine. Chromium, molybdenum and nickel microminerals do not have a set requirement and are not normally added to mineral mixtures in dairy cow rations. Only three of the microminerals (copper, zinc and selenium) are likely to be deficient in the vacillate rations that are grazing. Micromineral requirements and maximum tolerable levels for beef cattle are shown in Table 2.

Cobalt

Cobalt functions as a component of vitamin B-12, which is synthesized in the rumen by bacteria. The main symptom of the deficiency is loss of appetite and weight loss. Most feeds have normal cobalt levels; however, it is usually added to the mineral mixture at about 10 ppm to ensure that there are no deficiencies. Cereal-rich diets require more cobalt than feed-based diets, and cobalt should always be included in the mineral mix when eating cereal-based diets.

Copper

Copper is the most common micro-mineral deficiency in grazing cows. Copper is an important component of many enzymatic systems that are essential for normal growth and development. Copper deficiency in rations leads to low fertility, low immunity and reduced hair pigmentation (black hair turns red). But most copper deficiencies in rations are caused by the consumption of antagonists, which reduces the absorption of copper. Copper should be supplemented in the form of copper sulphate, tribase copper chloride or a complex organic form, as copper oxide is very poorly absorbed.

Iodine

Iodine is an essential mineral for the functioning of thyroid hormones that regulate energy metabolism. The first sign of iodine deficiency is goiter in newborn calves. Iodine is usually supplemented as ethylenediamine dihydroidide (EDDI). The maximum legal EDDI supplementation is 50 mg per head per day. In some cases, EDDI has been included in rations to prevent leg rot; however, the amount of EDDI needed to prevent foot rot is much higher than the requirements, and most likely will not prevent foot rot when included at the legal maximum.

Iron

Iron is primarily needed for hemoglobin formation. Symptoms of deficiency include anemia, low immunity, and weight loss. Iron deficiency is rarely seen in grazing cows. Iron oxide is often included in mineral mixtures, but is not available to the animal and only serves as a coloring agent to give the mineral a dark red color. Iron sulphate is available for the animal and should be used if iron supplementation is required.

Manganese

Manganese is necessary for normal reproduction and for fetal and udder development. Manganese deficiency is rare and is unlikely to be a problem for grazing cows. Manganese oxide is the most common form of manganese used in mineral mixtures. Corn rations are low in manganese and supplementation is needed when cows are fed these rations.

Selenium

Selenium deficiency causes white muscle disease (similar to muscular dystrophy) in newborn calves. Selenium deficiency can also cause calves to be weak at birth and increase their susceptibility to calf diseases such as diarrhea. Elevated placental abruption and low fertilization rates are often seen in selenium-deficient cows.

Selenium is added to mineral mixtures in the form of sodium selenite. Selenium is very toxic and should only be used in a premixed form. The FDA allows the use of selenium at a level not to exceed 0.3 ppm of the dry matter in the total ration of dairy cattle. Selenium deficiency should not be a problem if adequate amounts of selenium are consumed in the mineral supplement.

Zinc

Zinc is a component of many enzymes and is important for immunity, male reproduction and the health of the skin and hooves. Cows have a limited capacity to store zinc and supplementation is always necessary. Zinc absorption is closely related to copper absorption, and the zinc-copper ratio should be maintained at approximately 3: 1. In addition, high iron levels can lower the absorption of zinc. Zinc absorption decreases once the ratio of iron to zinc exceeds 2: 1.

Vitamins

Vitamins are closely related to the metabolism and absorption of minerals. Vitamin A helps keep skin and mucous membranes healthy. Vitamin A requirements are usually met by grazing fresh, green, and growing grass. Oxidation damages vitamin A during storage, so stored feed rations should be supplemented with vitamin A. Vitamin A can be added to a mixture of minerals in a stabilized form to prevent oxidation. The minimum amount should be about 120,000 international units (IU) of vitamin A per kilogram of mineral. Vitamin A can be added to the grain mix to provide 15,000 to 30,000 IU per head per day, depending on individual requirements.

Vitamin D helps in the absorption of calcium and phosphorus from the intestine and their deposition in the skeletal bone. The signs of vitamin D deficiency are similar to calcium or phosphorus deficiency. Most cows exposed to direct sunlight synthesize enough vitamin D, but cows raised in the stable may need extra vitamin D.

Vitamin E is usually present in rations in sufficient quantities for all classes of cows; however, a selenium deficiency could lead to an apparent vitamin E deficiency. Vitamin E can be useful for short periods of stress that can occur when calves are mixed and transported to weaning.

Other essential vitamins are usually present in adequate amounts in the diet or are synthesized by bacteria in the rumen.

Choosing a mineral supplement

The actual mineral content of feed, in particular feed and by-products, will vary, so all feed should be tested for actual mineral content. However, mineral concentrations can be used as a guide when choosing a mineral supplement to supplement a particular feed ingredient. The calcium / phosphorus ratio in most mineral mixtures should be 2: 1 to 4: 1. Phosphorus supplementation may not be necessary if the feed has been fertilized with poultry bedding or when fed with high phosphorus feed such as cottonseed, cottonseed meal, distillation cereals or gluten-free feed. maize. Salt is not stored in the animal's body and should be available continuously. Salt is the only mineral that cows crave, and cows that do not have salt will often eat dirt or wood. A mixture of minerals should contain 15 to 22 percent salt. Magnesium should be at least 14% in the mineral mixture when grass tetany is a problem. Also look closely at the labels of minerals to add unnecessary products, such as B vitamins (thiamine, riboflavin, folic acid). These vitamins are not normally needed in grazing cows because they are produced by bacteria in the rumen and increase the cost of the supplement.

Conclusions

Efficient production in domestic animals requires essential nutrients to be supplied, in adequate quantities and in the most biologically useful forms. Minerals that affect breeding in cattle are generally found in the group of trace elements, although calcium and phosphorus deficiencies can also affect fertility.

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