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EFFECTS OF DEFICIENT NUTRITION ON THE REPRODUCTION OF THE MILK COWS

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Abstract

In the past decades, the downsize of the fertility in the milk cows stock farm has become a more and more acute problem. This downsize being caused by a series of factors and reasons such as: genetic improving, inadequate nutrition (deficient or excessive diet), deficient management of reproduction, raise of diseases rate due to immunity abasement, growth technology wrongly applied and the overall well-being of the animal.

In the paper the following are presented: causes, etiology, cause-related mechanisms of under and over feeding, vitamins and minerals substances deficient, involved in causes which determine nutritional infertility. Of the highest importance is ensuring the corresponding proportion of each feeding principle. Cows with large milk production are predisposed to genitalia diseases due to metabolic overload.

In zootechnical exploitations over 60% of the infertility cases are due to unbalanced diets, so that the protein deficiency from food disturbs the hypothalamic-hypophyseal activity, which leads to the deficit of gonadotropic hormones creation, causing hypoesthesia, apparition, anovular heat.

Infertility determined by insufficient energetic substances: the lack of fibrous from food causes the decrease of inferior vermilion fat acids, which are the base for steroid hormone synthesis.

Infertility caused by the lack of Vitamin A occurs by the retention of fetal tectorium, uterine under growth, anovular heat apparition. The Vitamin D insufficiency can cause dysgravidism.

Vitamin E insufficiency can cause placental degenerative processes. Also, Vitamin C is involved in stress related annihilation problems.

Microelements insufficiency such as: Mg,P,Ca,Na,K,Cl,S,Fe,Mn,Cu,Zn, will cause several affections such as: anovular heat set up, luteal cysts, placental retentions, uterine involution, anoestrum, weak or ailing conception products.

Key words: *genital apparatus, gonadotropic hormones, ovarian cysts, anovular heat, infertility, luteal cysts, uterine involution, anoestrum.*

INTRODUCTION

The genetic selection of milk cows has proven that there is a connection between the activity of hemadens and the nutritional metabolic balance, so that the reproduction is compromised in the periods when the diet is insufficient, especially at the beginning of lactation. The necessary energy demand to synthesize and release hormones, to keep an embryo in early stages of development, is probably minimum compared to the energy necessary to keep lactation.

In any case, the and endocrine metabolic signs associated with the Negative Energy Balance (NEB)affect the ovulatory cycles, oocytes, the quality of the embryo as well as keeping the fetation.

The organism requirements to synthesize milk are higher, the reproduction function may be affected when the nutritional absorption is insufficient to ensure the necessary energetia, mineral and minor elements substances, which are extremely important for the organism in this period.

The milk production rate grows fast in the first week after birth.

In the period when milk synthesis rises, the reproduction function may diminish, if the compensatory necessary absorption of nutritive substances level is not reached. Several recent studies show that the milk production rises at a very fast pace in regard to the energy absorption (Villa –Godoy et al., 1988, Vasconcelos et al., 2003).

When cows suffer from a Negative Energy Balance (NEB), the free fat acids concentration from blood rises, registering at the same time low values of IgF-1, glucoses and insulin. These changes in metabolites and blood

hormones may compromize ovarian functions and fertility.

Also there has been reported that the Negative Energy Balance (NEB) and the dry matter substance intake (DMS) may affect the plasma concentrations in progesteron (Villa –Godoy et al., 1988, Vasconcelos et al., 2003) fact that may interfere in the evolution of ovarian folicules and keeping the fetation. Over the last decades genetic selection and cow population managing have increased extraordinarily the production of milk cows, at the same time decreasing fertility. (Butler, 2003).

This was also due to the fact that the endocrine profile of the milk cow was modified so that the somatotrophin and galactin from the bovines blood have also increased, while insulin has decreased. (Bonczeck et al., 1988).

These hormonal changes and the grown nutrient necessary for the milk production may negatively affect the reproduction of the milk cows.

In any case, adequate diets and proper administration have shown an equilibrium between production and fertility decrease within the cows populations with an ordinary milk production, larger the 12,000 l/cow/year, (Nebel and McGiliard, 1993; Jordan and Foudraine ,1993).

Several nutritional strategies were proposed to enhance the milk cow reproduction, without affecting the milk production performance. Maximizing the dry matter consume in this period of transition determined a minimization of the postpartum problems incidents, diets which have higher insulin concentrations from the beginning of the lactation, as well as adding additional fats, manipulating fat acids consume (FA), fat resources, it is expected to bring benefits to the milk cow reproduction. (Santos 2010).

The economic desideratum in milk cows farms represent on one side obtaining a milk production where the milk is rich in protein, and on the other side obtaining a calf every year.

In this regard there must be a good functioning of the axis level: hypothalamus-hyphophysis-uterus-ovary.

The main hormones in the oestral cycle, ovulation and conception are progesterone and estrogen, whose production varies according to several nutritional causes and unbalanced diets. Progesterone is a steroid hormone induced by the ovarian yellow body cells, and during the gestation period is also produced by the placenta.

Its role is to prepare the uterine mucosa to receive the fertilized ovule. The estrogen is produced by the ovaries with the role of maintaining the structure and function of the vagina wall, and is responsible with the nutrition of the fertilized ovule and later of the development of the fetus.

A good functioning of this mechanism leads to an uterine involution, to a normal ovary rhythm, to an eloquent manifestation of heat and finally to the installation of a new gestation.

There must be ensured a balanced diet from the quantity and quality point of view, any unbalance between these factors or disrespect of the proportion between the necessary nutrition elements will cause the organism to look to the accumulated reserves and the decrease of reproduction will be installed, infertility, decrease of vitality of the new born. The scarce diet of the cow determined faint heat, the reduction in volume of the ovaries (ovarian underdevelopment), affecting the follice genesis and ovigenesis or even the total lack of heat. All these abnormalities are installed before the apparition of clinical loss of weight signs (Birtoiu et al., 2006)

The effects of the milk cow scarce diet

Infertility determined by lack of protein

The protein insufficiency affects the metabolic processes, diminishes the plastic and cellurar recovery processes, the hepatic reduction oxidation processes, it interrupts the hypothalamus-hyphophysis activity, the hyphophysis being deprived of the necessary amino acids and as a consequence the gonadotropic hormones elaboration, causing hiposympathicotonia and ovarian inactivity. The antehypophyseal hipofunction induces the shut-off of follicule and ovulation maturation. In some follicues, oocytes present modifications characterized by the contraction of the propoplasma and nucleus pyknosis. In ovaries the progestative bodies are missing and the ovaries become half-grown, while the parenchyma becomes dense and lack of elasticity.(Birtoiu et al.,2006).

Infertility determined by lack of protein

Lactating cows need large quantities of metabolized amino acids necessary for the synthethys of the milk protein.

It is necessary that the administered rates to contain between 16-18% of raw protein. Feedstuffs which have reduced quantities of raw protein may compromise microbial development and fermentation processed from the vermilion, also causing the milk production decrease.

On the other hand feedstuffs which contain excess protein cause higher concentrations of ammoniac and urea in the blood, causing the decrease of fertility. (Butler, 1998).The decrease of fertility of milk cows on excess protein diets is due to the decrease of uterin pH at the beginning of the luteal phase of the estral cycle.(Butler, 1998).This effect seems to limit itself only to the first stages of development of the embryo. (Rhoads et al.,2006).

Because high-producing lactating dairy cows are more efficient in utilizing protein sources when diets are moderate in crude protein and are balanced for the supplies of metabolizable protein and limiting amino acids (Noftsger et al., 2003), it is not justified to feed diets with protein concentrations that will increase urea N and harm fertility.

Excess protein may cause the aggravation of the energy balance, which may cause the delay of the first ovulation after birth. The ammoniac excess in the vermilion causes a high level of urea in the blood which has a toxic effect on the embryo and ovulation too. The large urea concentration in the blood has negative effects on the progesterone secernment too. (Rhoads et al.,2006).

The lack of lipids from the diet has a bad influence on the reproduction. The accumulation of large quantities of ketonic bodies in the organism resulted from incomplete and abnormal adjusting of lipids associated with the lack of carbohydrates influence the hiphosis and ovarian functions, causing the hipofunction of the antehyphophyseal. The lipids excess in the diet will lead to adiposis of the animals, which negatively affects fertility. (Şara.A., 2007).

Table 1. The inadequate and excessive influence of the nutrient diet input, on the bovine reproduction (Bearden et al,1992).

Nutrient intake	Consequences
Excess energy intake	Decreased conception rate, abortion, dystocia, placenta retentions, libido decrease
Inadequate energy intake	Late puberty, suppression of the oestrus, ovulation and libido and suppression of sperm production
Excess protein intake	Low conception rate
Inadequate protein intake	Suppresses estrus, decreased conception rate, fetal absorbtion, early birth, week fetuses
Vitamin A deficiency	Affects spermatogenesis, anoestrum, low conception rate, abortion, week progenies, placenta retentions

Infertility caused by energetical substances

Cow fertility is tightly connected to the feedstuffs input, both raw and fiber. The lack of fiber leads to the decrease of the fat content in milk, to ruminal oxydosis, genital ketosis and genital secretion causing a decrease of inferior fat acids in the vermilion, which are the basis of steroid hormones synthesis, causing this way the decrease of sexual steroids and as a consequence the apparition of fertility affections. (Birtoiu et al., 2006)

Tetany is an extension of a normal metabolic process which happens to milk cows with large milk productions. The glucoses (or sugar) deficit in the blood and tissue leads to the apparition of ketosis.

The glucoses is synthesize by cows from carbohydrates which are found in plats from grazing fields or in administered foodstuffs diets. During late gestation the glucose is mainly used for the normal development of the fetus. During the lactation period glucose is essential to form lactosis and milk fat. The glucose requirement being at a high level will determine the decrease of its concentration in the blood setting for hypoglycaemia.

Fifty grams of glucoses are necessary to produce a liter of milk which has 4,8% lactosum and thirty grams of glucoses for litre

of milk which has a fat content of 4%. To satisfy this necessary the diets can be succenturiated with different quantities of carbohydrates.
In case the glucide quantity of the diet is not enough to satisfy the glucoses necessary which the cow needs then the liver will produce glucoses from other basic compoundsof the organism, usually mobilizing the fat reserves. As a consequence of these metabolic processes the cetone are resulted (Ballarat, 2007).

The primary cetone is installed when the cows with large milk productions are not ensured with diets which have a sufficient quantity of carbohydrates.
The secondary cetone may be installed when primary problem or desease appears which determines digestive or carbohydrate failures. (Ballarat, 2007).
Hypoglycaemia, during artificial insemination, but even 3-4 days prior to it suppresses the oestrus or inhibits fecundation.

Table 2. The main biochemical modifications seen in phleboi blood during ketosis at milk cows in mg/dl (after J. Brugere P. ,1978)

Concentration	**Normal**	**Clinical ketosis**
Glucoses	40-70	30 (20-40)
Cetonic bodies	< 10	10-100
Free plasmatic fat acids	8	30

The values of glycaemia for cows are between 40-70 mg/dl of blood.
In clinical ketosis the blood glucoses level decreases between 30-20 mg/dl.
In case of secondary ketosis glycaemia is always superior to the value of 40 mg/dl, often being over the average of 50 mg/dl of blood.
In hiperacetonemia the normal blood level of the cetonic bodies, which is lower than 10 mg/dl, becomes higher (from 10-100 mg/dl of blood).In case of secondary ketosis, the acetonemia is rarely superior to the value of 50 mg/dl.

In acetonemia there is registered the rise of the AGLP level, from 8 mg/dl-30 mg/dl, this rise demonstrating a lipomobilization.
The value of cetonic bodies in milk varies between 3 mg/dl, at a healthy cow and 40 mg/dl, at a cow with ketosis. (J. Brugere, 1978)
The negative energy balance present after fecundation may determine early embryonarmortality. To avoid this process a stimulating diet must be applied post oestrus (flushing postestral). The energy excess is as damaging as the lack of it causing a higher frequency of quiet heat and affecting nidation. (Birtoiu et al., 2006)

Table 3. Metabolic load (ML) causes negative energy balance (NEB) and increase metabolic rates impairing Reproduction in lactating, high-producing dairy cows. (Knight et al. 1999

Metabolic load (ML) causes:	**Categories of changes and consequences**			
	Metabolic/endocrine	**Ovarian/endocrine**	**Functional/clinical**	**Breeding consequences**
Negative Energy Balance (NEB)	- Reduced synthesis and secretion of GnRH and LH - Reduced glucose - Reduced insulin - Reduced IGF-I	- Low or absent production of estrogens - Delayed LH-peak - Delay or absence of ovulation	- Poor estrous signs - poor oocyte quality - Failure of fertilization - Early embryo death - Shorter estrous cycles - Anestrus	- Repeat breeding - Low pregnancy rates - Low calving rates - Extended calving interval - Economic losses - Poor animal welfare
			- Impaired liver function - Impaired endometrial function (less favourable for embryo development) - Impaired immune function (increased propensity to endometritis and retained placenta)	
Increased metabolic hepatic rates	Increased catabolism of estradiol and progesterone	Lower levels of estradiol and progesterone in circulating blood	- Poor or absent estrous signs - Failure of fertilization - Early embryo death	

Vitamin A insufficiency

Vitamin A or retinol is the most important vitamin in the bovine diet. It is the only vitamin which must be added to the bovine diet. The beta-caroten is found in large quantity in green plants, this being converted in the animal organism in vitamin A. In cows, such a deficiency may occur only towards the end of winter, and then only if no green forage is available at that time.The Holstein-Fries breed can convert better the beta-caroten in vitamin A as the Jersey breed. Vitamin A is stored in the liver and is necessary to the good development of the bones, sight, maintaining epitalial tissue and has a very important role in reproduction.

The symptoms of vitamin A deficiency are scouring, low resistance to bacterial infection.The fertility of cows is always affected. A shortened period of gestation, a high incidence of retained placentas, stillbirths and abortions are common symptoms. Often calves are born blind and their movements are unco-ordinated. .(Bredon et al., 2005)

Vitamin A insufficiency may negatively influence gametogenesis, sexual cycles, anuvulate heat apparition, involution of the heat luteal body, apparition of the persistent luteal body. Vitamin A directly or indirectly participates to the biosinthesys of the progesterone. (Bîrțoiu et al., 2006).

Vitamin D insufficiecy

Vitamin D is found in plants of the provitamin form which is converted in the animal body in vitamin D when these are exposed to the sun. At cows the vitamine D insufficiency may also appear in cases of low quantities of calcium and phosphorus in the body. Because of the lack of vitamin D the bony cage of calves become very weak, with rachitis phenomena. At adult cows the vitamin D insufficiency will cause the decrease of the reproductive function as well that of the milk production. (Blezinger, 2004)

Vitamin E insufficiency

Vitamin E was identified as an essential nutritive element for animals 60 years ago. Rats fed with diets without vitamin E cannot reproduce; lots of studies demonstrated similar results for other species.

In case of vitamin E insufficiency a major problem for milk cows is mammitis, especially clinical mammitis or infections of the mammary gland. The plasma concentrations of the tocopherol (the chemical active form of vitamin E)are connected with the vitamin E input. During the peripartum period the plasma concentrations of tocopherol are significantly lower than during the gestation and lactation period.

At milk cows with plasma concentrations of the tocopherol less than 3 mg/l , it has been observed a grater incidence of clinical mammitis. Vitamin E interacts with selenium together with the two nutrients prevent the deterioration of the tissues. The vitamin E or selenium insufficiency may cause the decrease of the reproduction performance, the increase of placenta retentions, it increases the risk of early abortion.(Blezinger, 2004)

Vitamin C insufficiecy

Vitamin C decreases the organism immunity and has an indirect action on reproduction neutralizing sterility problems related to stress, intervenes in the development of and maturment of ovarian follicule and in the synthesis of steroid hormones. (Bîrțoiu et al., 2006)

Microelements insufficiency It is know that diets lacking of some mineral substances can cause infecundity states at animas.

Calcium insufficiency

Milk fever generally appears at cows with large production starting from the third lactation. Tetany is usually associated with birth, installing at 72 hours after birth. Because of the calcium request and due to the large volume of milk and poor calcium diets, the level of calcium from the blood drops, and tetany is installed.

Calcium is essential for the muscular activity. The calcium insufficiency may affect different groups of muscles, causing the apparition of hypomotility of the digestive system. Also it can affect the genital system muscles. The cervix may be dilated, atonic, uterine contractions are weak in intensity or can even be missing, the uterus is atonic, which may cause dystocia, late births which last very long, affecting both the cow as well as the calf, placenta retentions, uterine involution. Due to the tardive involution of the uterus the apparition of the first estrus after birth is prolonged, increasing the risk of clinical and subclinical uterine infections which may

influence negatively the reproductive function. Tetany cows have a high level of cortisol in the blood which may decrease immunity facilitating infections such as mammitis or hysteritis. (Macky, 2007.)

Table 4. Consequences of subclinical hypocalcaemia (after Kamgarpourr et al, 1999)

Digestive apparatus	Decrease of vermillion and rennin
Genital apparatus	Decrease uterine contractions Placenta retention Decrease of uterine and cervical involution speed Increase the birth-fecundation interval Decrease of fertility Decrease of the follicle number Decrease of the yellow body size Decrease of the progesterone

Phosphorus insufficiency

Phosphorus is essential for the normal functioning of the tissue. In the situation of a diet poor in phosphorus the animal compensates the phosphorus insufficiency in the blood by mobilizing it from the bones reserves. In the conditions of a long term diet poor in phosphorus there will appear growth failures, bone failures, decrease of appetite, the milk production and fertility are affected. The phosphorus insufficiency determined a low conception rate, quiet heat, oestrous irregular cycles and infertility. (Brendon et al., 2005).

The phosphorus excess blocks the calcium absorption, in the same time affecting also the reproduction function.

Magnesium insufficiency

Magnesium is necessary in the bovine diet especially to form bones. Cows need 1,9 g Mg/kg/dry matter.(Hamlyn-Hil, 2012) .The magnesium insufficiency may cause dystocia and placenta retention.(Rotaru, 2009)

Sodium insufficiency

Sodium is an essential macroelement. The subclinical sign of the sodium insufficiency are similar to those of the phosphorus insufficiency. The sodium insufficicency from the diet causes the decrease of the milk production. (Hamlyn-Hill, 2012).

Diets poor in sodium may cause sexual cycles affections, decrease of fertility and placenta retentions.(Bîrțoiu et al.,2006)

Potassium insufficiency

Potassium has a large number of functions, it facilitates glucoses and neutral amino acids absorption, maintaining the balance of basic acids in the body The Potassium necessary in that of 5 g /Kg/dry matter. (Hamlyn-Hill, 2012).

Hipopotassemia was associated with muscular weakness, decrease of muscular trophism. In the K insufficiency the plasma value is that of 2,5 mmoli/l(Goff, 2006).

The extracellular concentration of K is that of 3,9-5,8 mmoli/l, Potassium having an important role in maintaining the basic acids balance. Potassium insufficiencies lead to the decrease of fertility by affecting sexual hormonopoiesis, causing the impossibility to synthesise steroid hormones. Diets with a high level of Potassium may delay ovulation affecting the luteal body, delaying growth and development of heifers as well as installing anoestrus.(Smith et al., 1979)

Trace elements insufficiency

Iodine insufficiency

Iodine is essential for the normal body development, half of the total Iodine quantity being present in the thyroid gland. The Iodine insufficiency at milk cows shows placenta retentions, decrease of reproductive performance, stopping fetus development which will cause fetus mortality, abortions, hairless descendants, irregular oestrous cycles or stoppage of these.(Brendon et al.,2005)

Manganese insufficiency

Although manganese insufficiencies rarely appear at ruminants, they can cause multiple problems, affecting development and reproduction.

Heat in cows and heifers are hard to observe (quiet heat) and the decreased conception rate. The Manganese insufficiency at cows with calf will cause weak calves with extremities problems.(Brendon et al.,2005).

Zinc insufficiency

Phosphorus insufficiency causes growth problems, parakeratosis, hair and skin traumas. The calcium excess in the diet may affect Zinc absorption although the zinc deficit at ruminants is rarely seen. (Brendon et al., 2005)

The zinc insufficiency causes a n underdevelopment of the genital apparatus and infertility by affecting ovulation. (Bîrțoiu et al., 2006)

Copper insufficiency

Phosphorus insufficiency in the diet may have rather serious consequences for the health of the animals. There is a strong correlation between hypocuprosis and abortion. A recent study showed that 87% of anoestrus heifers are due to cuprum deficit.

A new born calf from a cow with copper deficit will suffer bone marrow affections which will determine muscular trembling, ataxia and paralysis.(Sakhaee, 2011)

A low level of cuprum in the body causes ovarian inactivity, increase of the placenta retentions, decrease of fertility and instalment of anoestrus. (Brendon et al. 2005),

Selenium insufficiency

Usually selenium insufficiency is found in animals with feedstuffs diets, from soils poor in selenium. The selenium deficit may cause a series of muscular affections, reproduction problems, decrease of fertility, cardiac insufficiency at young animals. At old bovines it causes the retention of fetal tectorium, ovarian cysts, anoestrus, embryo mortality, mammitis and the increase of somatic cells number in milk. (Heather, 2009)

CONCLUSIONS

Genetic selections at cows in the past decades have concentrated mainly on the increase of milk production. By increasing production performances a series of problems have appeared, causing health problems of the animals and the decrease of fertility.

Studies have shown that nutrition management during the transition period may improve reproduction, minimizing metabolic affections during the postpartum period and even later on.

Managing the negative energy balance and increasing the energy intake improve the reproduction function. The mineral elements present in the animal body are characterized by properties favourable to circulation and chemical mobility necessary to life. There still are many mineral interrelationships and interdependencies probably many unknown facts until present time where excess or deficit of a mineral will influence the absorption or usage of another mineral.

It is very clear that diets are strictly connected to the milk cows reproductive function. The basic issue is the deficit level, the unbalance or excess in the diet of animals with large productions.

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