THE EFFECT OF COLOSTRUM DOSING ON BLOOD IMMUNOGLOBULIN LEVELS IN CALVES

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Abstract: *The authors carried out their research in Holstein-Friesian breed under the conditions of organic farming. The colostrum antibody content was measured as a function of the time elapsed since calving, the authors also measured the effect of the time of the first colostrum on the antibody level of the 48-hour calf serum and on the number of days of disease until the 10th day of life. The efficacy of a commercially available bovine colostrum product against fresh colostrum has also been investigated. Colostrum at calving Brix % (control value) 26.96+/-3.11; after 12 hours 17.50+/-1.30 (65% of control value); after 24 hours 8.04+/-0.92 (30% of control value) (n = 10; SD5% = 1.85). Brix % of the serum of 48-hour calves, fed immediately after birth (control value) 9.06+/-0.73; fed 2 hours later 7.32+/-0.34 (81 % of control value); fed 4 hours later 5.86+/-0.35 (65 % of control value). In case of calves fed by the colostrum product just after birth 7.66+/-0.24 (85 % of control value) (n = 10; SD5% = 0.41). The number of days of disease per 1 calf being fed immediately after birth is 0.4; that in the 2-hour group is 0.8; in the 4-hour group 1.3; in the group with the colostrum product it is 0.5 – it shows a very close second degree correlation with serum Brix % values (R2 = 0.9559). It can be stated that the content of colostrum antibody (Brix %) decreased rapidly after calving. In case of calves, the more time passed between the birth and first colostrum feeding the less effective it was to pick up the antibody from the colostrum, which is supported by the Brix % of serum and the number of days of disease, as well. Each group received colostrum milked immediately after calving, only the time of first drink was different. If necessary, timely drinking of a good quality colostrum preparation can be an appropriate alternative for calves, but their mothers' fresh colostrum is a more reliable protection. The results confirm that calf rearing by feeding them with colostrum after birth is the most sensitive segment of cattle breeding and that well-functioning colostrum management is key to establishing well-producing stocks.*

Key words: *Holstein-Friesian, colostrum management, calf rearing, bucket feeding*

INTRODUCTION

It is always in the vital interest of a farmer that he can provide the best possible development of the small animals that he has domesticated. The animals can later become healthy, well-reproducing, long-lived breeding or fattening animals for economical production. This is a particularly important issue for cattle, as this species is not among the well reproductive animals. Bovine breeders define the rearing of calves as the most delicate segment of their activity. Cattle can be brought to breeding relatively late, gestation period is long, and one offspring is born per calving. All of this means that one cow can only win one calf every year. Dairy farms, which specialize in dairy farming, have a serious problem that 50% of the calves that are born can not be used directly in production (bull), and even among the heifers - despite the greatest care - more or less unsuitable for breeding.

97% of Hungary's controlled milk production comes from the Holstein-Friesian variety, which is undoubtedly the world leader in dairy farming. At the same time, breeders of this breed have to face such problems as their short-term useful life, with a high proportion of the loss (disease) after the first calving, frequent infertility and late re-gestation (BAKOS, 2008; BERTA, 2010).

It follows from all this that every single loss in the calf age does not only cause significant material damage, but also endangers the number of dairy herds. It is understandable, therefore, that we do not experience a great deal of experimentation in the field of calf rearing, that is, breeders are generally reluctant to deviate from the technology that already works well in their economy.

The oldest, most natural and least problematic way of rearing calves is when the cow is raising its own calf. In this case, the calf will stay with her mother for months, and she can suck her up to 15-20 times a day. Over time, this lactating calf rearing has remained justifiable in farming systems where milk production is not an objective, so cows are not milked (primitive or specifically cultivated for meat production). In the milk-producing or dual-use sectors - where the cows are milked - the calf is separated from its mother very early and is raised artificially (bucket feeding).

In most cases, the calf is isolated directly after calving in order not to develop close contact with the mother. However, human errors related to colostrum drinking (lack of professional knowledge, labor problems) cannot be completely excluded. Considering that the heifers born today are dairy cows for the future, it is extremely important to have colostrum management at the farm.

Main characteristics of digestion of newborn calves

At the birth of the calf, it already has all compartments of the special stomach typical of ruminants, but the digestion of the nutrients is actually only in the abomasum and small intestine. Forestomachs (rumen, reticulum and omasum) are inactive. Their operation begins at the age of 3-4 weeks of the calf, and only in the 7-8. it becomes perfect in a weekly life (but it depends to a great extent on how the solid feed is). The calf is therefore considered a monogastric animal in the first weeks of its life (HOLLÓ et al., 2011).

It is important to note that the capacity of the newborn calf's stomach is low, about 1.5-2 liters. If they are kept together with their mother - so they can take the colostrum in a natural way - they suck 8-10 times a day on average. In the case of bucket feeding, it should be attempted to drink as many times as possible in the first two days, but at least 4-5 times per day, and not to limit the amount that can be taken once (HOLLÓ et al., 2011).

Composition of colostrum

According to HOLLÓ et al. (2011), the composition of colostrum differs significantly from that of normal milk, however, this difference is relatively fast disappearing, about 3-5 days after calving. The *dry matter content* is drastically reduced (CSAPÓ and CSAPÓNÉ, 1984; SZENTPÉTERI et al., 1986). The authors measured 24-25% on the day of calving, one day later they found the dry matter content of colostrum was only 13-16% (12-13% of normal cow's milk). The higher dry matter content is likely to be related to the fact that the calf is initially able to consume only a small amount at a time. CSAPÓ et al. (1994) describe that colostrum of Holstein-Friesian cows with twin calfs may contain substantially more dry matter (29-30%) at calving than a calf feeder, but the difference disappears on the day after calving. The colostrum of the different breeds may have different dry matter content at the calving, however, it should be taken into account that measurements were made at different places, time (year) and number of animals (VERTSÉNÉ, 2008). Thus, e.g. IBEAWUCHI and DANGUT (1996), in the case of zebu subspecies - besides hot, wet climatic factors - only 14-15% of the dry matter content of the colostrum. Although it was less than the value of most breeds, it did not show any significant decrease over time (13-14% left).

According to ÁLDÁSY and ERDŐS (1969) studies of Hungarian Simmental cows, the *protein content* of colostrum varied from 9.6 to 19.6% at calving, to 5.8 to 10.8% for the following day, while at 3th day after calving only 1.2-3.7%. The mean values of immunglobulin content at the same times were 7.56; 3.00 and 0.78%. According to SCHMIDT and ZSÉDELY (2011), the initial immunoglobulin content of the colostrum is 5-7%; It is halved every 6-8 hours, with only 0.2% of the immunglobulin present in the milk on day 7. The

proportion of whey protein in colostrum is very high. On the one hand, the biological value of whey protein is one and a half times that of casein, on the other hand, this fraction contains immunoglobulins (CSAPÓ and CSAPÓ-KISS, 1988; CSAPÓ et al., 1994).

The *fat content* of colostrum is the highest after calving, decreasing for the next day, and fluctuating after whitout a clear tendency to day 4 (KOVÁCS, 1999; WAGENHOFFER et al., 2002; PASZCZYK et al., 2005). In case of Holstein-Friesian cows, mastitis occurring in the late period of dryness does not affect the fat content of colostrum (MANUSELL et al., 1998), but the heat stress it may reduce it at the same time (NARDONE et al., 1997). The proportion of fatty acids within the fat (e.g. trans-C18:1 fatty acids or CLA) is different after calving than in normal milk produced later (PASZCZYK et al., 2005).

The *milk-sugar content* of the colostrum is lower than normal milk and is expected to be 5-6th day it reaches 4.8-5.0% of normal milk (MERÉNYI and LENGYEL, 1996; KOVÁCS, 1999).

Colostrum contains more *minerals* than normal milk. The concentration of Ca, P, Mg, Na, Fe, Mn and Cu shows a rapidly decreasing tendency after calving (KUME and TANABE, 1993; KUME et al., 1998; LEVIEUX, 1999).

MATERIAL AND METHOD

Objectives of Experiments

We tried to answer the following questions with our series of experiments:

- At what rate does the Brix% of expressive colostrum change (decrease) at 24 hours after calving?
- How does the choice of the first colostrum dosing (0-2-4 hours) affect on the Brix% value of the 48-hour calf serum, ie the supply of antibody?
- Does the time of the first colostrum drink have a noticeable effect on the health of calves, the number of days of disease?
- Is there a statistical correlation between the percentage of bovine serum brix and the number of days of disease?
- What are the results of using a commercially available bovine colostrum preparation for newborn calves?

The questions asked were examined in the Holstein-Friesian breed and in the conditions of organic farming.

Effect of milking time on Brix% of colostrum

10 Holstein-Friesian cows were included in the study, which had been given at least one time earlier, and there was no complication around their current calving. Individual colostrum samples from selected cows were taken immediately after calving and after 12 and 24 hours. Brix% of the samples was measured using a digital refractometer. The values measured at the three time points were compared by one-way analysis of variance.

Effect of the first drinking time on Brix% of calf serum

40 non-first-born Holstein-Friesian calves were included in the study, 4 group of which were formed (n = 10). 1-3. group received colostrum of the mother, immediately after birth (group 1), 2 hours (group 2), 4 hours (group 3). In the case of groups 2-3, colostrum developed immediately after calving was milked and stored chilled, but was heated to 38°C before drinking. Group 4 immediately after birth received a commercially available bovine colostrum preparation. For each test, 7 ml blood samples were taken 48 hours after birth for each calf and fractionated for 24 hours. Brix% of the precipitated serum was measured using a digital refractometer. The values of the different groups were compared by one-way analysis of variance.

Influence of the first drink time on the number of days of disease

We qualified as a day for every day when the health and vitality of a calf apparently deviated from normal, e.g. diarrhea, general weakness, refusal of milk. The number of days of disease was recorded individually for 10 days. We calculated the days os disease by groups and divided by the number of groups (10), a value in day per calf. The dependence of this on the Brix% of serum was tested by correlation calculation using Microsoft Excel.

RESULTS AND DISCUSSION

Effect of milking time on Brix% of colostrum

The average Brix% of colostrum samples taken from 10 cows, as a function of time, is shown in *Table 1*.

Table 1.

The evolution of colostrum Brix% as a function of milking time (n = 10)

	Colostrum milking (hours, after the calving)		
	0	12	24
Colostrum Brix%	26,96 (a) ± 3,11	17,50 (b) ± 1,30	8,04 (c) ± 0,92

a/b/c = Values marked with different letters differ significantly (SD5% = 1.85)

Based on the measured Brix% values, it can be concluded that, over time, the average colostrum antibody levels in cows decreased to 65% in 12 hours and to 30% in 24 hours.

Effect of the first drinking time on Brix% of calf serum

The serum Brix% of calves is shown in *Table 2.* for each group.

Table 2.

Brix% of calf serum in each group (n = 10)

	Time of the first drinkig (hours, after the calving)			
	0	2	4	0/K
Serum Brix%	9,06 (a) ± 0,73	7,32 (b) ± 0,34	5,86 (c) ± 0,35	7,66 (b) ± 0,24

K = The group received a commercial colostrum preparation instead of a freshly sown colostrum
a/b/c = Values marked with different letters differ significantly (SD5% = 0.41)

The more time it took after calving, the less effective the intake of antibodies from the colostrum. The values also show that the group that did not receive the mother's colostrum, only colostrum preparation at 0 o'clock, did not reach the degree of immunity, than the calf fed with her mother's colostrum at 0 o'clock. The average value of the preparation group can only be the same as the value of the second-hour group.

Influence of the first drink time on the number of days of disease

In the first group, who received colostrum immediately after birth, thus having the highest serum antibody level *(Table 2.)* – the total number of days of disease in the group was 4, ie 0.4 day per calf.

In the second group, which received colostrum 2 hours later, the serum antibody concentration was lower. The total number of days of disease in the group was 8, ie 0.8 day per calf.

The third group of colostrum showed the lowest blood serum Brix%, with this group having the worst health status. The total number of days of disease in the group is 13, ie 1.3 days per calf. There were hardly any calves in this group that would not have had any health problems in their first 10 days of life.

In the fourth group of colostrum preparation, the number of days of disease was barely above the values of the first group, so it can be stated that a good quality colostrum preparation may be an appropriate alternative to colostrum management. The total number of days of disease in the group was 5, ie 0.5 day per calf.

Figure 1. illustrates the relationship between the Brix% of serum and the number of days of disease per calf.

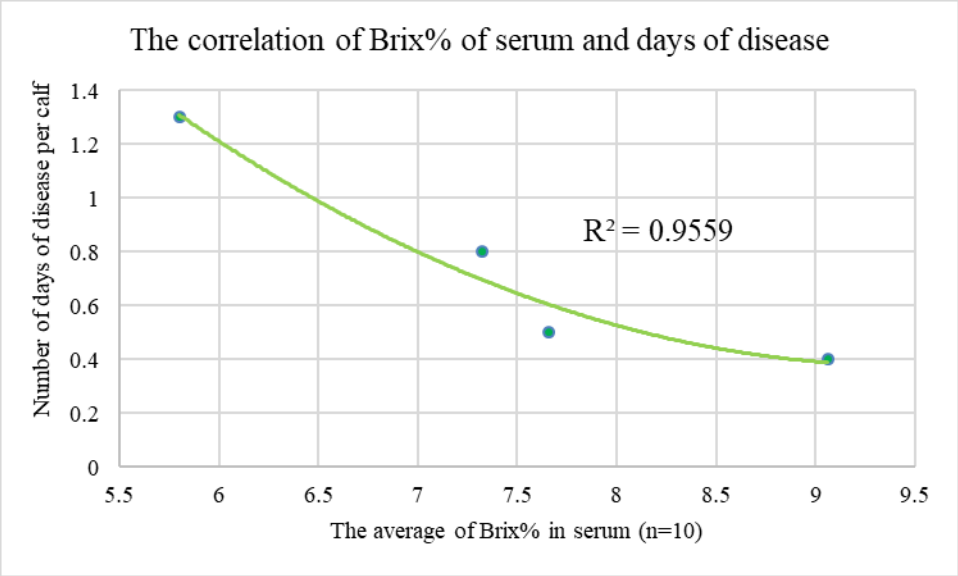

Fig. 1. The correlation between the percentage of Brix in serum and the number of days of disease per calf

The calf to be born without gamma globulins, the antibodies found in the colostrum provide natural passive immunity, ie protection against pathogens in the environment. Although these antibodies (gamma-globulins) are proteins, at the beginning of life - but only in the first 24-36 hours - it is possible to absorb them without digestion. This is made possible by the protease inhibitory effect of the colostrum and the special structure of the epithelial cells at this time (HOLLÓ et al., 2011; SCHMIDT and ZSÉDELY, 2011). It has long been known that the calf's immune system begins to develop only by the uptake of colostrum, or more precisely, by the large molecule immunoglobulins contained therein (EHRLICH, 1892).

According to studies by HAMMON and BLUM (1999), the first colostrum intake after calving leads to an increase in the protein level of the blood plasma of calves. In addition, the colostrum has a significant effect on the free amino acid (especially glutamine and glutamic acid) level in the plasma.

If the calf consumes at least 2-3 liters of colostrum in the first 6 hours, it is expected that the amount of antibodies in the blood will reach the level required on the first day, 1.5 g/100 ml (HOLLÓ et al., 2011). According to SCHMIDT and ZSÉDELY (2011), it takes 2.5 liters in 6 hours, and 4 liters in the first 12 hours to achieve proper protection. If the calf is not willing to take, coercion should be used.

It is important to note that colostrum is not only essential for the development of the immune system, but also for the calf after the birth of its exclusive feed. For its initial development, all the necessary nutrients (protein, fat, carbohydrate), vitamins, macro- and microelements, as well as many other biologically active substances, are provided by colostrum (BLUM and HAMMON, 2000).

CONCLUSIONS

Our results clearly show that properly prepared and implemented colostrum management is key to establishing a well-producing stock.

After calving, the level of antibodies in the colostrum of cows are intensively reduced.

The time of the first colostrum intake is closer to calving, the higher the Brix% (ie antibody level) of the serum.

Those calves will be more resistant to the diseases that typically occur in the first few days of life, and they will get their mother's colostrum as soon as possible.

If necessary, drinking a good quality colostrum preparation can be a good alternative for calves, but freshly-fed colostrum provides more reliable protection.

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BIBLIOGRAPHY

ÁLDÁSY P. – ERDŐS P. (1969): A föcstej jelentősége az újszülött borjak egészséges felnevelésében. Magyar Állatorvosok Lapja, 24, 183 – 186.

BAKOS G. (2008): A korai TMR etetésének tapasztalatai a borjúnevelésben. Magyartarka 8 (1) 12-14.

BERTA A. (2010): A hasznos élettartam növelésének tenyésztési lehetőségei tejelő szarvasmarha állományokban. Doktori (PhD) értekezés, Debreceni Egyetem.

BLUM, J. W. – HAMMON, H. M. (2000): Colostrum effects on the gastrointestinal tract, and on nutritional, endocrine and metabolic parameters in neonatal calves. Livestock Production Science, 66 (2) 151-159.

CSAPÓ J. – CSAPÓ JNÉ (1984): A hungarofríz alapon végzett jersey és holstein-fríz crisscross keresztezések hatása a kolosztrum és a tej összetételére. Szaktanácsok, 1, 32 – 37.

CSAPÓ J. – CSAPÓ-KISS ZS. – MARTIN T. G. – SZENTPÉTERI J. – WOLF GY. (1994): Composition of colostrum from goats, ewes and cows producing twins, International Dairy Journal, 5 (4) 445-458.

CSAPÓ J. – CSAPÓ-KISS ZS. (1988): Biological value and change of milk protein in cattle, goats, and sheep during lactation. Acta Alimentaria, 4, 372.

EHRLICH, P. (1892): Über immunität durch Vererbung und Zeugung. Z. Hyg. Inf.-skrank. 12, 183.

HAMMON, H. M. – BLUM, J. W. (1999): Free amino acids in plasma of neonatal calves are influenced by feeding colostrum for different durations or by feeding only milli replacer. J. Animal Physiology and Animal Nutrition, 82 (4) 193-204.

HOLLÓ I. – SZABÓ F. – TŐZSÉR J. – HÚTH B. (2011): Szarvasmarhatenyésztés. E-tananyag az Állattenyésztő Mérnöki BSc Szak hallgatói számára. Kaposvári Egyetem – Pannon Egyetem.

IBEAWUCHI, J. A. – DANGUT, A. J. (1996): Influence of stage of lactation on milk constituents of Bunaji (zebu) cattle in a hot humid tropical environment. Discovery and Innovation, 8 (3) 249-256.

KOVÁCS A. Z. (1999): Anyatehenek tejelékenysége és a borjak növekedésének összefüggése. Doktori (PhD) értekezés, PANNON Agrártudományi Egyetem, Mezőgazdaságtudományi Kar, Mosonmagyaróvár.

KUME, S. – TANABE, S. (1993): Effect of parity on colostral mineral concentrations of Holstein cows and value of colostrum as a mineral source for newborn calves. J. Dairy Science, 76 (6) 1654-1660.

KUME, S. – YAMAMATO, E. – KUDO, T. – TOHARMAT, T. – NONAKA, I. (1998): Effect of parity on mineral concentration in milk and plasma of Holstein cows during early lactation. Asian-Australian J. Animal Sciences, 11 (2) 133-138.

LEVIEUX, D. (1999): Colostrum, a milk particularly rich in numerous components. Is it possible to detect its unlawful addition in milk supplies? Lait, 79 (5) 465-488.
MANUSELL, F. P. – MORIN, D. E. – CONSTABLE, P. D. – HURLEY, W. L. – MCCOY, G. C. – KAKOMA, I. – ISAACSON, R. E. (1998): Effects of mastitis on the volume and composition of colostrum produced by Holstein cows, J. Dairy Science, 81 (5) 1291-1299.
MERÉNYI, I. – LENGYEL Z. (szerk.) (1996): Tejgazdasági Kézikönyv. Gazda Kiadó, Budapest
NARDONE, A. – LACETERA, N. – BARNEBUCCI, U. – RONCHI, B. (1997): Composition of coplostrum from dairy heifers exposed to high air temperatures during the late pregnancy and the early postpartum period. J. Dairy Science, 80 (5) 838 – 844.
PASZCZYK, B. – ZEGARSKA, Z. – BOREJSZO, Z. (2005): The contents of trans fatty acids and CLA in cow colostrum and milk fat in the early lactation period. Czech J. Food Science, 32 (4) 159-165.
SCHMIDT J. – ZSÉDELY E. (2011): Kérődző állatok takarmányozása. Oktatási segédlet az Állattenyésztő mérnöki, valamint a Takarmányozási és takarmánybiztonsági mérnöki (MSc) mesterszak hallgatói számára 5. fejezet: Borjak takarmányozása. Nyugat-Magyarországi Egyetem.
SZENTPÉTERI J. – KARLE G. – GUNDEL JNÉ – CSAPÓ J. – CSAPÓ JNÉ (1986): A hungarofríz alapom végzett jersey és holstein-fríz keresztezés hatása a kolosztrum és tej összetételére. Állattenyésztés és Takarmányozás, 28 (6) 549 – 558.
VERTSÉNÉ Z. R. (2008): Charolais tehenek borjúnevelő képességét befolyásoló néhány tényező vizsgálata. Doktori (PhD) értekezés, Szent István Egyetem, Gödöllő.
WAGENHOFFER ZS. – KOVÁCS A. Z. – SZABÓ F. – STEFLER J. (2002): Fehér-kék belga húsmarha fajta kolosztrumának és tejének vizsgálata. Állattenyésztés és Takarmányozás, 51 (6) 597 – 605.