

Factors of early embryo mortality incidence in dairy cows

Anatoly Bolgov^{1,*}, Irina Lepasheva¹, and Natalia Grishina¹

¹Petrozavodsk State University, Institute of Biology, Ecology and Agricultural technologies, 185910 Lenin str. 33, Petrozavodsk, Russia

Abstract. Early embryo mortality (EEM) is considered to be one of the causes of dairy cows' productivity reduction. The aim of the research was to study the factors of EEM expansion and the ways to its minimization in order to determine the possibilities of maintaining cows' productivity. About 4 thousand Ayrshire cows were studied. EEM was registered in 21.7% cows. Low level of EEM was observed in first lactating cows (12.1%), the highest level (27.3%) was registered in old cows (seven lactations and more). Cows with higher productivity are more susceptible to this abnormality: 12.3% of cows with 4500 kg and less of milk yield and 26.5% of cows with milk yield of over 7000 kg. Less cases of embryo mortality are registered during spring and summer seasons of calving (12.0-16.3%) in comparison with autumn and winter ones (19.1-25.7). EEM is observed 1.7 times more in case of deficient feeding than in case of full feeding. Frequency of EEM varied from 5.6 to 44.4% in daughters of different bulls. It is possible to reduce the level of EEM in dairy cows by implementing complex measures of disease prevention and optimization of paratypic, physiological and hereditary factors.

1 Introduction

Reduction of cow productivity level in high yielding (7000-10 000 kg) dairy herds presents an urgent problem. Calf crop percent from one hundred cows reduces to 75-80% or less. The main causes for such situation are late insemination, increase of embryo mortality frequency, fetal abortions, and postnatal mortality of calves.

Researchers have established that the fertility of dairy cows and heifers is 85-90%, conception rate at single service is 70% [1, 2], however, about 30-40% of cows do not keep the embryo [3, 4]. According to some authors in some cases (5-40%), this is due to embryo mortality during the first days after conception before and after implantation and during early stages of development: zygote, blastocyst and early gastrulation.

Energetic imbalance of diet during the period of increasing milk yield is considered to be the most common cause of reproduction function reduction in high-yielding cows [5, 6]. However, etiological factors of this abnormality are not narrowed down to this only cause; they are diversified and not clear enough. Thus, it is necessary to study the causes and ways to reduce EEM especially in high-yielding cows.

The aim of this research was to study the complex of factors causing incidences of early embryo mortality in dairy cows.

2 Materials and methods

The research was conducted in three large Ayrshire dairy herds in the Republic of Karelia (Russia) and about 4 thousand cows from Karelian population were examined. Stable keeping system was used during cold seasons and then animals pastured from May to October. The frequency of EEM was registered taking into account cow age, amount of milk yield during 305 days of lactation, time of insemination after calving (indifference period), season of calving, feeding conditions, animals hereditary.

Information from databases, record books of cows' inseminations and calving, and reports on livestock judgment was used in the research.

There are various methods of pregnancy testing in cows: clinical, in particular, ultrasonic examination and laboratory methods (progesterone concentration in milk and in blood serum; pregnancy hormones in urine, etc). However, it is time consuming and difficult to use these methods in field conditions for mass examination because the apparatus and examination processes are expensive.

In this research, we used an indirect method of embryos identification or their early mortality based on records of insemination times after calving, periods between inseminations, and specificity of estrous cycle [7]. The rationale for EEM registration was an increased (25-35 days) interval between contiguous cows inseminations compared to the normal one (20-22 days). This interval includes the period from zygote formation

* Corresponding author: bolg@petsu.ru

to embryo mortality and the evidence of a new estrous cycle. The level of EEM in each sampling was determined by the percentage ratio of cows with prolonged interval between contiguous cow inseminations (25-35 days) to the total number of the examined animals.

The influence of energy diet value on EEM was studied in two groups of cows. Cows in the first group received 5500 – 5800 fodder units per year; cows in the second group received 3700 fodder units per year.

Variations of EEM levels between groups of paternal hairs were determined by comparison of daughters' indicators for three best and three worst bulls.

All statistical data analyses were performed in statistical program STATISTICA, version 6 (StatSoft, Inc., 2003). For establishing a linear connection between variables, Pearson's correlation coefficient was used.

3 Results and Discussion

Average parameters and variability. Not all studied indices of Ayrshire cows' reproduction were optimal. We determined relatively high frequency (21.7%) of early embryo mortality with high coefficient of variability 39.5%.

Cow age. The lowest level of embryo mortality was found in cows at first lactation (12.1%), old cows had higher level of EEM (27.3%), and the level of EEM in other age groups was nearly the same (21.4-22.5%).

Duration of period from calving to first insemination (the indifference period IP). High embryo mortality was found in cows mated at the time less than 30 days after calving – 35.9%. When the duration of IP increased to 30-45 days the frequency of EEM was two times lower ($P \leq 0.01$). The best levels of EEM were found at the first insemination at 2.5 – 3.5 months after calving (10.8-7.4%). Sharp increase of embryo mortality was found in cow' insemination at 120 and more days after calving.

Level of energy in ration. The cows of the second group who received low energy fodder had higher frequency of embryo mortality (19.1-38.9 %) than cows of the first group who received better fodder during lactation (7.6-18.2 %).

Milk yield. The lowest level of embryo mortality was found in cows with milk yield amount less than 4500 kg.

The frequency of EEM increased with the increase of milk yield amount. Maximum frequency of EEM (26.5%) was registered in cows with the highest milk yield (7001 kg and more).

The influence of milk productivity level on the level of EEM is confirmed by the correlation coefficients between the amount of milk yield and embryo mortality. This correlation increased with the age of cows (to 0.390; $P \leq 0.001$).

Season of calving. The index of embryo mortality varied from 12.0 to 16.3 % during spring and summer seasons; the frequency of EEM increased to 19.1-25.7 % during autumn and winter seasons. The most distinct and statistically valid seasonal effect was revealed in cows who received higher energy fodder.

Effect of early embryo mortality on other indices of cow productivity. The second insemination following the death of the first embryo conceived during the first insemination resulted in conception only in 48.3% cases. The cows of the same age who did not suffer from EEM became pregnant in 62.5% cases ($P < 0.05$). Thus, EEM reduces cow conception rate and leads to more repeated insemination. Expansion of EEM results in the increase of conception index (IC). Significant positive relation has been established between these two indicators; correlation coefficient varied from 0.386 to 0.468 ($P < 0.01$) in cows of different age.

Early embryo mortality increases the duration of service period thus postponing the time for pregnancy. In cases when embryo mortality was registered during the period between contiguous cow inseminations, the next fruitful insemination happened 18-87 days later than usual ($P \leq 0.05$; $P \leq 0.01$).

Hereditary. The frequency of early embryo mortality in daughters of different bulls varied from 7.7 to 36.4% in best feeding conditions and from 5.6 to 44.4% in the worst ones. Variations of EEM between groups of paternal hairs are valid ($P \leq 0.01$). Variance analysis showed that bull's genotype share in total variability of early embryo mortality is not significant; heritability estimate (h^2) in different samplings varies from 0.5 to 4.6%.

Early embryo mortality in cows is a common abnormality. According to our data its average value is 21.7% in Karelian population of Ayrshire cows. Some researchers reported that the level of EEM was over 30% among cows of different breeds [8, 9].

The level of EEM in cows is affected by numerous paratypic factors. Feeding is one of the most important factors. Both too low and too high energy levels of fodder have negative effect on embryogenesis [10]. We have established negative effect of low energy level of fodder on embryo viability. According to some researchers, increase of embryo mortality in cows who receive fodder with low energy level and suffer from energy and protein deficit is connected with disturbances in endocrine system and uterus activity [11], with body weight loss and insufficient condition [12, 9], with disturbances in metabolism [13].

We have shown that cows with high milk yield respond stronger to nutrient deficiency in fodder by increasing EEM frequency than cows with low milk yield (38.9% against 21.3%; $P \leq 0.01$). This response could be caused by stress-factor due to high milk yield, by inhibition of full involution of uterus, by unreadiness of uterine glands and uterine lining [14].

We have revealed direct relation between the amount of milk yield and frequency of EEM, this is confirmed by other authors. This unfavorable phenomenon could be caused by various factors. Butler and Smith [15] think that lower outcome of the first insemination of high-producing cows could result from insufficient body weight and condition. Slow increase of progesterone concentration necessary for the embryo development could be one of the possible causes as well as insufficient activity of corpus luteum [16]. Thus, the

increase of milk yield predisposes the increase of EEM frequency.

The time for cow insemination after calving could be the factor of EEM incidence. In our research we have registered the highest levels of EEM during the first month after calving and when the first insemination was very late. The latter could be accounted to reproductive system disease and disturbance of ovaries functional activity [17]. It seems that one of the factors for EEM reducing could be differential approach when determining the time of insemination after calving, which should take into account milk yield amount and stabilization of energy balance.

Index of EEM varies with the age of cows. Aging dairy cows suffer from both early and late embryo mortality [1, 18].

The research materials on effect of calving season on the frequency of EEM are contradictory. Lower frequency of EEM during spring and summer seasons observed in our research might be due to mild temperatures that are typical for the Karelian climate and to cattle grazing during these periods.

We have established low genetic variability of early embryo mortality ($h^2 = 0.5-4.6\%$). According to Lindhe et al. [19], heritability of calf-producing capabilities index was 5.5%. Low indices of fertility characteristics heritability are conditioned by polygenicity of their inheritance under ascendancy of environmental and physiological factors. Nevertheless, the revealed differences between bulls according to different levels of EEM in their daughters together with genetic variability justify introduction of this characteristics into selection programs.

4 Conclusion

The research demonstrated that there is a possibility to reduce the level of early embryo mortality in dairy cows by implementation of complex preventive measures and by optimization of paratypic and physiological factors. Cows should be provided with high energy feeding balanced according to nutrient materials and negative energy balance should be excluded especially at early stages of embryo development. Besides, the time of insemination after calving should be optimized; stress-factors, health condition, metabolism, body mass dynamics and body condition should be controlled. It is desirable to include the index of early embryo mortality in the complex index of breeding value of dairy cows and bulls. Priority should be given to selection of bulls' mothers and stud bulls and to management of incidence factors of EEM in herds and populations.

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