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Duration of calving stages in beef cows under different housing systems

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ABSTRACT

The goal of research was to analyze the calving process and duration of calving stages in beef cows under moderately continental climate conditions and various systems of housing and feeding. Duration of calving stages have been studied in Ukrainian Beef breed cows under four types of housing conditions: tie-stall housing before and during calving; free stall housing before calving with calving in the calving pens; housing in the outside paddocks and calving in the calving pens; keeping cows on pasture before and during calving. It has been proved that under tie-stall housing system of cows, the preparatory stage is the shortest, and period of withdrawal of the fetus and period of placenta discharge are the most prolonged. When cows were kept on pastures, the preparatory stage labour lasted for or a longer time, but the withdrawal of the fetus and the after-labour period were the shortest. When close-up cows stayed in free-stall barns and calved in the pens or calving chutes, the stages of labour went faster as compared to calving in the outside paddocks, but longer as compared to calving on pasture. Movement of cows from outside paddocks into calving pens increases variability in the duration of parturition, due to the stress of changing location.

Keywords: Big fetus index, Calving, Cattle, Cervix, Placenta

The calving process can be divided into three stages: the preparation, fetus withdrawal, or labour itself and placenta discharge. Their inaccurate detection leads to the growth of dystocia in females, i.e. the birth of calves, that require help, or causes their weakness, increased mortality rate and injury to the mother. The inability of a cow to give birth to a calf without assistance can be diagnosed at the first or second stages of labour. Difficult calving negatively impacts the farms, economy due to the mortality of newborn calves (Singh *et al.* 2018, Manimaran *et al.* 2019, Nehru *et al.* 2019), results in later recovery of ovarian activity in cows, induce endometritis, which leads to reduction of reproductive performance (Yildiz 2018). The most common cause of dystocia is the discrepancy between the internal dimensions of the mother's pelvis and the width of the head and shoulders and shoulder joints of a fetus. The second reason is an abnormal position, or wrong fetal presentation. The third reason is weak contractions and attempts, incomplete opening of cervix. There are other factors that cause dystocia (Selvan *et al.* 2019). It is higher in calves born in winter, summer and rainy seasons and with a higher birth weight, it is also greater in bull calves as compared to heifers.

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Knowledge of the length of the labour stages allows to identify dystocia earlier and observe the calving to provide adequate assistance to cows and calves. The precise prediction of calving time in females is a key factor of cow welfare, because providing calving assistance too early may lead to an increase in the proportion of dystocia, negatively impacts the health of the newborns, and increases calf mortality risk. The negative effects of dystocia are minimized by applying real-time monitoring to detect the start of calving process and provide assistance when needed (Krieger *et al.* 2018).

A tail lift detection algorithm was developed (Krieger *et al.* 2018) and a decision function was created based on its frequency and duration. Exceeding the threshold induces the calving signa.·

Reproductive performance is the main productive trait in the beef farming. Tie-stall, outdoor and pasture-based systems for keeping of beef cows are used. Combination of tie stall and free stall housing systems are practiced as well. In the most common scenario of calving of cows on pasture or at the outside pens, automation devices of calving date prediction are practically impossible to apply. Information on the duration of stages of physiologically normal calving in beef cows, under various housing systems, which could be used for prediction of dystocia and development of the signaling system of difficult calving detection in real time is far from sufficient. The goal of research was to understand duration of calving stages in beef cows, kept in the Forest-Steppe zone of Ukraine (moderately continental climate).

MATERIALS AND METHODS

The effect of housing system on the length of the calving stages was investigated on close- up cows of the Ukrainian Beef breed. For this purpose, four groups of females aged 4 to 7 years were formed and kept in different ways. Cows of Group 1 (control) were kept indoors before, during and after calving. The animals of Group 2 were kept at the outside paddocks. They were transferred to calving pens 12 to 20 days prior to the expected calving date. They calved in pens of 3.0 × 3.5 m size and stayed there with calves during a month after calving. Cows of Group 3 were kept the same as the second one. They were transferred to calving pens 12 to 20 days prior to expected calving date and stayed in pens. Immediately before calving, they were transferred into individual boxes of 3.5 × 5.0 m size. Three days after calving, they were moved into a separate tie stall. Cows of Group 4 were on pastures during the summer. 10 to 15 days prior to expected calving, they were isolated from the herd and transferred to a covered stable. Two days after parturition the calves were separated in a specially equipped pen with a creep feeder, and the cows were moved to pasture.

The influences of different feeding levels of close-up cows (n = 12) and heifers (n = 12) of Chianina breed on the duration of their calving stages was studied. Females were divided equally into control and experimental groups. During the last four months of pregnancy, the level of animal feeding in the control groups was lower than the recommended nutritional standards by 21%, and in the experimental groups it exceeded the control levels. For cows, it corresponded to requirements, and for heifers it exceeded the requirements by 38%. Heifers were regularly provided with an active exercise 3 h during the day. Cows in free stalls had a pen for calving with the area size of 10 m^2. From days 10 to 15 after calving, all cows were kept in the same group and fed according to their nutrient requirements.

Vaginal prolapse in cows, viability and mortality in calves have been recorded additionally. Calves, died at birth or within 24 h after, have been considered as stillborn. Big fetus index was determined by the formula (1):

$$K_{bf} = \frac{W_o}{W_t} \times 100 \quad ...(1)$$

where, K_{bf}, index of big fetus; W_o, live weight of newborn calves (kg); W_t, live weight of mother (kg).

In the postpartum period, uterine involution was studied in relation to the calving process. It was done by the methods of clinical observation and biochemical studies of lochies for the presence of mucins in order to diagnose endometritis by laboratory methods through reaction of sedimentation of mucins with a 1% solution of acetic acid. The reaction was considered positive when the formed clot did not burst at shaking.

The average arithmetic mean (M), its error (± m) of the length of the labour stages in females were calculated according to generally accepted methods of statistical analysis (Plohinskiy 1969).

RESULTS AND DISCUSSION

Duration of the calving stages of females was affected by the systems of housing prior to calving (Table 1). In the tie-stalls, in calving pens or boxes the cows feel discomfort and spend less time for preparation to parturition.

Calving of animals in the barns with insufficient exercise reduces the overall tone of the body, impairs the absorption of nutrients from the ration. Prolonged hypodynamy leads to a violation of homeostasis and regulatory functions in the body of animals. The lack of exercise particularly negatively affects the stage of withdrawal of the fetus and period of discharge of placenta. Due to stagnant phenomena in organs and tissues, the restoration of their functions is delayed, the level of all metabolic processes is weakened. Muscle activity is the best way of activation of all organs and systems of the female before and after calving, which promotes the intensive blood supply to all organs. When muscles work, the motoric function of the uterus increases, which contributes to the accelerated withdrawal of lochia from its cavity after delivery. In cows on pastures, the time from the beginning of the opening of the cervix to the withdrawal of placenta is the shortest. The preparatory stage is the longest, and the withdrawal of the fetus and placenta is the shortest. The total duration of labour in animals of this group has aslight variation. Free grazing of cows on pastures is beneficial for their calving. Under these conditions, cows are calmer and often separated from the herd. They slow down the rumination activity, reduce the duration of feeding and consumption of dry matter, reduce lying time and increase the number of resting cycles lying down.

Air quality and solar radiation is one of the important biological environmental factors influencing the reproductive capacity. It positively affects the health and fertility of animals. Cows kept on the pasture calved without assistance and remained in the herd. It has no negative effect

Table 1. Duration of labour stages in cows under various housing systems (minutes), M ± m

	1 (n=23)	2 (n=24)	3 (n=25)	4 (n=21)
Preparatory	300±12.4	360±12.2**	350±14.5**	416±14.7***
Fetal withdrawal	169±7.1	116±6.0***	102±7.9***	78±6.9***
Placental discharge	318±17.5	243±11.3**	197±30.6**	144±9.3***
Total	787±20.5	718±10.7**	650±33.9**	638±4.9***

** P<0.01; *** P<0.001.

on fresh cows. The active motion and the fresh air affects the involution of the genital organs, improves mineral metabolism, chemical and physical thermoregulation.

Cows kept in free stalls and calved in the stalls of the calving area had faster calving as compared to the cows of Group 1 and longer calving as compared to the Groups 3 and 4. The preparatory stage lasts longer as compared to the cows in tie-stalls and fetal expulsion and placental discharge periods were shorter. Duration of calving in cows of Group 2 was characterized by a small variability. Cows kept in free stalls and calved in the boxes of the calving area (Group 3) had almost the same preparatory stage as the Group 2. The fetal expulsion was more vigorous and they have a shorter placental discharge period. Generally, their calving were the same as that of the cows on pastures. Parturition in special boxes do not have a positive effect on the calving process in most of the cows. The greater variability of the stages of removal of the fetus, placental discharge and overall calving process indicates that moving of animals prior to calving to a new pen induces stress. Part of the cows are poorly adapted to the housing in boxes. As a result, the periods of fetal expulsion and placental discharge were longer than in cows on pastures.

When cows were kept on pastures (Group 4), preparation for parturition was longer with reduction of stages of fetal excretion and placental discharge. Prolonged preparation for the removal of the fetus is possible in order to create the calm and comfortable environment for calving. Extended preparatory stage allows for more complete opening of the cervix, so the, the second stage of labour, the most difficult in terms of energy demand, does not last long. It also promotes the normal separation of fetal placenta from uterus and excretion of fetal membranes during the afterbirth stage.

The cows of Group 3, calved in stalls, had longer duration of all calving stages as compared to the cows calved on pastures or in the calving pens. Movement of animals to new conditions of the cow barn (from one group to another, isolation, etc.) causes an increase in the plasma concentration of corticoids and their excretion in the urine, which negatively affects the physiological state of the animals and their reproductive functions. Calving of females of Group 3 in separate calving pens had disadvantage as compared to pastures. Cows that were separated before calving in the calving pens, had longer interval from appearance of the amniotic sac and hooves till the calf birth as compared to the cows on pastures. This results in more injuries to the vulva or vagina of the cows and retention of the placenta. The long period of stay in calving pens was associated with longer calving duration as compared to the cows calved on bed packs. Cows move freely in bad pack area and select a place for calving not by accident, but close to the places of previous calving, due to the presence of amniotic fluid. Because close-up cows select places for their calving, this should be used in reproduction technology based on the motivational behaviour of females. Calving in groups should be practiced on cattle farms in order to improve ease of calving and reduce stillbirths.

Only 17% of the cows kept in tie-stalls (Group 1) demonstrated mucin in lochies. The rest of the cows did not have lochies and were postpartum diagnosed with catarrhal endometritis. 95.2% cows on pasture had mucin in the lochies and only 4.8% of the group developed catarrhal metritis. Taking into account the obtained results as to duration of calving stages, we can conclude that calving on pastures is physiologically normal for the beef cows.

Feeding the cows of Chianina breed according to their requirements or increase of feeding level of heifers by 38% during the last four months of pregnancy leads to a decrease in the length of all labour stages (Table 3). In the experimental group, compared to the control group, labour lasts an average of 21.4% less, including the stage of withdrawal of the fetus by 25% and the placental discharge by 43.7%. One of the heifers in the control group had retained placenta after calving.

The second stage of calving was shorter in mature Chianina cows as compared to heifers. Older cow shed faster fetal discharge. Heifers are more likely to have heavy calving and stillbirths as compared to mature cows. Heifers have not only a smaller pelvic opening, but their soft tissues have never been enlarged. Abnormal fetal excretion is observed under conditions of malnutrition of close-up females. With a slight decrease of dry matter in the diet, the concentration of glucose in the blood decreases; which inhibits the gonadotropic function of the pituitary gland (Toledo- Alvarado *et al.* 2018). The malnutrition of heifers not only causes them to be small sized, but also reduces the amount of energy available for parturition. Those heifers are more rapidly depleted and have longer calving (Bosque *et al.* 2017). Parturition is a complex physiological process that requires a lot of energy,that is released in the animal body from glucose metabolism. Reduced glucose blood concentration leads to retained placenta.

With an increase of feeding level, the cows produce calves with a live weight greater by 26.5% (Table 2). Despite the 18.2% increase of the big fetus index in heifers,

Table 2. Big fetus index and calving difficulties in females at different levels of feeding

Cow group	Heifer group		Indicator	
	Control (n=6)	Experimental (n=6)	Experimental (n=6)	Control (n=6)
Live weight of cows in labour, kg	626±37.1	639±32.5	455±39.4	463±26.5
Live weight of newborn calves, kg	35.2±3.0	34.2±3.2	29.4±1.4	37.2±1.6
Big fetus index	5.6±0.38	5.4±0.55	6.6±0.45	7.8±0.26
Calving difficulties, cases	2 stillborn calves	none	1 vaginal prolapse	none

compared with the control group, their calving occurs naturally. The decrease in the feeding level in females over the last four months increased the probability of vaginal prolapse and stillbirth of calves.

Malnutrition is one of the main reasons for delaying the recovery of reproductive cycle after birth, since the reproductive system of animals is one of the first to respond to nutritional deficiencies in the diet. Malnutrition leads to impaired metabolism in the body of females, which reduces the activity of endocrine glands (pituitary, thyroid, adrenal cortex). As a result, hormone synthesis is inhibited, and the liver decreases the ability to inactivate steroid hormones. All this causes disorder of the hormonal interaction in the body. In addition, the resistance of the reproductive organs against the action of pathogens has been reduced.

Stillborn calves appear more frequently under unfavourable feeding conditions. Cows with a restricted diet are more prone to dystocia and have mortality rate of the newborn calves. If cattle females obtain rations that are 21% less than requirements, they reduce body condition (BCS) in the last stages of pregnancy, which is a major factor in the interaction between their reproduction, feeding and housing system. In order to achieve optimal reproductive performance, it is necessary that adult cows are calved with BCS of 2.5–3 points (5-point Scottish system). In heifers, the condition score should be higher, which is related to their growth and to compensate for additional nutrient requirements. As the level of body condition during calving increases, fertility parameters of fresh cows improve (Kavya *et al.* 2018, Sharma *et al.* 2018).

Over-stressing of the functional systems of the body of the cows in the final stages of pregnancy adversely affects calving process. Longer duration of calving birth increases the risk of maternal and fetal complications and mortality of the newborns. Adaptation of calves to postnatal life depends mainly on lung function, which is affected by fetal development, that stimulates effective removal of fluid from their parenchyma during the transition period (Vannucchi *et al.* 2018).

Calving that lasts longer than 4 h, significantly inhibits the breathing activity of calves. Prolonged second stage of calving causes weak calf syndrome. This occurs due to increase of time of the impact of increased uterine pressure on fetal body during uterine construction. Prolonged second stage, without removal of the calf leads to the hypoxia. These calves do not have enough strength for normal breathing, reduction of heart beat rate decreases the transport of oxygen to organs and tissues and carbon dioxide to the lungs. These calves are depressed, they have impaired locomotion activity, and when they are cool, they do not experience tremor aimed at increased heat generation for self-heating. They have reduced levels of metabolic processes, so body temperature is reduced. Most of them stop feed consumption and die within 12–24 h.

In conclusion, under conditions of moderately continental climate keeping the cows on pasture had the best impact on the calving process of beef females. Deficient nutrition in the second half of gestation resulted in increased duration of calving, increased risk of gynecological disorders post calving, increased mortality rate of the newborn calves. Housing the cows of Ukrainian beef breed in tie-stalls three weeks prior to calving, during and after calving resulted in the shortest preparatory stage, the longest duration of calving, and the longest period of fetal and placental discharge. Cows kept on pastures had the longest preparatory calving stage, and the shortest period of fetal and placental discharge. Calving on pastures is the physiological norm for beef cows.

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