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Influence of selected feed supplements on the growth and health of calves depending on the sex, season of birth, and number of the dam's lactations

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Abstract

The aim of this study was to prove the hypothesis that the growth and health of calves are dependent on feed supplements with an antidiarrhoeic effect, in relation to sex, season of birth, and number of the dam's lactations. A total of 186 calves were included in the experiment. After birth the calves were divided into three treatment groups: *Ascophyllum nodosum* (brown seaweed hydrolyzate, prebiotics), *Lactobacillus sporogenes (*probiotics), and the control group. All calves were weighed within two h after birth. The growth and health were investigated from the birth to the fourth week of age. Compared to the control, a significant effect of applied feed supplements was found in the *Lactobacillus sporogenes* group in the body weight at 28 days of life ($P < 0.01$) and in the average daily gains ($P < 0.001$). Differences between sexes were found in the body weight at birth ($P < 0.001$) and in the body weight at 28 days of life ($P < 0.01$). The effect of the season of birth was recorded in the average daily gains ($P < 0.01$). The effect of the number of the dam's lactations on calf was proved in body weights at birth and 28 days of life ($P < 0.01$). The interaction between treatment and sex ($P < 0.05$), and between treatment and season of birth ($P < 0.01$) were calculated in the average daily gains. We concluded from the analysis that only the use of *Lactobacillus sporogenes* had a positive influence on increasing the growth. Neither of the two supplements had a positive impact on the health of calves.

Calf, diarrhoea, microbiota, nutrition, probiotics

In the intensive management system of farm animals, especially in calf rearing without the dam, the natural acquisition of autochthonous microflora is drastically reduced by changing the intestinal environment and allowing pathogens to colonize the microbiota (Rosmini et al. 2004). The incidence of metabolic disorders in dairy calves in the Czech Republic represents a highly actual problem and one of the important factors influencing this condition is insufficient care for and the related insufficient colostral nutrition of calves (Podhorský et al. 2007; Šlosárková et al. 2014). As proved by many studies (Nogalski 2003; Svensson et al. 2003; Svensson and Hultgren 2008; Kamal et al. 2014), the growth of live body weight and occurrence of diarrhoeas in dairy calves are influenced also by the dam's parity and the season of birth.

The importance of probiotics and prebiotics is based on their ability to stabilize the inner microbiota and to influence the calf's health and welfare. Positive effects of *Ascophyllum nodosum* on the reduction of the pathogen *E. coli* O157:H7 were proven in cattle and sheep (Bach et al. 2008). The effect of *Lactobacillus sporogenes* on *Salmonella* Dublin was verified by Frizzo et al. (2011); the effect of *Lactobacillus* on the started feed intake and

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on the weight gain by Higginbotham and Bath (1993); and the effect of *Lactobacillus acidophilus* on the occurrence of calf diarrhoeas by Tarboush et al. (1996).

Regular administration of probiotics may help to create stable and balanced intestinal microflora that will improve the calf's health (Soto et al. 2011). Probiotics are viable microorganisms exerting a favourable effect on the host's health by improving its intestinal microbial balance (Kaur et al. 2002). Probiotics are competitors for pathogenic microorganisms in the utilization of intestinal space and nutrients, they reduce intestinal pH by the production of organic acids, release bacteriocins and hydrogen peroxide, and stimulate the host's immunity system. Probiotics may reduce the risk of infections and intestinal disorders (Ewaschuk et al. 2004). To maintain a changeless, high level of probiotics in the digestive tract of calves, administration of these products should continue for as long as possible (Ohashi et al. 2009). The inclusion of a probiotic in the feed ration decreases the amount of pathogenic strains of *Escherichia coli* by 36% in the faeces of sheep and heifers (Braden et al. 2004). After the administration of a probiotic to grazing dairy cows in the summer season the temperature of their body surface decreases, which contributes to alleviation of the heat stress of animals (Pompeu et al. 2011).

Prebiotics are selectively fermented components facilitating specific changes in the large intestine, both in the composition and growth and in the activity of bacteria in the digestive tract. Metabolically, the large intestine is one of the most active organs in the body; therefore, the intake of prebiotic products has a significant influence on its function (Wang 2009). The use of prebiotics showed a positive influence on the production of short-chain fatty acids in the intestinal microflora (Scheid et al. 2013).

Feed supplements will have a positive effect on reducing the incidence of diarrhoeal disease and improving the health status of calves. The aim of this study was to investigate the hypothesis that the growth and health in calves are affected by probiotic and prebiotic feed supplements with an anti-diarrhoeic effect, in relation to sex, season of birth, and number of the dam's lactations.

Materials and Methods

A total of 186 Holstein calves (62 in the *Lactobacillus sporogenes* group, 62 in the *Ascophyllum nodosum* group, and 62 in the control group) from one herd of dairy cows were included in the experiment. After birth the calves were randomly divided into 3 treatment groups: Group 1 - *Ascophyllum nodosum*, Group 2 - *Lactobacillus sporogenes*, and control Group 3. The calves were separated from the dams on the first day after birth and then they were reared in individual littered hutches till weaning. They received colostrum and mother's milk *ad libitum* × 3 a day from a bucket with a nipple from day 2 to 4. From day 5 they received 4.5 kg of milk replacer per day divided into 3 portions, a starter mixture (crushed wheat 20%, crushed barley 15%, whole maize grains 10%, whole oat grains 19.5%, extracted rapeseed meal 15%, extracted soybean meal 15%, Tetravit (Nita-Farm, Saratov, Russia) – vitamin-mineral premix 5%, calcium 0.5%) and alfalfa hay *ad libitum* until weaning. Colostrum and subsequently milk replacer were administered to calves in plastic buckets with nipples that were fitted in the hutches at a height of 40 cm above the ground. The calves had a free access to drinking water for the entire experimental period. The experiment was conducted from February 2011 to January 2013.

The *Ascophyllum nodosum* experimental group received orally 5 ml of hydrolyzate from brown seaweeds in addition to the colostrum and milk replacer. The *Lactobacillus sporogenes* experimental group received orally 1 tablet of probiotics added to the colostrum at first and then to the milk replacer and thoroughly mixed. The formulation of one tablet of probiotics was 4×10^7 *Lactobacillus sporogenes*. Experimental groups were administered these feed supplements × 1 a day (at the second feeding). Both supplements were applied to experimental groups within the first fortnight after the birth. The control group received a non-supplemented diet, consisted 1.5 kg of milk replacer per feeding (totally 4.5 kg), starter mixture and alfalfa hay *ad libitum*. All calves were observed until day 28 of life.

All calves were weighed within two hours after birth and then they were weighed regularly every week. Classical method for the evaluation and expression of diarrhoea according to Larson et al. (1977) was used. Observations of faeces and health condition was evaluated twice a day together with rectal temperature measurements at the time of feeding. Respiratory condition was assessed by the symptom type (normal, runny nose, heavy breathing, and cough – moist or dry). Other frequency of cough (possible respiratory disorder) was assessed as occasional, intermittent, or persistent. Operators observed the condition of hair and eyes (dullness and brightness) and signs of dehydration (sunken eyes, inelastic skin, and prostration).

During long lasting diarrhoeal diseases calves from all treatment groups were treated using the preparation Argivo Se (Deltavit, France) at 40 g per day.

The data were analyzed using a General Linear Model ANOVA (four ways with the interactions) of the statistical package STATISTICS 10 (Analytical Software, Tallahassee, FL, USA). Factors were evaluated of the treatment group (1 – *Ascophyllum nodosum*, N = 62, 2 - *Lactobacillus sporogenes*, N = 62; and 3 – control, N = 62); sex (male, N = 87; female, N = 99), season of the birth (1 - spring, N = 35; 2 - summer, N = 61; 3 – fall, N = 53; and 4 – winter, N = 37), and number of the dam's lactations (first lactation, N = 58; 2 - second and higher lactation, N = 128). Normality of data distribution was evaluated by Wilk-Shapiro/Rankin Plot procedure. All data conformed to a normal distribution. Significant differences between groups were tested by Comparisons of Mean Ranks. Values are expressed as means ± SD and differences were considered significant at $P < 0.05$.

Results

The calves from the treatment group 2 (probiotics) reached the highest live body weight at 28 days. Differences were significant in comparison to group 1 and control group (53.77 ± 6.18 kg vs 51.27 ± 4.71 kg, $P < 0.05$; 53.77 ± 6.18 kg vs 50.15 ± 5.61 kg, $P < 0.01$). Similarly, the average daily weight gains over the experimental period were also the highest in the probiotics group 2 (0.39 ± 0.09 kg vs 0.33 ± 0.10 kg, $P < 0.05$; 0.39 ± 0.09 kg vs 0.30 ± 0.10 kg, $P < 0.01$) (Table 1).

In our study significant effects of sex and season of the birth on growth intensity of calves (Tables 2 and 3) were found. Males were heavier at birth and at 28 days of life compared to females (43.00 ± 5.05 kg vs 40.24 ± 4.67 kg, $P < 0.001$; 53.13 ± 6.22 kg vs 50.50 ± 4.94 kg, $P < 0.01$). Calves born during the summer period had the lowest average daily gains over the observed period from the first week to the termination of the experiment (0.30 ± 0.08 kg compared to 0.36 ± 0.13 kg, 0.36 ± 0.11 kg, and 0.36 ± 0.11 kg; $P < 0.05$).

Table 1. The effect of applied supplements on the growth and morbidity of calves.

Variables	N	Treatment groups			*P*	Significance
		Ascophyllum nodosum	*Lactobacillus sporogenes*	Control		
		$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD		
BW at birth (kg)	186	41.49 ± 5.11	42.11 ± 5.28	40.99 ± 4.70	0.4642	
BW in 28th day (kg)	186	51.27 ± 4.71	53.77 ± 6.18	50.15 ± 5.61	0.0012**	2:3**, 1:2*
ADG from birth to 28th day (kg)	186	0.33 ± 0.10	0.39 ± 0.09	0.30 ± 0.10	0.0000	2:3**, 1:2*
Number of diarrhoeas, Week 1	186	0.19 ± 0.40	0.15 ± 0.36	0.31 ± 0.46	0.0813	
Number of diarrhoeas, Week 2	186	0.19 ± 0.40	0.16 ± 0.37	0.24 ± 0.43	0.5311	
Number of diarrhoeas, Week 3	186	0.05 ± 0.22	0.03 ± 0.18	0.02 ± 0.13	0.6006	
Number of diarrhoeas, Week 4	186	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	M	
Duration of diarrhoea (day)	186	1.71 ± 3.46	1.27 ± 3.04	2.40 ± 3.61	0.1743	
Total number of diarrhoeas	186	0.23 ± 0.42	0.16 ± 0.37	0.34 ± 0.48	0.0657	

*$P < 0.05$; **$P < 0.01$; SD = standard deviation; ADG = average daily gains; BW = body weight; *P* = significance; N = number (1 – *Ascophyllum nodosum*, N = 62, 2 - *Lactobacillus sporogenes*, N = 62; and 3 – control, N = 62); M = missing value

Table 2. The effect of sex on the growth and morbidity of calves.

Variables	N	Sex				*P*
		Male	Female	Min	Max	
		$\bar{x} \pm SD$	$\bar{x} \pm SD$			
BW at birth (kg)	186	43.00 ± 5.05	40.24 ± 4.67	27.00	53.00	0.0002***
BW in 28th day (kg)	186	53.13 ± 6.22	50.50 ± 4.94	34.00	68.00	0.0016**
ADG from birth to 28th day (kg)	186	0.34 ± 0.12	0.34 ± 0.09	0.10	0.80	0.7651
Number of diarrhoeas, Week 1	186	0.25 ± 0.44	0.18 ± 0.39	0.00	1.00	0.2416
Number of diarrhoeas, Week 2	186	0.25 ± 0.44	0.15 ± 0.36	0.00	1.00	0.0849
Number of diarrhoeas, Week 3	186	0.01 ± 1.10	0.05 ± 0.22	0.00	1.00	0.1344
Number of diarrhoeas, Week 4	186	0.00 ± 0.00	0.00 ± 0.00	0.00	0.00	M
Duration of diarrhoea (day)	186	1.99 ± 3.45	1.63 ± 3.35	0.00	16.00	0.4686
Total number of diarrhoeas	186	0.28 ± 0.45	0.21 ± 0.41	0.00	1.00	0.3137

$^{**}P < 0.01$; $^{***}P < 0.001$; SD = standard deviation; ADG = average daily gains; BW = body weight; *P* = significance; N = number (male, N = 87; female, N = 99), M = missing value; Min = minimum; Max = maximum

Table 3. The effect of birth season on the growth and morbidity of calves.

Variables	Birth season				*P*	Significance
	1	2	3	4		
	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$		
BW at birth (kg)	41.91 ± 5.22	41.50 ± 4.99	40.99 ± 5.01	42.00 ± 5.07	0.7706	
BW in 28th day (kg)	52.86 ± 6.58	50.39 ± 5.16	51.83 ± 4.90	52.74 ± 6.52	0.1147	
ADG from birth to 28th day (kg)	0.36 ± 0.13	0.30 ± 0.08	0.36 ± 0.11	0.36 ± 0.11	0.0012**	2:3**, 1:2*, 2:4*
Number of diarrhoeas, Week 1	0.11 ± 0.32	0.25 ± 0.43	0.23 ± 0.42	0.24 ± 0.44	0.4518	
Number of diarrhoeas, Week 2	0.17 ± 0.38	0.20 ± 0.40	0.19 ± 0.40	0.24 ± 0.44	0.8855	
Number of diarrhoeas, Week 3	0.09 ± 0.28	0.03 ± 0.18	0.02 ± 0.14	0.00 ± 0.00	0.194	
Number of diarrhoeas, Week 4	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	M	
Duration of diarrhoea (day)	1.40 ± 3.24	1.77 ± 3.30	2.00 ± 3.74	1.92 ± 3.24	0.8701	
Total number of diarrhoeas	0.17 ± 0.38	0.26 ± 0.44	0.25 ± 0.43	0.27 ± 0.45	0.7453	

$^{*}P < 0.05$; $^{**}P < 0.01$; SD = standard deviation; ADG = average daily gains; BW = body weight; 1 = spring, 2 = summer, 3 = fall, 4 = winter; *P* = significance; N (1 - spring, N = 35; 2 - summer, N = 61; 3 – fall, N = 53; and 4 – winter, N = 37), M = missing value

Table 4. The influence of the number of mother's lactations on the growth and morbidity of calves.

Variables	N	Number of lactations				*P*
		1	2	Min	Max	
		$\bar{x} \pm SD$	$\bar{x} \pm SD$			
BW at birth (kg)	186	40.10 ± 4.80	42.18 ± 5.01	27.00	53.50	0.0084**
BW in 28th day (kg)	186	49.99 ± 5.64	52.52 ± 5.59	34.00	68.00	0.0049**
ADG from birth to 28th day (kg)	186	0.33 ± 0.10	0.34 ± 0.11	0.10	0.80	0.3686
Number of diarrhoeas, Week 1	186	0.24 ± 0.43	0.20 ± 0.40	0.00	1.00	0.5589
Number of diarrhoeas, Week 2	186	0.17 ± 0.38	0.21 ± 0.40	0.00	1.00	0.5446
Number of diarrhoeas, Week 3	186	0.02 ± 0.13	0.04 ± 0.19	0.00	1.00	0.438
Number of diarrhoeas, Week 4	186	0.00 ± 0.00	0.00 ± 0.00	0.00	0.00	M
Duration of diarrhoea (day)	186	1.78 ± 3.31	1.80 ± 3.44	0.00	16.00	0.9573
Total number of diarrhoeas	186	0.24 ± 0.43	0.24 ± 0.43	0.00	1.00	0.9906

*$P < 0.05$; **$P < 0.01$; SD = standard deviation; ADG = average daily gains; BW = body weight; 1 = primaparous, 2 = multiparous; *P* = significance; N = number (and number of mother's lactations (first lactation, N = 58; 2 - second and higher lactation, N = 128); M = missing value; Min = minimum; Max = maximum

Calves born to primiparous dams showed significantly lower live body weights at birth, also at the last weighing on day 28 compared to calves from older cows (40.10 ± 4.80 kg vs 42.18 ± 5.01 kg, $P < 0.01$; 49.99 ± 5.64 kg vs 52.52 ± 5.59 kg, $P < 0.01$) (Table 4).

The interaction between treatment and sex ($P < 0.05$), and between treatment and season of the birth ($P < 0.01$) were calculated in the average daily gains.

Neither *Ascophyllum nodosum* (treatment group 1) nor *Lactobacillus sporogenes* (treatment group 2) supplement had the influence on scour incidence. It affected neither of the indices (number of diarrhoeas in calves in each week and totally, and duration of scours (Table 1). No calf from our experiment died or was culled for bad health. The faeces had liquid consistency during the first weeks and then became firm. In the first week the colour was yellow, later on green.

Discussion

In the present work we studied the impacts of two feed supplements. However, a significant effect was shown only in treatment group 2 which received probiotics. These calves had the most intensive increase of live body weight.

A positive influence of the use of *Lactobacillus sporogenes* on the weight gains of calves was also reported by Fuller (1989), Tarboush et al. (1996), Schneider et al. (2004), Timmerman et al. (2005), Frizzo et al. (2010), and Soto et al. (2014). A low or no influence on the increase in weight gains of animals in the group with *Ascophyllum* *nodosum* may be a result of the availability of a sufficient amount of prebiotics in common feed like oats, barley, and wheat (Gaggía et al. 2010).

In our study we found significant effects of sex and season of the birth on growth intensity of calves. Males were heavier at birth and at 28 days of life than females.

Kertz et al. (1997) reported in their study different weight gains in young bulls and heifers; the gains in young bulls were higher by 8.5% compared to heifers; similar results were found out also by Dhakal et al. (2013).

Calves born during the summer period had the lowest average daily gains over the observed period from the first week to the termination of the experiment. The main advantage of the hutch rearing of calves is the minimized risk of disease transfer from calf to calf. However, the temperature stress is generally disregarded (Coleman et al. 1996; Spain and Spiers 1996). Our research has confirmed the findings of many authors that high air temperature can also cause stress in calves (Mader and Davis 2004; Broucek et al. 2009). The growth of live body weight of calves was also influenced by the factors of birth seasonality and the number of the dam's lactations. The interaction between treatment and sex, and between treatment and season of birth were recorded in the average daily gains evaluation. It means that treatment by probiotics can be positively or negatively influenced by the sex of treated calves, and also by the season of birth.

Calves of young dams displayed lower live body weights than calves of older dams. Kertz et al. (1997), Svensson et al. (2003), and Dhakal et al. (2013) identically reported higher weight gains in calves born to mothers at the second and higher lactations.

The use of *Ascophyllum nodosum* has no effect on improving the growth and health of calves. The results showed no positive effect of either observed supplement (*Ascophyllum nodosum* or *Lactobacillus sporogenes*) on health and especially, on scour incidences.

We concluded from the analysis, that the effect of the probiotic *Lactobacillus sporogenes* was manifested only in the increased growth of calves. The action and effect of this feed supplement may be affected by the season of birth and the sex of calves.

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