

Influence of birth weight and weaning weight on performance and veal quality

Klára Vavrišínová, Katarína Hozáková, Milan Margetín, Martin Janíček, Jaroslav Dóbi

Department of Animal Husbandry, Faculty of Agrobiological and Food Resources, Slovak University of Agriculture, Nitra, Slovakia



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The aim of this paper was to evaluate the influence of birth weight and weaning weight on selected fattening, carcass, and physical technological traits, and proximate composition of *Longissimus thoracis et lumborum* muscle of 45 male Holstein veal calves. Birth weight was grouped in 3 classes, namely low (less than 37.5 kg), medium (from 37.5 to 40 kg), and high (more than 40 kg); similarly, weaning weight was grouped in 3 classes, namely low (less than 90 kg), medium (from 90 to 100 kg), and high (more than 100 kg). Each group consisted of 15 animals. Slaughter weight, weight gains, body measurements, carcass conformation, retail yield (meat, trimmed fat, bones), and meat characteristics 24 hours and 7 days *post mortem* (pH, drip loss, shear force, colour, chemical composition) were studied. Calves of medium weaning weight had the highest lifetime average daily gain. Among monitored groups, significant effect of birth weight and weaning weight on hip height and heart girth were observed. Dressing percentage differed little due to birth weight ($P < 0.05$) and weaning weight ($P < 0.01$). Calves of lighter birth weight had the least retail meat yield, but the most bones in carcass. Significant effect of weaning weight on protein content ($P < 0.01$) of *Longissimus thoracis et lumborum* muscle was observed. Effect of birth weight or weaning weight on worsening or improving of physical technological traits of veal *Longissimus thoracis et lumborum* muscle was not clear. Significantly lower ultimate pH value (24 hours *post mortem*) was found in group of low birth weight ($P < 0.01$). Lightness of the meat was not influenced by birth weight, but it was significantly affected by weaning weight ($P < 0.01$). Content of palmitic acid was affected by both birth weight ($P < 0.001$) and weaning weight ($P < 0.01$). No significant influence of birth weight or weaning weight on fattening, carcass yield, physical technological and qualitative traits of calves was detected.

Keywords: birth weight, average daily gain, weaning, proximate composition, retail yield

1 Introduction

In last decades, the quality of food in human nutrition has become of utmost importance on global scale, especially with regard to the occurrence of various lifestyle diseases (Dimov et al., 2012). The increase in research works and consumer awareness of the potential health benefits of various micro-components in food have led to shift the composition of the human diet, which has resulted in a higher intake of fats, in particular saturated fatty acids (Lock and Bauman, 2004).

Beef has long been criticized for its high fat content and inappropriate fatty acid composition (Scollan et al., 2006; Jenkins et al., 2008). In contrast, red meat is considered a major source of protein (McAfee et al., 2010) and an important source of bio-available essential trace elements in human nutrition (Pereira et al., 2017). The overall value of meat is determined by several factors, which can be generally described by safety (hygienic quality), health safety (nutritional quality), satisfaction (organoleptic quality) and usability (suitability for processing, price) (Listrat et al., 2016; Domaradzki et al., 2017). In addition to these aspects, health and nutritional value is a key determinant for the consumer (Scollan et al., 2006).

Growth is a basic and decisive factor in meat utility and especially in the categories intended for fattening, growth intensity is crucial (Schreurs et al., 2008). Meat production is based on the process of animal growth, which depends on several environmental factors as well as management practices (Irshad et al., 2013). The nutrition of calf after birth containing higher amount of fat is associated with the maturation of the rumen, and metabolic and endocrine systems (Greenwood and Cafe, 2007). The

growth of calves before weaning is affected by the quality and amount of nutrients ingested. In particular, forage diets lead to the production of volatile fatty acids, which stimulate rumen development until weaning (Bispo et al., 2010). On the other hand, restriction of feeding from birth to weaning, followed by high-energy feeding from weaning to slaughter, results in an increase of carcass fatness at the same slaughter weight as animals with unrestricted feeding (Greenwood et al., 2006). Several studies suggest that later weaning, hence higher weaning weight, affects the growth rate and quality of carcasses in ruminants. Likewise, meat quality is influenced by weaning management (Vieira et al., 2005; Moreno et al., 2006; Blanco et al., 2009; Bispo et al., 2010). However, there is only limited information on the effect of birth weight on meat quality.

The aim of this study was to assess the effect of birth weight and weaning weight on growth and a set of meat performance and quality traits in Holstein veal calves.

2 Material and methods

2.1 Animals, experimental design, housing, management and nutrition

The animals used in this study were male Holstein veal calves ($n = 45$) from a local dairy farm. Calves were born in about the same period (within a one month) and were randomly selected for the experiment. Animals were reared under standard feeding conditions divided in the colostrum, milk replacer and forage nutrition phases. During first stage of the experiment each calf was individually housed in outdoor crates and fed with milk replacer based on dried whey with *ad libitum* access to water and starter feed mixture. After about 60 days calves were kept in group according to the weaning weight (15 calves in outdoor pens). Immediately, habit period to solid forage feeding began. Each calf received liquid dairy feed mixture once a day with *ad libitum* amount of the starter feed mixture. Gradually they were fed with a small amount of maize silage based total mixed ration. The next period of experiment was carried out from weaning (about 2 months of age) to the required final weight (170 ± 10 kg). Immediately after weaning, calves were again divided into groups with their respective weaning weight. During this stage of experiment all 45 calves were fed with complete feed mixture (total mixed ration) based on maize silage composed with hay, alfalfa silage and starter feed mixture. After habit period to solid feed, starter feed mixture was replaced with feed mixture for rearing of calves on forage diet. Fresh water was available *ad libitum* during whole experiment. Calves were grouped into 3 classes of birth weight (LBW), i.e. low (LBW < 37.5 kg), medium (LBW between 37.5 and 40 kg), and high (LBW > 40 kg), and 3 classes of weaning weight (WW), i.e. low (WW < 90 kg), medium (WW between 90 and 100 kg), and high (WW > 100 kg). Each group consisted of 15 animals. After reaching the required slaughter weight, animals were weighed and measured for linear body measurements (withers height, hip height, heart girth, body length).

2.2 Slaughter procedures and veal quality measurements

Before slaughter animals were transported to an experimental centre. After restriction of food for 12 hours, calves were weighed and slaughtered. Each animal was slaughtered by standard methods in accordance with legislation for protection of animals during slaughter. Immediately after slaughter, carcasses were split into two sides and chilled overnight with air temperature of 4-5°C. Moreover, dressing percentage and ideal dressing percentage as proportion of the meat from slaughter weight reduced by weight of digestive tract were calculated. After 24 hours chilling, samples of *Longissimus thoracis et lumborum muscle* were collected from each carcass for the proximate composition, cholesterol content and fatty acid profile. Furthermore, pH was recorded 1 hour and 24 hours *post mortem*. After 7 days *post mortem*, colour [lightness (L^*), redness (a^*), yellowness (b^*)], drip loss, and shear force were recorded. For all experimental analyses, standard laboratory methods were used as described in Vavrišinová et al. (2019). Right side of each carcass was commercially boned-out and weight of valuable meat cuts, trimmed fat and bones was determined. During dissection two categories of meat were classified: high quality meat cuts (top round, sirloin, tenderloin, shoulder) and other meat cuts (neck, short loin, flank, shank, brisket, boneless rib, chuck, trimmed meat).

2.3 Statistical analysis

The impact of classes of LBW and WW on growth traits and slaughter characteristics, chemical composition and physical technological properties was tested using one-way ANOVA. Significant differences between groups were declared at *** $P < 0.001$, ** $P < 0.01$, and * $P < 0.05$. All results of the present study were analysed using the SPSS package program.

3 Results and discussion

Fattening characteristics (final weight, slaughter weight, average daily gain) were highest in the group of medium LBW (Table 1); however, results were not significant. According to Praharani et al. (2019) birth weight of calves is an important contributory factor for improving growth performance.

For the early fattening period, there were no effects of LBW on fattening characteristics. Significant differences between groups were observed for body measurements – withers height ($P<0.05$), hip height ($P<0.01$) and heart girth ($P<0.001$). Opposite to findings of Greenwood et al. (2006) we found similar weight of carcasses in different LBW groups. Dressing percentage differ due to birth weight ($P<0.05$), and it was higher for the group of heaviest calves at birth (49.61%) than for the group of medium LBW calves. Weight of intraabdominal fats was 1.0 kg greater in high compared with medium LBW calves ($P<0.001$). Similar to our findings, Greenwood and Café (2007) reported that calves with low birth weight had similar meat yield of highest quality and bone content at equivalent carcass weight in comparison with counterparts with higher birth weight. The effect of LBW on weight of other meat cuts ($P<0.05$) and trimmed fat ($P<0.001$) was evident. In particular, the amount of trimmed fat was lower in medium LBW than in low and high LBW calves (Table 1).

Table 1 Effect of birth weight (LBW) on fattening and carcass characteristics of male Holstein veal calves

Trait	Low LBW (1)		Medium LBW (2)		High LBW (3)		P -value	Significance between groups		
	Mean	SE	Mean	SE	Mean	SE		1:2	1:3	2:3
Final weight (kg)	168.65	2.37	173.55	1.78	170.83	1.31	0.350	ns	ns	ns
Slaughter weight (kg)	161.80	3.39	165.99	1.85	160.50	1.32	0.271	ns	ns	ns
Number of feeding days	169.30	0.84	171.18	1.46	171.67	0.70	0.183	ns	ns	ns
ADG ($\text{kg}\cdot\text{d}^{-1}$)	0.79	0.01	0.79	0.01	0.76	0.07	0.151	ns	ns	ns
Withers height (cm)	111.10	0.73	110.91	0.47	108.00	1.21	0.016	ns	*	ns
Hip height (cm)	115.20	0.27	111.27	0.86	112.00	1.13	0.007	*	*	ns
Heart girth (cm)	135.30	0.71	133.36	1.13	139.00	0.79	<0.001	ns	*	**
Body length (cm)	62.70	1.22	61.64	0.81	60.67	1.77	0.489	ns	ns	ns
Cold carcass weight (kg)	79.01	1.68	78.95	1.27	79.59	0.92	0.936	ns	ns	ns
Ideal DP (%)	64.52	0.48	63.83	0.96	66.66	0.81	0.046	ns	ns	*
Dressing percentage (%)	48.84	0.18	47.60	0.54	49.61	0.56	0.016	ns	ns	*
Intraabdominal fats ¹ (kg)	2.02	0.12	1.56	0.13	2.57	0.19	<0.001	ns	*	**
Offals ² (kg)	6.43	0.18	6.39	0.07	6.43	0.05	0.915	ns	ns	ns
RHC hindquarter (kg)	21.11	0.43	20.77	0.37	21.69	0.26	0.235	ns	ns	ns
RHC forequarter (kg)	17.51	0.36	17.94	0.21	17.93	0.24	0.658	ns	ns	ns
Trimmed fat ³ (kg)	2.78	0.20	2.35	0.05	3.27	0.08	<0.001	*	ns	***
Bones ³ (kg)	9.10	0.19	8.52	0.09	8.75	0.21	0.052	*	ns	ns
HQ meat cuts ³ (kg)	12.85	0.28	13.01	0.34	12.98	0.11	0.896	ns	ns	ns
Other meat cuts ³ (kg)	11.71	0.27	12.57	0.25	12.69	0.11	0.035	ns	*	ns

ADG - lifetime average daily gain; DP - dressing percentage; RHC - right-half carcass; HQ - highest quality; SE - standard error; ns – not significant; * - $P<0.05$; ** - $P<0.01$; *** - $P<0.001$

¹Intraabdominal fats include rumen fat, intestinal fat, kidney fat, pelvic fat; ²Offals include liver, heart, spleen, lungs; ³From right-half carcass

Table 2 Effect of weaning weight (WW) on fattening and carcass characteristics of male Holstein veal calves

Trait	Low WW (1)		Medium WW (2)		High WW (3)		P-value	Significance between groups		
	Mean	SE	Mean	SE	Mean	SE		1:2	1:3	2:3
Final weight (kg)	175.88	1.11	166.96	1.98	171.88	1.86	0.017	*	ns	ns
Slaughter weight (kg)	169.63	0.44	159.00	2.54	161.91	2.40	0.009	*	ns	ns
Number of feeding days	175.50	0.33	170.64	0.76	167.27	0.76	<0.001	***	***	***
ADG (kg.d ⁻¹)	0.78	0.01	0.75	0.01	0.79	0.02	0.090	ns	ns	ns
Withers height (cm)	112.25	0.12	110.55	0.63	108.18	1.18	0.002	ns	**	ns
Hip height (cm)	113.88	0.22	115.27	0.17	109.55	1.09	<0.001	ns	***	***
Heart girth (cm)	139.00	0.50	137.00	0.92	132.00	0.84	<0.001	ns	***	***
Body length (cm)	63.25	1.21	61.09	1.66	61.18	1.23	0.452	ns	ns	ns
Cold carcass weight (kg)	81.73	1.10	79.00	1.21	77.45	1.30	0.080	ns	ns	ns
Ideal DP (%)	64.82	1.22	65.91	0.66	63.98	0.30	0.100	ns	ns	ns
Dressing percentage (%)	48.19	0.67	49.71	0.67	47.82	0.17	0.010	ns	ns	*
Intraabdominal fats ¹ (kg)	2.26	0.20	2.07	0.19	1.78	0.19	0.099	ns	ns	ns
Offals ² (kg)	6.44	0.06	6.33	0.12	6.49	0.12	0.508	ns	ns	ns
RHC hindquarter (kg)	21.86	0.37	21.20	0.35	20.61	0.32	0.054	ns	*	ns
RHC forequarter (kg)	18.08	0.18	17.73	0.28	17.65	0.31	0.465	ns	ns	ns
Trimmed fat ³ (kg)	2.62	0.17	2.89	0.16	2.76	0.15	0.404	ns	ns	ns
Bones ³ (kg)	9.01	0.13	9.08	0.14	8.31	0.19	0.001	ns	**	**
HQ meat cuts ³ (kg)	13.51	0.28	12.87	0.15	12.61	0.26	0.051	ns	*	ns
Other meat cuts ³ (kg)	12.68	0.18	11.94	0.28	12.43	0.22	0.323	ns	ns	ns

ADG - lifetime average daily gain; DP - dressing percentage; RHC - right-half carcass; HQ - highest quality; SE - standard error; ns – not significant; * - P<0.05; ** - P <0.01; *** - P < 0.001

¹Intraabdominal fats include rumen fat, intestinal fat, kidney fat, pelvic fat; ²Offals include liver, heart, spleen, lungs; ³From right-half carcass

Early weaning of dairy calves and transition to solid feed has become popular due to high milk feed costs and because it carries a lot of health risks. Moreover, according to various authors (Moreno et al., 2006; Bispo et al., 2010) early weaning of calves and consumption of solid feed is associated with rumen papillae development and higher daily gains during the finishing period. Despite of these findings, we did not observe significant effect of the WW on lifetime average daily gain (Table 2). Slaughter weight was influenced by WW, resulting higher in the low than the medium WW group (P<0.01). This result could be associated with the higher number of feeding days, which was statistically significant (P<0.001). Opposite to our findings, Greenwood et al. (2006) reported higher content of separable fat at an equivalent carcass weight. Weaning weight did not have a significant impact on carcass characteristics, but it had some effects on dressing percentage (P<0.05) and bone content (P<0.001). Large individual differences in the monitored indicators were observed, which is in line with results of several authors (e.g. Vacek et al., 2012) who suggested that the genetic variability in the body size and growth of animals could sometimes be greater within the breed than between breeds.

Proximate composition of veal meat did not change across LBW groups, except for intramuscular fat content which was higher in medium than low LBW calves (P<0.05), assessed at equivalent carcass weight. In line with findings of Greenwood et al. (2006), we did not observe significant effect of LBW on shear force in the *Longissimus thoracis et lumborum* muscle (Table 3).

Table 3 Effect of birth weight (LBW) on quality traits of *Longissimus thoracis et lumborum* muscle of male Holstein veal calves

Trait	Low LBW (1)		Medium LBW (2)		High LBW (3)		P-value	Significance between groups		
	Mean	SE	Mean	SE	Mean	SE		1:2	1:3	2:3
Moisture content (g.100 g ⁻¹)	74.25	0.18	73.84	0.24	73.66	0.09	0.154	ns	ns	ns
Protein content (g.100 g ⁻¹)	22.66	0.11	22.89	0.16	23.02	0.17	0.257	ns	ns	ns
IMF content (g.100 g ⁻¹)	1.44	0.11	1.78	0.07	1.66	0.03	0.014	*	ns	ns
Cholesterol content (g.kg ⁻¹)	0.35	0.01	0.36	0.04	0.36	0.01	0.692	ns	ns	ns
pH ₁	6.91	0.06	6.92	0.02	7.03	0.04	0.038	ns	*	ns
pH ₂₄	5.96	0.01	6.01	0.01	6.02	0.01	0.002	ns	**	ns
Drip loss (%)	1.07	0.19	1.29	0.17	1.42	0.12	0.344	ns	ns	ns
Shear force (kg.cm ⁻²)	5.99	0.27	5.72	0.30	4.95	0.35	0.119	ns	ns	ns
Lightness (L*) 7 days	48.74	0.81	47.53	0.66	48.81	0.99	0.452	ns	ns	ns
Redness (a*) 7 days	6.73	0.25	7.66	0.24	8.17	0.24	<0.001	*	***	ns
Yellowness (b*) 7 days	10.69	0.19	10.47	0.20	11.79	0.33	0.001	ns	*	**
SFA (g.100 g ⁻¹ FAME)	33.76	0.45	33.63	0.29	34.56	0.22	0.098	ns	ns	ns
MUFA (g.100 g ⁻¹ FAME)	47.37	0.47	47.30	0.35	48.38	0.18	0.029	ns	*	ns
PUFA (g.100 g ⁻¹ FAME)	12.49	0.41	13.25	0.43	11.68	0.26	0.017	ns	ns	*
Essential FA (g.100 g ⁻¹ FAME)	9.24	0.22	9.54	0.13	9.01	0.15	0.114	ns	ns	ns
Palmitic acid (g.100 g ⁻¹ FAME)	24.55	0.05	24.30	0.04	24.34	0.03	<0.001	***	**	ns
Stearic acid (g.100 g ⁻¹ FAME)	10.50	0.06	10.46	0.05	10.34	0.04	0.030	ns	*	ns
Oleic acid (g.100 g ⁻¹ FAME)	27.01	2.16	25.64	2.24	34.37	0.42	0.002	ns	*	**

IMF - intramuscular fat; pH₁ - pH recorded 1 hour after slaughter; pH₂₄ - pH recorded 24 hours after slaughter; SFA - saturated fatty acids; FAME - fatty acid methyl esters; MUFA - monounsaturated fatty acids; PUFA - polyunsaturated fatty acids; FA - fatty acids; SE – standard error; ns – not significant; * - P<0.05; ** - P <0.01; *** - P < 0.001

Effect of LBW on drip loss was not significant; however, we observed an increase of the amount of free water with increased LBW of calves. Ultimate pH value measured 24 hours *post mortem* differed significantly between low and high LBW calves (P<0.01). Meat colour of individual muscles could vary due to anatomical location of the muscle, pigment content or proportion of red fibres. The pH value is often associated with meat colour and content of pigments in muscle. Usually it is measured as a consequence factor. It was observed that the ultimate colour of *Longissimus thoracis et lumborum* muscle is affected by pigment content in the larger extent and the pH decline is relatively slow compared with *Psoas major* or *Triceps brachii* muscles (Ngapo and Gariépy, 2006). Meat L* of the *Longissimus thoracis et lumborum* muscle was not affected by LBW (Table 3). On the other hand, a* was different among the groups with increasing values moving from low to high LBW calves (P<0.001). Content of saturated fatty acids did not differ, but content of monounsaturated and polyunsaturated fatty acids differ significantly (P<0.05) between some LBW groups (Table 3). Contrariwise to Blanco et al. (2010) and Gálvez et al. (2018), we found higher content of monounsaturated fatty acids in veal loin. Content of palmitic acid, which is known to have a cholesterolemic effect was significantly higher (P<0.001) in the lightest group of calves.

In the present study, there was a significant effect of WW on protein content (P<0.01) of the *Longissimus thoracis et lumborum* muscle (Table 4). In particular, low WW calves had higher protein content than medium WW calves. When three different ages at weaning were compared (Bispo et al., 2010) the moisture and crude protein contents of *Longissimus thoracis et lumborum* muscle were similar. Nevertheless, we did not find significant effect of WW on the intramuscular fat content. On the other hand, Bispo et al. (2010) and Moreno et al. (2006) found higher levels of intramuscular fat in heavier weaned calves. The pH of the *Longissimus thoracis et lumborum* muscle 1 hour after slaughter was significantly higher (P<0.01) in medium WW than high WW. According to Bispo et al. (2010) the length of feeding period is one of the most important factors influencing meat ultimate pH. However, Hornick et al. (1998) did not consider nutrition as a major factor of meat pH. Some of physical technological properties (drip loss, shear force) were not affected by WW, supporting findings

of other studies (Vieira et al., 2005; Blanco et al., 2009). The L^* of *Longissimus thoracis et lumborum* muscle 7 days *post mortem* was significantly lower in low than medium and high WW groups ($P < 0.05$), whereas b^* was higher in high WW than low WW group ($P < 0.05$). In agreement with our results, Bispo et al. (2010) and Pateiro et al. (2013) reported significant effect of weaning status on meat a^* . The content of monounsaturated fatty acids of heavier weaned calves was lower than that of low and medium WW calves ($P < 0.001$), whereas content of polyunsaturated fatty acids was higher for the heaviest calves ($P < 0.05$). Content of monounsaturated fatty acids could be influenced by weight of animal, especially in bulls; heavier animals are closer to puberty (Scollan et al., 2006). Veal of the heaviest calves at weaning had more desirable content of essential fatty acids; however, results were not significant. Contrariwise, the lowest content of oleic acid ($P < 0.01$) was found in high WW group. Oleic acid is quantitatively the most important monounsaturated fatty acid in veal muscles and usually ranged from 22 to 38%. Prevalence of this acid in veal is associated with several individual factors, such as diet, breed, genetic background, animal fatness and age (Moreno et al., 2006; Scollan et al., 2006; Ripoll et al., 2013). It is important to note that fatty acid content in veal muscle is influenced by rumen biohydrogenation and development (Domaradzki et al., 2017).

Table 4 Effect of weaning weight (WW) on quality traits of *Longissimus thoracis et lumborum* muscle of male Holstein veal calves

Trait	Low WW (1)		Medium WW (2)		High WW (3)		P-value	Significance between groups		
	Mean	SE	Mean	SE	Mean	SE		1:2	1:3	2:3
Moisture content (g.100 g ⁻¹)	74.04	0.15	74.23	0.20	73.55	0.19	0.047	ns	ns	*
Protein content (g.100 g ⁻¹)	23.22	0.05	22.43	0.11	22.93	0.17	0.002	*	ns	ns
IMF content (g.100 g ⁻¹)	1.74	0.04	1.55	0.07	1.63	0.10	0.147	ns	ns	ns
Cholesterol content (g.kg ⁻¹)	0.36	0.01	0.35	0.01	0.36	0.01	0.835	ns	ns	ns
pH ₁	6.96	0.04	7.02	0.05	6.87	0.03	0.003	ns	ns	**
pH ₂₄	6.02	0.01	5.97	0.01	6.01	0.01	0.077	ns	ns	ns
Drip loss (%)	1.03	0.18	1.21	0.16	1.47	0.17	0.385	ns	ns	ns
Shear force (kg.cm ⁻²)	5.74	0.44	6.02	0.43	5.03	0.15	0.562	ns	ns	ns
Lightness (L*) 7 days	45.59	0.37	49.44	1.02	49.18	0.69	0.002	*	**	ns
Redness (a*) 7 days	8.18	0.18	6.96	0.32	7.56	0.31	0.063	ns	ns	ns
Yellowness (b*) 7 days	10.16	0.20	11.08	0.28	11.37	0.27	0.006	ns	*	ns
SFA (g.100 g ⁻¹ FAME)	34.24	0.22	34.01	0.31	33.69	0.43	0.610	ns	ns	ns
MUFA (g.100 g ⁻¹ FAME)	48.44	0.04	48.14	0.41	46.59	0.28	<0.001	ns	***	***
PUFA (g.100 g ⁻¹ FAME)	12.11	0.16	11.74	0.36	13.60	0.41	<0.001	ns	*	***
Essential FA (g.100 g ⁻¹ FAME)	9.29	0.09	9.12	0.18	9.43	0.22	0.730	ns	ns	ns
Palmitic acid (g.100 g ⁻¹ FAME)	24.26	0.04	24.52	0.04	24.37	0.04	0.007	**	ns	ns
Stearic acid (g.100 g ⁻¹ FAME)	10.51	0.02	10.44	0.05	10.38	0.07	0.507	ns	ns	ns
Oleic acid (g.100 g ⁻¹ FAME)	31.74	1.63	30.94	1.75	24.29	2.09	0.004	ns	*	*

IMF = intramuscular fat; pH₁ – pH recorded 1 hour after slaughter; pH₂₄ – pH recorded 24 hours after slaughter; SFA - saturated fatty acids; FAME – fatty acid methyl esters; MUFA - monounsaturated fatty acids; PUFA - polyunsaturated fatty acids; FA - fatty acids; SE – standard error; ns – not significant; * - $P < 0.05$; ** - $P < 0.01$; *** - $P < 0.001$

Conclusions

Overall, LBW and WW were not important sources of variation of fattening, carcass, physical technological and qualitative properties of monitored calves. Although a significant effect of LBW and WW on some characteristics was determined, the changes (improvements or worsening of the indicators) depending on the higher live weight at birth and at weaning were not clearly confirmed.

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