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AMOUNTS OF ESSENTIAL AND NON-ESSENTIAL AMINO ACIDS AND THE RATIO IN LITHUANIA BRED CATTLE MEAT

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Abstract: The aim of the research was to determine the amounts of essential and non-essential amino acids and the ratio in various breed cattle meat. The content of amino acids and the ratio at the longest dorsal muscle (*musculus longissimus dorsi*) was determined analyzing Angus, Hereford, Charolais, Limousine purebreds, Lithuanian Black and White x Charolais (LTBWxCHA) crossbreed, Lithuanian Black and White x Limousine (LTBWxLI) crossbreed, Lithuanian Black and White x Simmental (LTBWxSI) crossbreed and Lithuanian Red x Limousine (LTRxLI) crossbreed. Analyzing the research results it was noticed that Lithuanian Black and White cattle breed meat contained the highest total amount of amino acids and Angus breed cattle meat contained the smallest amounts. The difference amounted to 33.87 g/kg or 4.1 percent ($p<0.01$). While comparing total amounts of amino acids at the purebred cattle breeds and the crossbreeds, it was noticed that the meat of purebred cattle contained higher amounts of amino acids, the difference ranging between 18.54 and 19.00 g/kg or 2.23-2.28 percent ($p<0.01$). Purebred cattle meat contains higher amounts of essential amino acids compared to crossbreed cattle meat. The meat of Aubrac and Angus breeds was determined to have the highest meat protein sufficiency rate. The lowest biological values were determined at Lithuanian Black and White x Charolais crossbreed meat. The highest amount of the amino acid leucine was observed in Aubrac breed cattle meat ($p<0.05$). The difference of the leucine amounts reached up to 0.45 g/kg ($p<0.01$) comparing to various crossbreed cattle meat.

Keywords: amino acids, essential, non-essential, breed, cattle, *longissimus dorsi.*

Introduction

Biological value of cattle meat is determined by essential or indispensable amino acids and lipid structure *(Serra et al., 2004; Raes et al., 2004)*.

The nutritional protein value depends upon its amino acid composition's ability to meet the organism's needs. *(Culioli et al., 2003)*. In order to determine the nutritional value of meat more exactly the tryptophan and oxiproline ratio is used, where tryptophan denotes the amount of complete proteins and oxiproline denotes the amount of incomplete proteins in the meat.

Meat quality is affected by many physical and (bio) chemical changes involved during the post-mortem conversion of muscle to meat *(Valin et al., 1992; Radovic et al., 2013)*. Significant differences in the balance of amino acids have been shown between species *(Sawyer, 1975)* and between muscles (*Lawrie, 1991; Purchas et al., 2009)*. Muscle enzymes are responsible for most of these changes and muscle aminopeptidases contribute to the generation of free amino acids in post *mortem* which improve the nutritional value *(Toldra et al., 1995)* and can affect flavour as taste enhancers or precursors of aroma compounds *(Toldra et al., 1997)*. Animal meats like beef have a score of approximately 0.9, compared with values of 0.5–0.7 for most plant foods. The amino acid glutamic acid/glutamine is present in meat in the highest amounts (16.5%), followed by arginine, alanine and aspartic acid *(Williams, 2007)*. The concentration for each amino acid is important for its contribution to taste *(Kato et al., 1989)*.

The aim of the research was to determine the composition of amino acids and their ratio at the longest dorsal muscle of different breeds and crossbreeds cattle grown in Lithuania under the same conditions. Controlled cattle rearing were carried at the company UAB "Šilutės Breeding Station" at identical feeding and storage conditions.

Material and methods

The study investigated the amounts of amino acids at the longest dorsal muscle (*Musculus longissimus dorsi*) of bulls reared at controlled rearing station at identical feeding and storage conditions, slaughtered at the age of 500 days concerning Angus, Hereford, Charolais and Limousine breeds, Lithuanian Black and White crossbred with Charolais (LTBW x CHA), Lithuanian Black and White crossbred with Limousine (LTBW x LI), Lithuanian Black and White crossbred with Simmental (LTBW x SI) and the Lithuanian Red crossbred with Limousine (LTR x LI).

The amounts of amino acids in bovine meat was determined while examinations of dry material applying following methods: technical regulation for assessment of the amounts of amino acids and olakvindox in the feed, Nr. 104-

3302 (EU directive 98/64/EB). The amount of amino acids in the meat was determined using automatic analyser for amino acids AAA 400.

"Microsoft Corporation Excell 2007" program was used for data analyses for calculating Arithmetic average (X), standard errors of arithmetic average (Sx), statistical reliability degree of groups (p).

Results and discussion

The Tables 1 and 2 present the amounts of essential or indispensable amino acids in the meat of different breed and crossbreed cattle.

Table 1. The amounts of essential amino acids in the meat of pure breed cattle, g/kg

	Cattle breed denomination					
Amino acids	**LTBW**	**AN**	**AU**	**HE**	**CHA**	**LI**
Threonine	36.76±1,02	33.43±0.25	35.97±2.47	35.67±2.22	35.82±0.07	35.74±0.34
Valine	42.29±2,08	46.09±1.98	41.87±2.01	41.43±0.98	41.65±0.93	41.54±1.01
Methionine	30.99±1,67	35.67±4.31	31.74±1.24	30.82±0.74	31.28±3.05	31.05±1.21
Isoleucine	43.24±0,94	42.06±1.73	42.14±2.60	41.70±2.23	41.92±0.66	41.81±0.67
Leucine	65.62±1,09	63.31±2.21	66.06±1.22	65.35±3.42	65.70±0.73	65.52±0.78
Phenylalanine	33.63±1,28	31.63±0.91	32.78±2.17	32.401.56	32.59±0.18	32.49±0.21
Lysine	66.00±2,42	71.83±1.67	68.27±1.99	69.61±4.33	68.74±1.27	68.48±1.78
Total:	318.53	322.53	318.83	316.98	317.70	316.63

Table 2. The amounts of essential amino acids in the meat of crossbreed cattle, g/kg

	Cattle crossbreed denomination		
Amino acids	**LTBWxCHA**	**LTBWxLI**	**LTBWxSI**
Threonine	35.78±0.45	35.76±0.67	35.77±1.54
Valine	41.60±1.28	41.57±2.02	41.58±0.56
Methionine	31.16±1.20	31.10±1.67	31.13±3.23
Isoleucine	41.86±0.87	41.84±0.95	41.85±0.84
Leucine	65.61±2.67	65.57±2.54	65.59±1.83
Phenylalanine	32.54±0.34	32.52±0.54	32.53±1.56
Lysine	68.61±1.32	64.54±2.87	68.57±1.84
Total:	317.16	312.90	317.02

The data in Table 1 and Table 2 proves, that the highest amount of essential amino acids is observed in AN cattle meat and the lowest amount is observed in LTBWxLI crossbred cattle meat. The difference amounted to 9.63 g/kg or 4.1 percent ($p<0.001$). Comparing the total amounts of essential amino acids in purebred cattle meat to the amounts in crossbreed cattle meat it is observed that purebred cattle meat contained higher amounts. AN breed cattle meat was noticed to have the highest amounts of following amino acids: valine, methionine and lysine ($p<0.01$). Similar results were obtained by other authors who have studied the ratio of amino acids in the bovine meat *(Lawrie, 1991; Purchas et al., 2009)*. The highest amount of the amino acid leucine was observed in AU breed cattle meat ($p<0.05$). The difference of the leucine amounts reached up to 0.45 g/kg ($p<0.01$) comparing to various crossbreed cattle meat. Similar results were obtained by other authors who have studied the amino acid amounts and the ratio in the bovine meat (*Williams, 2007*). The amounts of non-essential amino acids in the pure bred cattle meat are presented in the Table 3 and Table 4.

Table 3. The amounts of non-essential amino acids in the meat of purebred cattle, g/kg

	Cattle breed denomination					
Amino acids	**LTBW**	**AN**	**AU**	**HE**	**CHA**	**LI**
Aspartic acid	77.47±0.56	74.67±0.32	77.13±1.15	76.26±2.53	76.69±0.86	76.47±0.56
Serine	35,13±1.12	32.10±1.06	32.54±0.84	32.51±3.15	32.52±1.92	32.51±0.43
Glutamic acid	150.3±2.12	140.75±6.58	146.65±0.10	145.76±6.61	142.21±0.57	145.98±2.12
Proline	29.93±1.45	28.35±0.35	29.65±2.52	29.61±1.73	29.63±0.77	29.62±0.24
Glycine	39.42±2.10	40.64±1.14	37.39±0.11	37.10±2.11	37.24±4.19	37.17±0.43
Alanine	43.23±0.91	47.65±0.65	45.63±0.83	44.92±0.85	43.28±0.30	45.10±0.67
Tyrosine	27.61±1.19	25.62±0.64	26.92±2.02	26.15±2.17	26.53±0.07	26.34±1.69
Histidine	43.27±0.87	46.84±0.54	47.99±1.07	48.69±0.32	45.34±2.81	48.51±1.56
Arginine	50.15±3.01	50.53±0.06	56.43±3.00	54.18±3.23	51.31±1.12	56.24±2.56
Total:	495.51	488.15	500.33	495.18	496.75	479.94

Table 4. The amounts of non-essential amino acids in the meat of crossbreed cattle, g/kg

Amino acids	Cattle crossbreed denomination		
	LTBW x CHA	**LTBW x LI**	**LTBW x SI**
Aspartic acid	76.58±1.09	76.53±0.89	76.56±0.58
Serine	32.52±1.12	32.52±2.12	32.52±0.85
Glutamic acid	146.09±1.23	146.04±1.38	146.07±1.43
Proline	29.62±0.67	29.62±0.89	29.62±1.67
Glycine	37.21±0.56	37.19±0.65	37.20±0.79
Alanine	45.19±0.82	45.14±1.29	45.16±1.08
Tyrosine	26.44±0.78	26.39±1.23	26.41±1.59
Histidine	48.42±1.34	48.47±2.17	48.45±2.06
Arginines	56.27±1.02	56.26±1.93	56.27±1.02
Total:	498.34	498.16	498.26

The data in Table 3 and Table 4 illustrates the changes of amounts of non-essential amino acids in various breed cattle meat. The highest amount of non-essential amino acids was observed in CHA breed cattle meat, the lowest in the LI breed cattle meat. The difference amounted up to 16.81 g/kg ($p<0.01$). Concerning various crossbreed cattle meat, the amounts of non-essential amino acids were alike. The ratios of oxiproline and tryptophan amino acids are presented in the Table 5 and Table 6 below.

Table 5. The ratio of amino acids oxiproline and tryptophan in the meat of purebred cattle.

Amino acids	Cattle crossbreed denomination		
	LTBWxCHA	**LTBWxLI**	**LTBWxSI**
Oxiproline	69.43±0.92	69.60±0.12***	54.07±1.20
Tryptophan	295.70±0.32	330.91±0.28	266.11±1.52
Tryptophan / Oxiproline ratio	4.47	4,85	5.23

*p<0.05; **p<0.01; ***p<0.001.

Table 6. The ratio of amino acids oxiproline and tryptophan in the meat of various crossbreed cattle.

Amino acids	Cattle crossbreed denomination		
	LTBWxCHA	**LTBWxLI**	**LTBWxSI**
Oxiproline	69.43±0.92	69.60±0.12***	54.07±1.20
Tryptophan	295.70±0.32	330.91±0.28	266.11±1.52
Tryptophan / Oxiproline ratio	4.47	4,85	5.23

*p<0.05; **p<0.01; ***p<0.001.

The data in Table 5 and Table 6 presents the nutritional value of bovine meat. The data proves, that the highest meat protein sufficiency ratio is observed in Au and AN breed cattle meat. All the purebred cattle have a meat protein sufficiency ratio greater than 5, and the meat is of high biological value. Concerning crossbred cattle meat, the highest quality of meat was determined in LTBW x SI. The lowest biological value was observed in LTBW x CHA crossbred meat. Similar results were obtained by other authors who have studied the ratio of amino acids in the bovine meat *(Jukna et al., 2013).*

Conclusions

The highest amount of essential amino acids was observed in AN breed cattle meat, the lowest in LTBW x LI crossbreed meat. The difference amounted to 9.63 g/kg or 4.1 percent ($p<0.001$). The AN breed cattle meat was observed to have the highest amounts of following essential amino acids: valine, methionine and lysine ($p<0.05$).

The highest meat protein sufficiency ratio was observed in Au and AN breed cattle meat. All the purebred cattle have a meat protein sufficiency ratio greater than 5, and the meat is of high biological value. Concerning crossbred cattle meat, the highest quality of meat was determined in LTBW x SI. The lowest biological value was observed in LTBW x CHA crossbred meat.

The purebred cattle meat was observed to have a higher total amount of amino acids comparing to crossbred cattle meat. No significant differences were observed concerning the amounts of amino acids in meat of separate cattle breeds.

Having results concerning the composition of amino acids of different cattle breeds and the composition's changes following crossbreeding it is possible to obtain bovine meat with more appropriate ratio of amino acids.

Esencijalne i ne-esencijalne amino kiseline i njihov odnos u meso goveda gajenih u Litvaniji

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Rezime

Cilj istraživanja bio je da se utvrde količine esencijalnih i ne-esencijalnih amino kiselina i njihov odnos u mesu različitih rasa goveda. Sadržaj aminokiselina i odnos u leđnom mišića (*musculus longissimus dorsi*) određen je analizom mesa goveda sledećih rasa: angus, hereford, šarole, limuzin, u čistoj rasi, melezu litvanske crno & bele rase x šarole (LTBVkCHA), melezu litvanske crno & bele rase x limuzina (LTBVkLI) melezu litvanske crno & bele rase x simentalske rase (LTBVkSI) i melezu goveda litvanske crvene rase x limuzina (LTRkLI). Analizirajući rezultate istraživanja uočeno je da je meso goveda litvanske crno & bele rase sadržavalo najviše ukupnih aminokiselina a meso goveda rase angus najmanje iznose. Razlika je iznosila 33,87 g/kg ili 4,1 % ($p<0,01$). U poređenju ukupne količinu aminokiselina u mesu čistokrvnih goveda i melez, primećeno je da meso čistokrvnih grla sadrži veće količine aminokiselina, razlika je bila u rasponu od 18.54 i 19.00 g/kg ili 2.23-2.28 % ($p<0,01$). Meso čistokrvnih goveda sadrži veće količine esencijalnih aminokiselina u poređenju sa mesom meleza. U mesu goveda rasa aubrac i angus rasa utvrđena je najveća najveća stopa dovoljnosti proteina u mesu. Najniže biološke vrednosti su određene u mesu meleza litvanske crno & bele rase x šarole. Najveći iznos amino kiseline leucin je registrovan u mesu goveda aubrac rase ($p<0,05$). Razlika u količini leucina dostigla je 0.45 g/kg ($P<0.01$) u odnosu na meso ostalih meleza.

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