Influence of Breed, Slaughter Weight and Gender on Chemical Composition of Beef. Part 1. Amino Acid Profile and Biological Value of Proteins

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ABSTRACT : In the first study of a series of experiment samples were taken from 11-13th rib of Hungarian Simmental (HS, n=22) and Holstein-Friesian (HF, n=18) cull cows. In the second one, that of females (n=15) and males (n=12) of HF breed was analysed for amino acid composition, and biological value (BV) of proteins. No significant influence of either breed or slaughter weight was established in this study. Thus, the essential amino acid content and biological value of the proteins in Hungarian Simmental breed are practically the same as in the Holstein-Friesian. On the other hand, gender proved to be a significant factor influencing the amino acid profile of beef proteins, as the quantity of essential amino acids turned out to be significantly larger in females than in males. No statistical difference could be established for the non-essential amino acids and BV between the two genders. *(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 11 : 1555-1559)*

Key Words : Essential- and Non-Essential Amino Acids, Biological Value, Meat, Cattle, Hungarian Simmental, Holstein-Friesian

INTRODUCTION

Nutrients in beef are appreciated because their high nutritional value and therefore they obtain significant role in human diet. The nutritive components of meat are easy to digest, their proteins have high biological value and almost all nutrients' availability seems to be excellent (Bruce, 1994). The protein and fat contents of beef deserve some special attention in the context of human nutrition. The beef consumption plays an important role in the balanced nutrition, and the question how to preserve your health through your nutrition came into the centre of interest in the last few decades in Hungary, according to which the consumer demands on the quality of the meat changed as well.

The muscles contain various types of proteins therefore their amino acid profile may also differ. Primarily the quality and ratio of essential amino acids determine the nutritional value of any protein, while these factors themselves depend on the ratio of proteins. Nevertheless, the breeds, slaughter weight and gender also may exert influence on them (Piva and Guglielmetti, 1978). Losand et al. (1991) reported that amino acid content is relative constant, but depend on muscle fat content, increasing fat content occur decreasing amino acid content in muscle.

During post mortem storage of meat, some proteolytic changes occur, the last step in the proteolysis observed the free amino acids due to the action of muscle aminopeptidases and di-tripeptidases (Nishimura et al., 1988). The increment in free amino acid detected during ageing in bovine meat was described by Feidt et al. (1996). Spanier and Edwards (1987) analysed the generation of peptides and amino acids during the ageing and their involvement in cooked meat flavour. Szűcs et al. (1985) found a negative correlation between the flavour and arginine and/or hystidine content of beef, thus the amino acid composition of proteins may also play a role in palatability and eating quality of meat. Molnár and Molnár (1981) studying the amino acid composition of different muscle groups of Hungarian Simmental differing in gender and age established significant differences in case in methionine, lysine and arginine content. They also established that the amino acid content is influenced by the stress as well.

Nicastro et al. (2000) analysed the influence of diet on amino acid profile of longissimus thoracis and semimembranosus muscles in Chianina beef. The results indicate that the levels of energy of the diet do not influence the profile of amino acids in the two muscles at 8 months of age.

There are few studies focussed on the differences among breeds, genders in terms of the amino acid profile in post mortem meat. The aim of the experiments was to establish differences in amino acid profile and the BV of proteins between Holstein-Friesian and Hungarian Simmental, the most frequent bred cattle breeds in Hungary. We also intended to analyse the influence of breed, gender and slaughter weight on amino acid composition and BV of proteins in beef.

MATERIALS AND METHODS

In the first one of two separate experiments, the effect

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of breed and that of weight before slaughter were studied. In Exp. 1, 18 Holstein-Friesian (HF) and 22 Hungarian Simmental (HS) cull cows (N=40) were slaughtered in a commercial abattoir. Animals were housed in cow sheets with free stalls and fed with maise-silage, grass hay and mixed-grain based diets. For HF and HS breeds the average slaughter weights were 508±51.26 kg and 526±41.16 kg, respectively. Based on the weight prior to slaughter and number of lactation the animals were assigned into two weight categories the range of them were 401-500 (culled after 1. lactation period) and 501-600 kg, (culled after 2. and 3. lactation period), respectively. After evisceration and chilling for 24 h samples were taken from right half carcasses, between 11-13th ribs. The samples were dissected and tissues were separated. The boneless meat was homogenised and samples were taken for chemical analysis. In experiment 2, 12 male (M) and 15 female (F) HF fattening cattle (N=27) were slaughtered. Animals were fattened in small groups and kept in a sheet with open front side with deep litter for resting. They were fed maise-silage, mixed-grain and grass-hay. The average weight for M and F animals were 463±25 kg and 458±23 kg, respectively. Samples for chemical analysis were taken just the same way, as it was the case in Exp1. The protein contents of samples were determined using Kjel-Foss rapid nitrogen analyser according to standard procedure. The amino acid profile was made by Labor MIM amino acid analyser. Protein was hydrolysed in 6 mole hydrochloric acid for 24 h at 110°C. Sulphurous amino acids were measured after performic acid oxidation according to the method described by Csapó et al. (1986). Biological value of proteins was calculated by the procedure of Morup and Olesen (1976). The authors cited chose a 2:1 ratio potato-egg mixture reference.

Statistical analysis was carried out by SPSS 9.0 program package. In Exp. 1 and 2 ANOVA was applied for main effects and two way interactions using GLM procedure with regression approach (Type III) and t-test for comparison of means, respectively.

RESULTS AND DISCUSSION

Experiment 1

Overall means and standard deviation as well as that of categorised by breed and slaughter weight categories for tissues in rib samples and chemical composition of homogenates are given in table 1. Statistical analysis reveals significant differences between breeds for percentage of boneless meat ($p<0.01$) and that of bone ($p<0.05$). Significant differences were established between slaughter weight categories for weight of rib sample ($p<0.001$), dry matter ($p<0.05$) and fat content ($p<0.05$) of homogenised samples without two-way interactions.

Mean values and standard deviation of amino acid profile are summarised in table 2 by breeds and slaughter weight categories. In both weight categories, the proteins in meat of HS breed contained almost the same amount of essential amino acids as their HF counterparts, even if slight differences were recorded with higher values for histidine and threonine and lower ones for valine in HS in comparison with HF at desired level of probability (table 3). For non-essential amino acids, similar phenomenon was shown. Low values were present for glycine and higher ones for glutamic acid and serine in HS than HF at desired level of significance. No significant differences may be associated with slaughter weight in any of amino acids analysed but lysine. Significant breed×slaughter weight interactions were present only for threonine and serine but the extent of differences does not seem to be of utmost importance. Overall mean and standard deviation of BV of proteins of beef was 73.92±11.71 falling within the scale published in relevant literature. Similar range (72-76) for BV of proteins of beef was established by Hegedűs et al. (1981).

Table 1. Tissue and chemical composition of rib samples by breed and slaughter weight

Item	Hungarian Simmental				Holstein-Friesian				Overall mean	
	401-500 kg		501-600 kg		401-500 kg		501-600 kg			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Tissue composition of rib samples										
Weight, g	2611.82	479.90	3061.64	376.32	2452.56	342.73	2833.44	200.2	2749.55	427.18
Meat, %	60.36	2.26	58.32	3.84	56.70	3.27	54.12	5.18	57.57	4.25
Bone, %	24.79	4.45	22.57	4.08	25.94	2.82	27.44	5.30	25.04	4.47
Fat, %	5.71	2.41	10.20	7.30	8.14	3.41	9.15	4.80	8.26	5.03
Pellicle, tendon, %	9.14	1.85	8.91	2.56	9.22	2.42	9.30	1.24	9.13	2.02
Chemical composition										
Dry matter, %	30.17	4.15	35.91	6.27	32.43	3.80	34.24	5.13	33.18	5.28
Protein, %	21.61	0.93	20.22	1.90	20.22	1.16	20.47	1.18	20.66	1.44
Fat, %	7.59	4.81	14.39	7.89	10.87	4.52	12.74	6.08	11.36	6.38
Ash, %	0.96	0.00	0.92	0.00	0.94	0.16	0.95	0.00	0.94	0.10

Table 2. Amino acid composition of protein in rib samples by breed and slaughter weight

Amino acids, g/100 g protein	Hungarian Simmental				Holstein-Friesian				Overall	
	401-500 kg		501-600 kg		401-500 kg		501-600 kg			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Essential amino acids	47.36	1.10	46.77	1.17	46.72	1.16	46.56	1.53	46.88	1.23
Arginine	6.20	0.37	6.06	0.37	5.99	0.53	6.02	0.65	6.07	0.47
Phenylalanine	4.15	0.27	4.13	0.18	4.19	0.33	4.21	0.24	4.17	0.25
Histidine	4.20	0.31	4.14	0.34	3.91	0.44	3.95	0.29	4.06	0.35
Isoleucine	4.20	0.33	4.26	0.41	4.33	0.27	4.42	0.38	4.30	0.35
Leucine	8.29	0.27	8.12	0.30	8.33	0.39	8.11	0.32	8.21	0.33
Lysine	9.35	0.35	9.01	0.48	9.09	0.49	8.77	0.72	9.07	0.54
Methionine	1.91	0.37	1.52	0.50	1.59	0.30	1.70	0.68	1.68	0.49
Threonine	4.68	0.38	5.02	0.29	4.68	0.35	4.41	0.31	4.71	0.39
Valine	4.37	0.43	4.53	0.42	4.61	0.47	4.97	0.69	4.60	0.53
Non-essential amino acids	51.56	1.21	52.16	1.30	52.21	1.19	52.17	1.46	52.01	1.27
Alanine	6.48	0.80	6.35	0.68	6.91	0.79	6.76	1.14	6.68	0.80
Aspartic acid	8.82	0.58	9.14	0.62	8.98	0.47	8.68	0.88	8.91	0.6ö
Cystine	1.02	0.33	0.87	0.32	0.98	0.45	1.20	0.33	1.01	0.365
Glycine	5.79	0.91	5.79	0.91	6.43	0.71	7.10	1.39	6.31	1.05
Glutamic acid	16.80	0.62	17.05	0.58	16.43	0.50	15.90	1.01	16.59	0.80
Proline	5.04	0.98	4.92	0.72	4.93	0.26	5.12	0.90	5.00	0.75
Serine	3.87	0.29	4.19	0.33	3.84	0.31	3.76	0.25	3.93	0.33
Tyrosine	3.75	0.30	3.55	0.20	3.70	0.36	3.66	0.39	3.66	0.31
Biological value	74.97	13.47	69.59	12.94	75.13	5.40	76.71	12.85	73.92	11.71

Table 3. Statistical evaluation of effect and two way interaction of breed and slaughter weight on amino acid composition and biological value of proteins in rib samples

Amino acids	Breed	Slaughter weight	Breed× slaughter weight
Essential amino acids	NS	NS	NS
Arginine	NS	NS	NS
Phenylalanine	NS	NS	NS
Histidine	X	NS	NS
Isoleucine	NS	NS	NS
Leucine	NS	NS	NS
Lysine	NS	X	NS
Methionine	NS	NS	NS
Threonine	XX	NS	XX
Valine	X	NS	NS
Nonessential amino acids	NS	NS	NS
Alanine	NS	NS	NS
Aspartic acid	NS	NS	NS
Cystine	NS	NS	NS
Glycine	XX	NS	NS
Glutamic acid	XXX	NS	NS
Proline	NS	NS	NS
Serine	X	NS	X
Tyrosine	NS	NS	NS
Biological value	NS	NS	NS

NS=p>0.05, x =p<0.05, xx =p<0.01, xxx=p<0.001

and Ensminger et al. (1995), as well. Thus, GLM models did not confirm the influence of either breeds or that of slaughter weight. Out of total variance threonine (R^2=0.32) and valine (R^2=0.17) are the essential amino acids to play major role, in BV, while share of glutamic acid (R^2=0.30), serine (R^2=0.26) and glycine (R^2=0.21) might be similar out of non-essential amino acids.

Experiment 2

Overall means and mean values and standard deviation for tissues in rib samples and chemical composition of boneless homogenates by gender for HF breed are presented in table 4. Figures reveal significant breed differences for percentage of boneless meat ($p<0.001$), dry matter ($p<0.05$), protein ($p<0.01$) and fat ($p<0.05$). Thus, the effect of gender on tissue composition of rib samples has been established in this study. Higher percentage of boneless meat and less fat were more typical characteristics for male animals than for females at same slaughter weight (Enser, 1991).

The amino acid profile and BV of proteins in beef by gender are presented in table 5. In accordance with literature (Losand et al., 1991) the one-third of all amino acid content were three amino acids, such as glutamic acid, aspartic acid and lysine. Larger amount of essential amino acids was recorded in the proteins of meat from females than from males. Consequently, the meat of females had a higher biological value, too. Statistical analysis reveal significant differences between genders for the total amount

Table 4. Tissue and chemical composition of rib samples by gender

Item	Overall		Female		Male	
	Mean	SD	Mean	SD	Mean	SD
Tissue composition of rib samples						
Weight, g	2639.00	525.07	2741.87	593.41	2510.42	413.53
Meat, %	57.39	5.16	54.31	4.61	61.24	2.60
Bone, %	23.68	3.09	23.96	3.74	23.33	2.13
Fat, %	12.42	7.21	14.48	8.97	9.84	2.69
Pellicles, tendons, %	6.62	2.73	7.51	3.15	5.58	1.75
Chemical composition						
Dry matter, %	35.02	6.16	37.28	7.36	32.2	2.26
Protein, %	19.71	2.04	18.83	2.34	20.81	0.71
Fat, %	14.23	8.09	17.23	9.66	10.47	2.89
Ash, %	0.88	0.12	0.87	0.16	0.90	0.003

Table 5. Amino acid composition of proteins in rib samples by gender

Amino acids (g/100 g protein)	Overall		Females		Males		Statistical difference between genders
	Mean	SD	Mean	SD	Mean	SD	
Essential amino acids	46.17	1.43	46.67	1.30	45.56	1.41	x
Arginine	6.49	1.05	6.13	0.51	6.93	1.37	x
Phenylalanine	4.15	0.64	4.14	0.29	4.16	0.94	NS
Histidine	3.90	0.47	4.07	0.46	3.68	0.40	x
Isoleucine	4.02	0.41	4.23	0.36	3.75	0.30	xxx
Leucine	8.09	0.43	8.29	0.37	7.83	0.37	xx
Lysine	8.67	0.72	8.99	0.66	8.28	0.60	xx
Methionine	1.99	0.53	1.73	0.38	2.32	0.52	xx
Threonine	4.56	0.36	4.66	0.35	4.43	0.34	NS
Valine	4.32	0.50	4.43	0.50	4.17	0.48	NS
Non-essential amino acids	52.66	1.61	52.25	1.55	53.18	1.60	NS
Alanine	6.64	0.72	6.64	0.84	6.65	0.56	NS
Aspartic acid	9.22	0.47	9.09	0.43	9.38	0.48	NS
Cystine	1.21	0.40	1.19	0.48	1.23	0.28	NS
Glycine	6.29	0.81	6.21	0.80	6.38	0.85	NS
Glutamic acid	16.33	0.80	16.29	0.76	16.39	0.86	NS
Proline	5.30	0.55	5.14	0.43	5.50	0.63	NS
Serine	3.98	0.36	3.87	0.27	4.12	0.41	NS
Tyrosine	3.68	0.39	3.80	0.38	3.53	0.34	NS
Biological value	72.09	9.32	74.51	6.98	69.07	11.19	NS

NS=p>0.05, x=p<0.05, xx=p<0.01, xxx=p<0.001.

of essential amino acids ($p<0.05$), but there was no significant effect for non-essential amino acids, and for the BV values of proteins in meat in spite of the fact that out of essential amino acids significant effects of genders were present for methionine ($p<0.01$), isoleucine ($p<0.001$), leucine ($p<0.01$), lysine ($p<0.01$), histidine ($p<0.05$) and arginine ($p<0.05$). There are similar significant differences to as they were reported by Molnár and Molnár (1981), but they found differences only in methionine and arginine content between genders in Hungarian Simmental breed.

CONCLUSIONS

Figures of the present study reveal that the amino acid profile in proteins of cattle rib samples does not seem to be influenced either by breed or live weight prior to slaughter. Gender, however, may be a factor that significantly influences the amino acid profile of proteins in beef, as the quantity of essential amino acids turned out to be significantly larger in females than in males. No statistical difference could be established for the quantity of non-essential amino acids and in the biological values of

proteins in samples taken from male and/or female animals.

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