2-4 BEEF QUALITY TRAITS IN DIFFERENT MUSCLES OF GROWING-FINISHING BULLS SLAUGHTERED AT VARIOUS AGES

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INTRODUCTION

Taking into account the importance attached to the existing differences in meat quality, only limited information is available to show the possible effect of breed or chronological age on chemical composition or palatability. Role of breed and that of age at slaughter, however, has been demonstrated several times by different authors /Norman, 1982., Ramsey, 1984., Cole et al., 1964., van der Wal et al., 1979., Bowling et al., 1978., Otto et al., 1975/. In a preliminary study /Szücs et al., 1982/ statistical differences in intramuscular fat, total connective tissue and total pigment content between age categories, breeds /Hungarian Red Spotted and Holstein Friesian/ and muscles were established for young fattening bulls. Mean values for protein content, however, showed only slight differences. No consequent differences were obtained in certain beef quality traits depending on pH_u such as W.-B. shear force value, though, in contrary, surface reflectance and cooking loss seemed to be altered by genotype and chronological age.

Because of gaps in our knowledge connected with genotype and age, our previous study has been extended to further cattle breeds such as Hungarian Grey and Hereford, as well. Thus, the aim of this study was to make comparisons among breeds listed above and age categories in case of growing-finishing bulls for chemical composition of their muscles and for meat quality traits depending on ultimate pH.

MATERIALS AND METHODS

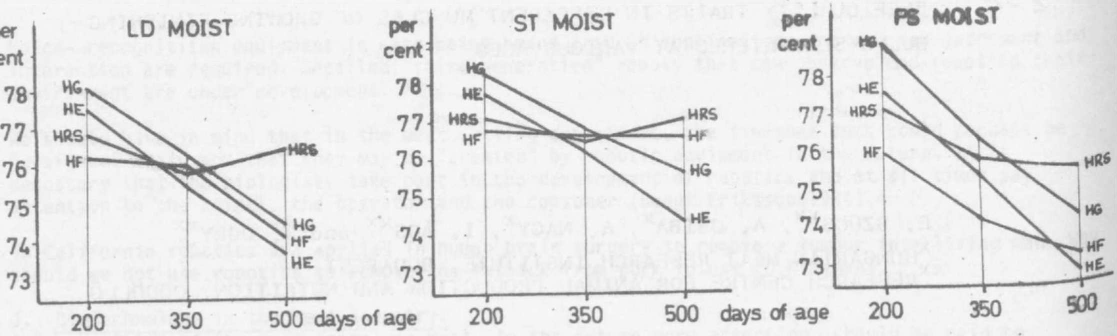
Hungarian Red Spotted /HRS/, Holstein Friesian /HF/, Hungarian Grey /HG/ and Hereford /HE/ bull calves and growing-finishing bulls were slaughtered at 200, 350 and 500 days of age, respectively. Animals were fed silo-maize based diets during the growing-finishing period with moderate concentrate supplementation. Number of animals involved and experimental design is shown in Table 1. On the whole 181 animals have been slaughtered. Age categories represent the initial, medial and final points of fattening. Muscle samples were taken from M. longissimus dorsi /LD/, M. semitendinosus /ST/ and M. psoas major /PS/ following traditional chilling for 24 hours. Analytical methods used for the determination of moisture, protein, intramuscular fat, total connective tissue, and total pigment content, as well as Warner-Bratzler shear force value and surface reflectance which was measured by GÖFO apparatus are listed in the Catalogue of the Hungarian Meat Research Institute /1973/ and in the COMECON Standard /1979/. All in all 542 muscle samples were analyzed. Data were processed and evaluated by means of analysis of variance.

RESULTS AND DISCUSSION

Chemical composition

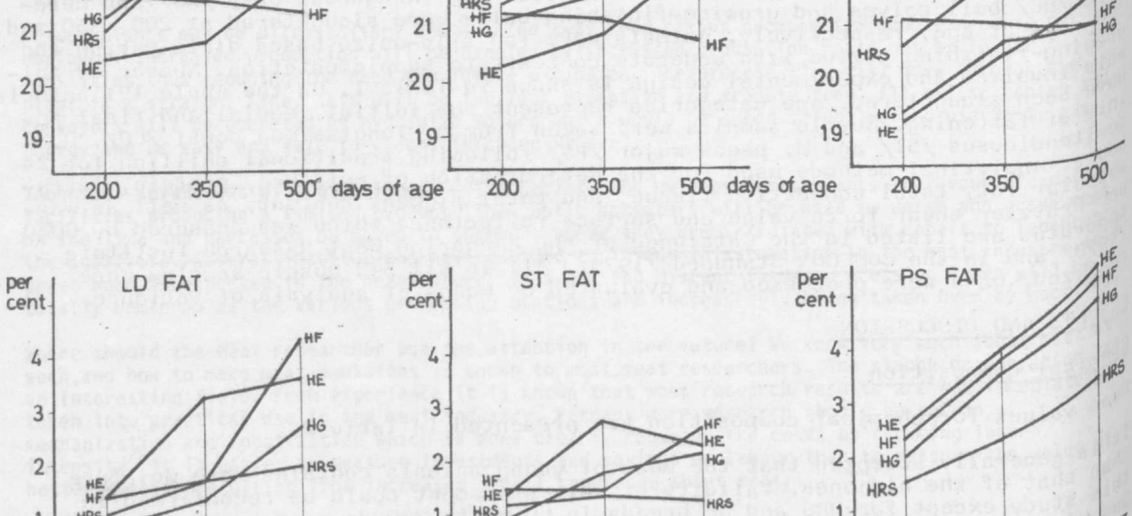
Mean values for chemical composition are presented in Table 2.

It is generally accepted that the meat of young animals contains more moisture than that of the old ones. Validity of this statement could be reconfirmed in this study except for HRS and HF breeds in LD up to 350 days of age and for HG and HE breeds in ST. This phenomenon may partly be attributed to increased intramuscular fat measurements being concomitant of advancing age. Consequently, strong relation of percentage of moisture and intramuscular fat may be presumed. Körmendy et al. /1981/ proposed closed relationship between the two parameters. Correlation coefficient calculated between moisture and intramuscular fat amounted r = -0.9 in Dransfield's /1977/ study.



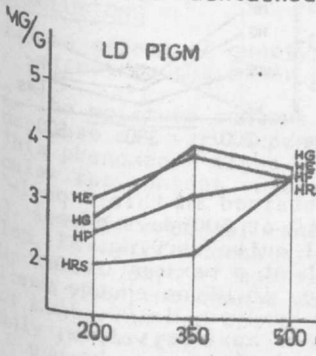
Protein content of muscles of growing-finishing bulls may differ, however, this differences owing to the relatively small range of measurements are although stastically significant, could not be considered of improtant. Variation of recordings may be in part due to changes in moisture content. Remarkable increase was found in HE for PS between 200 and 500 days of age and for LD and ST between 350 and 500 days of age. No change was observed in HF for neither age categories nor muscles. In HRS and HG protein content increased between 200 and 350 days of age, later on it maintained on the same level for PS, in HRS for LD and ST, however, no alteration was present. In HG peak values were attained at 350 days of age for LD.

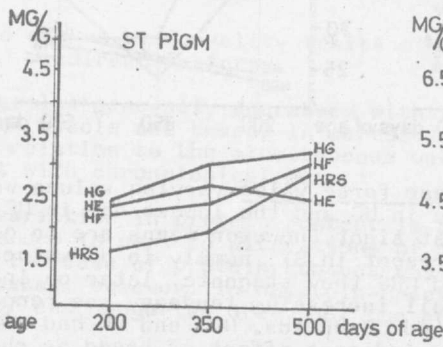
Overall increase of intramuscular fat content with advancing chronological age was shown in this study mainly for PS in all genotypes investigated. In PS marked contrasts exist among means of HRS and the other breeds. For LD and ST in HRS no, or only slight alterations could be established. In HF young bulls the intramuscular fat content seemed to increase at a lower rate during the first phase of fattening for LD and ST than later. The same process was present in HG for LD, but nearly balanced rate of increase was shown for ST. In contrary, the rate of increase of intramuscular fat content in HE was higher at younger age, later on it ascended moderately. Thus, periodicity or evenness of increase of intramuscular fat content

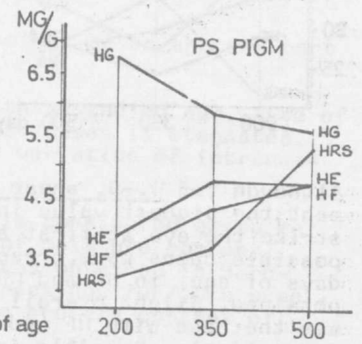


in LD and ST might be considered as a breed-bounded character during the growth of young fattening bulls investigated in this study.

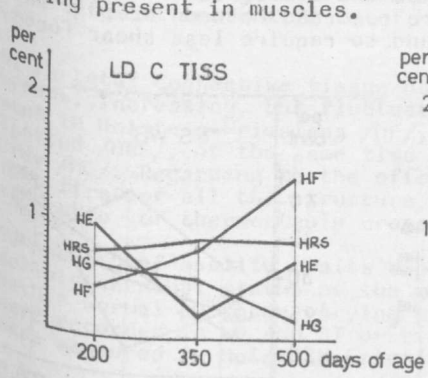
Total pigment levels were expressed in mg/g wet weight tissue. Mean values are comparable to figures published by Norman /1982/, who recorded significant differences between breeds. Our preliminary results reveal significant effects for breed, age and muscles /Szűcs et al., 1982/. Within the growth period investigated in this series of experiment higher total pigment levels were found with advancing age. Consequently, meat of animals of "older" age contain higher amount of mioglobin and the colour will be darker. The highest values were recorded in PS, the lowest ones in ST. For LD, up to 350 days of age no change was observed in HRS, increase in HF was balanced throughout the growing-finishing period, in HG and HE following an early ascending phase values remained at the same level with small fluctuations. In ST of HRS young bulls total pigment content tend to increase between 200 and 350 days of age at a lower rate, which was changed showing higher increase later. Quite unexpected, total pigment content in PS of HG decreased within the age categories investigated, in contrary, elevated values were recorded in HRS between 350 and 500 days of age. Higher rate of increase was shown in HF and HE at the early stage of growth, which was followed by a period when total pigment content was maintained on the same level.

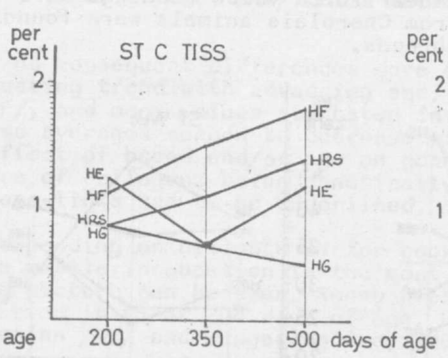


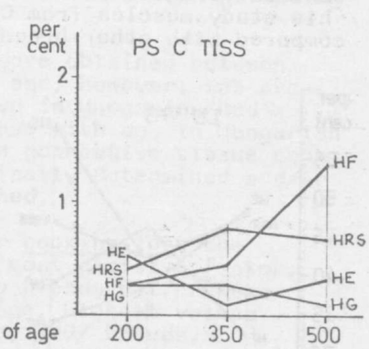




As far as total connective tissue is concerned varying picture could be stated. Inconstant trends among breeds with small, fluctuating increase due to advancing chronological age were recorded. In HF mean values tend to increase, in HRS they stagnate, in HG in turn decrease was observed with advancing age. Former findings reveal that the development of connective tissue may be associated with the dairy or beef character of breeds. Bailey /1976/ suggested that the cause of this may be due to the genetically different composition of collagens constructing the specific anatomical parts of intramuscular connective tissue. In addition they may influence the proportion of thermostable cross-links playing role in the soluble part of connective tissue. In consequence, from the point of view of the effect of breed and age on palatability its quality has to be emphasized instead of the amount being present in muscles.



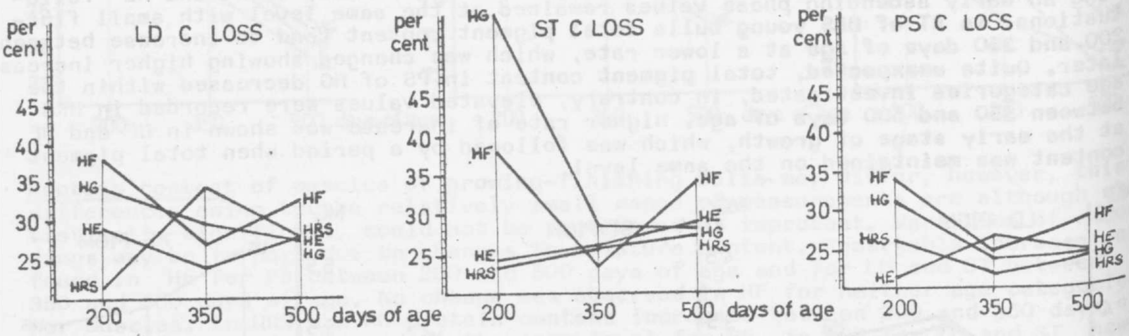




Beef quality traits depending on ultimate PH

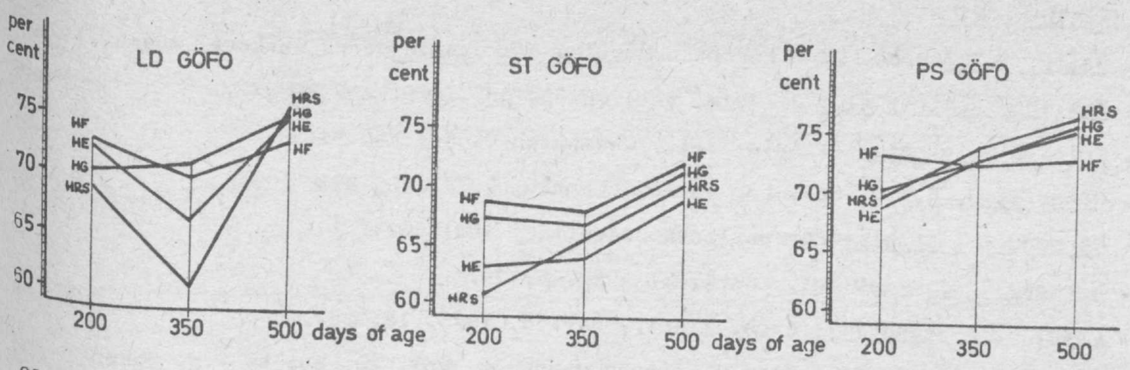
Since the effect of pH on palatability and tenderness of meat is well documented, muscle samples showing DC-character were excluded from the analysis /pH $5.4 \leq x \leq 5.8$/. The aim of this procedure was that muscle samples of only normal quality should be included when making comparison among breeds and age categories. Mean values for cooking-loss, Warner-Bratzler shear force value and surface reflectance are given in Table 3.

As far as cooking-closs is concerned the effect of colloid-chemical status of the given muscle might have utmost importance. Although comparisons were made within a normal pH range, findings are inconsistent. Depending on breed, variability was higher at 200 days of age in all muscles investigated /LD, ST PS/. Changes were inconsequent. In HG and HF higher cooking-loss was measured at 200 days of age as compared to either HRS or HE breeds. In spite of this van der Wal et al. /1979/ recorded increased cooking-losses in heavier animals. Differences between genotypes /Dutch Friesian and Dutch Red and White/ was demonstrated in their study, a conclusion that supports our findings at least as far as breed differences are concerned.



Although for W.-B. shear force value varying values were obtained in this experiment the highest value in HG and the lowest one in HE for LD at 500 days of age strike the eye at first sight, however means are in general quite varying. All possible cases were present in ST, namely in HE values rich at a maximum in 350 days of age, in HF and HRS they stagnate, later on increase, in HG no change was obtained. Slight overall increasing tendency was recorded, however, in PS. This was the case with HF and HG breeds. HRS and HE had minimum or maximum values, respectively. Possible indirect effect of breed or chronological age may be due to differences in the structure of connective tissue. Further influencing factors may be present caused by changes of cooking-loss. Owing to its close relation to slaughter weight chronological age exerts certain influence on chilling conditions of carcasses of different size. For this reason variation of W.-B. shear force value may be expected as well. In our previous study /Szücs et al., 1982/ no significant effect of breed and/or age was found in W.-B. shear force value. This phenomenon was explained by the fact that the young fattening bulls were slaughtered at relatively young age in the experiment cited. According to van der Wal et al. /1979/ increase of W.-B. shear force value occures in bulls of higher weight. Breed differences that may be presumed on the account of findings on cows by Otto et al. /1975/ could be observed in only a limited way. Norman /1982/ reported that with the exception of PS muscles, marked and statistically significant differences in shear force value readings were recorded between breeds. In his study muscles from Charolais animals were found to require less shear force compared with other breeds.

Changes in surface reflectance /GÖFO/ might be due to total pigment content of muscles within the pH range studied. In LD values were inconsistent and no change was recorded in case of HG with advancing age. Continuous increase occured in 500 days of age. In PS increase of GÖFO value was stated in all genotypes but HF. The latter breed show no alterations. Vada et al. /1981/ calculated a close multiple correlation among surface reflectance, pH and total pigment content /R = 0.76/. Since the effect of pH was eliminated from the present analysis variations of surface reflectance might be associated in part with total pigment content.



CONCLUSIONS

1. The effect of genotype and age on beef quality traits might be on the one part direct on the other part indirect factors.

2. The moisture content of muscles generally decreases with advancing age. Rate of decrease may vary depending on muscle and breed, in certain cases it stagnates. This phenomenon might have a relation to the simultaneous variation of intramuscular fat content concomitant with chronological age.

3. Even if order of rank of variation in protein content is considered as to be low, its differences might be due in part to alterations of moisture content. Up to 500 days of age slight increase of protein content was obtained in Herefords /HE/, no change was present, however, in Holstein-Friesians /HF/. In case of Hungarian Red Spotted /HRS/ and Hungarian Grey /HG/ the protein content of only PS varied.

4. For intramuscular fat the clearest picture was shown in PS. The Hungarian Red Spotted /HRS/ breed could completaly differentiated from the other genotypes examined. In LD and ST muscles no marked differences for HRS were present. Increased rate of intramuscular fat content in HE at the early stage of development was recorded, in HF and HG, however, this occured only in the late phase of growing-finishing period. Variation of intramuscular fat content according to chronological age seemed to be of a breed-linked trait.

5. Total pigment content in muscles of growing-finishing bulls varies among breeds, age categories and muscles. Beef of "older" animals contain higher amounts of mioglobine than that of "younger" ones, in consequence, it is darker. Periodicity of total pigment content during growth is related to breed. Conspicuously, total pigment content in PS of Hungarian Grey /HG/ bulls decreased with advancing age.

6. In total connective tissue no consequent differences were obtained between breeds. Increasing, but fluctuating trend with advancing age, however, was present in Holstein-Friesians /HF/, and mean values stagnated in Hungarian Red Spotted /HRS/. At the same time averages seemed to decrease with age in Hungarian Grey /HG/. Regarding to the effect of breed and/or age on connective tissue content first of all the structure of collagens being genetically determined and/or the ratio of thermostable cross-links has to be underlined.

7. Among beef quality traits depending on ultimate pH for cooking-loss the colloid-chemical status of the muscle in question is the most decisive factor. Within normal pH range varying picture can be seen. Among breeds differences were recorded in LD and ST or even in PS at 200 days of age. Highest values were measured in Holstein-Friesian /HF/ and Hungarian Grey /HG/ breeds.

8. In case of Warner-Bratzler shear force value varying and slight increasing measurements were made with an extreme mean value of Hungarian Grey /HG/ in 500 days of age. Indirect effect of age and genotype might be the consequence of alterations of intramuscular fat content, structure of connective tissue and influence of carcass weight on chilling conditions within the carcass. The role of breed was clearly shown.

9. The variation in surface reflectance /GÖFO/ might be due to alterations of total pigment content in muscles, for this reason the influence of breed and age might be considered as being indirect.

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Table 1

Experimental design and number of samples

Muscles	Breeds	Age in days 200	350	500	Total
M. longissimus dorsi /LD/	HRS	29	29	29	87
	HF	11	9	10	30
	HG	10	10	11	31
	HE	10	12	10	32
	Total:	60	60	60	180
M. semitendinosus /ST/	HRS	30	29	29	88
	HF	11	9	10	30
	HG	10	10	11	31
	HE	10	12	10	32
	Total:	61	60	60	181
M. psoas major /PS/	HRS	30	29	29	88
	HF	11	9	10	30
	HG	10	10	11	31
	HE	10	12	9	31
	Total:	61	60	60	181
Grand total:		182	180	180	542

Breeds: HRS = Hungarian Red Spotted
HF = Holstein Friesian
HG = Hungarian Grey
HE = Hereford

Table 2

Chemical composition of selected muscles from growing-finishing bulls slaughtered at different ages

	Breeds	Muscles								
		LD			ST			PS		
		200	350	500	200	350	500	200	350	500
Moisture /per cent/	HRS	76.7	75.7	75.8	76.9	76.3	76.7	77.0	75.6	75.3
	HF	76.1	75.8	74.0	76.6	76.4	76.4	75.8	74.1	73.1
	HG	77.9	76.2	74.4	78.0	76.6	75.4	78.5	75.9	74.1
	HE	77.3	75.4	73.7	75.3	76.1	74.2	77.3	75.2	72.6
Protein /per cent/	HRS	21.0	22.7	22.1	21.4	22.4	21.9	20.5	22.0	21.8
	HF	21.7	21.6	21.4	21.3	21.2	20.8	21.1	21.0	20.9
	HG	21.2	22.6	22.6	21.2	21.7	22.3	19.2	20.6	20.9
	HE	20.4	20.7	22.2	20.3	20.9	22.3	19.1	20.4	21.4
Intramuscular fat /per cent/	HRS	1.0	1.6	1.9	1.1	1.3	1.2	1.5	2.3	3.3
	HF	1.3	1.6	4.3	1.4	1.4	2.6	2.3	3.9	5.2
	HG	0.7	1.3	2.6	0.8	1.7	2.1	2.0	3.6	4.7
	HE	1.3	3.3	3.6	1.3	2.7	2.3	2.6	4.0	5.4
Total pigment /mg/g/	HRS	2.1	2.3	3.5	1.6	1.9	2.9	3.2	3.7	5.3
	HF	2.6	3.2	3.5	2.2	2.4	3.0	3.5	4.3	4.7
	HG	2.8	4.0	3.7	2.5	3.0	3.2	6.7	5.8	5.5
	HE	3.1	3.9	3.5	2.3	2.7	2.5	3.8	4.7	4.7
Total connective tissue /per cent/	HRS	0.8	0.9	0.9	0.9	1.1	1.4	0.5	0.8	0.7
	HF	0.5	0.8	1.4	1.1	1.5	1.8	0.4	0.5	1.3
	HG	0.7	0.6	0.3	0.9	0.7	0.6	0.4	0.4	0.2
	HE	1.0	0.3	0.7	1.3	0.7	1.2	0.6	0.2	0.4

Muscles: LD = Musculus longissimus dorsi
ST = Musculus semitendinosus
PS = Musculus psoas major

Age categories: 200 days of age
350 days of age
500 days of age

Breeds: HRS = Hungarian Red Spotted
HF = Holstein Friesian
HG = Hungarian Grey
HE = Hereford

Table 3

Beef quality traits depending on ultimate pH[x] in selected muscles taken from growing-finishing bulls at different ages

	Breeds	Muscles								
		LD			ST			PS		
		200	350	500	200	350	500	200	350	500
Cooking-loss /per cent/	HRS	21.9	34.5	28.3	23.5	26.0	28.1	26.5	22.3	23.7
	HF	38.2	27.3	32.8	38.8	23.8	33.8	34.4	24.9	29.1
	HG	34.7	30.0	28.0	57.1	28.6	28.5	31.4	23.7	23.9
	HE	29.0	24.4	28.3	24.4	26.2	28.8	21.5	26.7	24.2
Warner-Bratzler shear force value /N/	HRS	48.3	41.6	46.5	29.4	24.7	35.0	25.0	20.4	39.3
	HF	31.6	45.9	38.6	26.9	26.3	34.9	25.1	29.5	36.4
	HG	37.2	41.5	58.6	36.9	36.0	39.8	23.7	31.1	36.9
	HE	48.9	38.9	33.9	38.3	46.5	31.2	31.1	40.6	32.9
Surface reflectance /GÖFO/ /per cent/	HRS	70.2	61.3	76.6	61.5	66.0	71.4	70.3	75.2	77.7
	HF	74.0	71.0	74.2	69.4	68.3	72.8	74.2	73.7	74.4
	HG	71.4	71.8	76.3	67.8	67.2	72.3	70.8	74.0	77.2
	HE	73.4	67.2	76.2	63.7	64.5	69.7	69.6	74.0	76.8

Muscles: LD = Musculus longissimus dorsi
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Age categories: 200 days of age
350 days of age
500 days of age

Breeds: HRS = Hungarian Red Spotted
HF = Holstein Friesian
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[x] $pH_u = 5.4 \leq x \leq 5.8$