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Some Characteristics of the Largest Muscles of Ham

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Ham is composed of muscles which differ amoung themselves in size, form, structure and colour. Being the most valuable part of meat of carcass, which is used as a whole in the production of high quality products, the existing differences in characteristics of these muscles negatively influence the quality of final products. These differences, especially in colour and water holding capacity (WHC), in muscles of ham are increasing with intensification of growing white, fleshy pigs.

Therefore it is important to establish the degree of variation of each of these characteristics and their influence on the uniformity of semipreserved products. Owing to this, we decided to determine (a) the content of protein of connective tissue, (b) WHC, (c) diameter of fibres, (d) toughness, (e) absorbance of watery extract of muscles, (f) colour, (g) content of fat and (h) content of water in the largest muscles of ham.

MATERIALS AND METHODS

Material. The muscles of ham of pigs in type of commercial white, fleshy ones have been investigated in this work. Pigs were old from 7 to 9 months, and weighted from 100 to 120 kg. Animals were slaughtered in an usual manner. Chilled muscles have been taken for examination 24 hr post mortem. All together there have been investigated 8 muscles taken from 5 hams. These muscles were: (1) m.semimembranaceus, (2) m.semitendineus, (3) m.adductor, (4) m.biceps femoris, (5) m.gastrocnemius, (6) m.gluteus medius, (7) m.rectus femoris, (8) m.vastus lateralis.

Methods. For the determination of WHC (by pressure), toughness and colour (by reflection) and for histological observation material has been always cut out from the same spot in the center of muscles. Remaining part of muscle was gound, mixed and then used for measurement of WHC (by centrifugation), content of protein of connective tissue, absorbance of watery extract, and content of fat and water.

Content of protein of connective tissue was determined by Neumann and Logan (18) method. Absorbance was measured at 560 mu.

WHC was determined by pressure method of Grau and Hamm and by centrifugation method. For the pressure method the filter paper Filtrak 388W has been used. WHC was determined by centrifugation method in such a way that to 20 g of ground sample were added 10 ml of water. After stirring and then staying for 60 min material was centrifugated for 10 min 3000 r/min. Immediately after the centrifugation, all separated liquid was measured.

Diameter of fibres was measured on native slices tick 5 μ, cut from the frozen samples. Average values were obtained from 40 individual measurements.

Toughness was measured by consistometer of Höppler loaded with 259 g/30 min. Average values were calculated from 10 individual measurements, according to the formula.

$$F_k = \frac{4 \times G}{T^2 \times \pi}$$

where G is the loading expressed in kg, and T corrected depths of penetration.

Myoglobin was extracted from muscles by method of Hart.

RESULTS

Content of protein of connective tissue of examined muscles (Table 1) was varying from 0.26 % of weight of raw muscles (m.aductor) to 0.80 % (m.gastrocn.). Relation between these values was larger than 1: 3. Relation between both the lowest and the highest values of content of protein of connective tissue of the samples of the same muscles was a little lower (1: 2).

By determination of WHC by pressure its highest value was found in m. adductor and the lowest one in m.vastus lat. Using centrifugation method it was found the highest WHC in m.gastronc., and the lowest one in m. semimembr., what differs from previous results. Differences between mean values determined both by pressure and centrifugation were relatively small — 2,0 cm^2 and 1,5 ml. However, differences in WHC between the samples of the same muscles were higher. The highest differences were 4,12 cm^2 and 4,5 ml.

The lowest values for diameter of fibres were detected in m.vastus lat., and the highest ones in m. biceps fem. Differences in fibre diameters between different muscles were small — 3,9 μ, while between the samples of the same muscles these differences were higher — the highest one was 20,7 μ in m. biceps fem.

It was found that the most tough was m.vastus lat., and the tenderest m. semit. The difference in mean values of these two muscles was 0,25 kg/cm^2. Variations in toughness between the samples of the same muscles were larger, i.e. from 0.090 (m.semit.) to 0.437 kg/cm^2 (m.gastrocn.).

Table 1. *Averages Values for Examined Characteristics of Ham Muscles.*

Characteristics		*Semim.*	*Semit.*	*Adductor*	*Bic. fem.*	*Gastrocn.*	*Glut. med.*	*Rect. fem.*	*Vast. lat.*
					M u s c l e s				
Connective tis. ..... % of raw musc.		0,37 (±0,06)	0,41 (±0,05)	0,26 (±0,08	0,54 (±0,15)	0,80 (±0,18)	0,41 (±0,08)	0,40 (±0,07)	0,45 (±0,08)
W H C	cm^2	7,4 (±1,3)	9,0 (±0,9)	7,2 (±1,2)	9,1 (±0,9)	7,9 (±0,9)	8,7 (±0,8)	8,03 (±1,0)	9,2 (±1,4)
	ml	10,8 (±0,7)	9,9 (±0,9)	9,9 (±0,8)	10,2 (±1,1)	9,3 (±0,9)	10,5 (±0,7)	9,8 (±1,6)	10,2 (±1,3)
Diameter of fibres (μ)		56,4 (±7,1)	56,8 (±5,9)	56,1 (±8,5)	59,4 (±3,6)	57,1 (±8,2)	57,1 (±4,9	55,8 (±7,0)	55,5 (±6,0)
Toughness		0,59 (±0,29)	0,46 (±0,03)	0,62 (±0,06)	0,62 (±0,07)	0,64 (±0,12)	0,55 (±0,05)	0,54 (±0,08)	0,71 (±0,06)
Absorbance of wat. extract		0,570 (±0,12)	0,633 (±0,13)	0,771 (±0,26)	0,714 (±0,12)	0,903 (±0,12)	0,615 (±0,13)	0,732 (±0,18)	0,726 (±0,09)
Colour, as refl.		17,7 (±2,7)	17,8 (±0,39)	14,5 (±2,25)	20,0 (±3,60)	16,1 (±3,92)	20,0 (±4,64)	16,7 (±3,24)	17,7 (±2,36)
Fat %		1,9 (±0,72)	4,2 (±1,04)	1,8 (±0,24)	3,2 (±0,84)	2,8 (±0,54)	2,0 (±0,40)	1,9 (±0,52)	1,7 (±0,32)
Water %		75,34 (±0,51)	75,02 (±0,35)	75,16 (±0,37)	74,43 (±1,22)	74,78 (±0,94)	76,22 (±1,52)	75,76 (±0,61)	76,87 (±1,29)

The absorption reading was the lowest in extract of m.semimembr. (0,570) and the highest in m.gastrocn. (0,903). It is obvious that the differences in mean values were larger in muscles with higher absorption readings. Among the investigated muscles was found that m.adductor was the darkest and m. biceps fem., as well as m.gluteus med. were the brihgtest ones.

Amount of fat was varying from 1,7 % (m.vastus lat.) to 4,2 % (m.semit.), while water content varyed from 74,43 % (m.biceps fem.) to 76,90 % (m. vastus lat.). The highest difference in content of fat in different muscles was close to difference in samples of the same muscle (the highest in m.semit.), while the difference in water content was lower in different muscles (2,47 %) than in the samples of the same muscle (m.vastus lat. — 3,81 %).

DISCUSSION

It was found that the differences in content of protein of connective tissue between different muscles overcome relation of 1: 2 (Table 1). Lawrie et al. found similar relation between two muscles in ham, while between different muscles in carcass this relation was significantly higher (1: 6). Rahelić and Rede (21) determined similar content of protein in connective tissue in m. iliopsoas and m.long. dorsi, like Lawrie et al., and Bendall (in beef). These findings prove the opinion that the content of collagen is influenced by the function of muscle. But, according to the data from the literature, as well as according to the results obtained in this work, it can be concluded that there is a great difference in content of connective tissue even between the same muscles from different carcasses.

Comparing the results of WHC obtained by pressure and those obtained by centrifugation method one can see that they differ among themselves. Using pressure method in m.semimembr. the value obtained by it was almost the highest, while obtained by centrifugation, in the same muscle, it was the lowest. In one of their previous works, Rahelić and Rede (21) have also found that there was no congruity in the results obtained by these two methods.

Quotations that the increase of connective tissue provokes increase of WHC (Savić, in beef) were not confirmed by the results obtained in this investigation because the correlation between WHC, determined by centrifugation, and the content of protein of connective tissue, was low ($r = -0,06$). Rahelić and Rede quoted the same in one of their previous works (21).

Differences in mean values of fibre diameters in different muscles were small — maximal one was 3,9 μ. On the other side, differences in fibre diameters between the samples of the same muscles were greater and the greatest one was 20,7 μ (m.biceps fem.). If the thickness of fibre influences the quality of muscle, then so small differences in fibre diameters could not provoke significant differences in quality between the muscles of ham.

Toughness, i.e. tenderness of muscles varied less between the extreme values of different muscles (0,25 kg/cm^2), than between the samples of the same muscles (m.gastrocn. 0,437 kg/cm^2). Finding that differences in toughness were so great in m.gastrocn. can be probably explained, by the fact that in this muscle there were so many tendons which are located in different positions and aggravate taking of samples of the same composition.

Toughness of muscles is often correlated with content of connective tissue and with thickness of fibres. In this work it was found low correlation between toughness and the content of protein in connective tissue (r= — 0,10), while higher correlation between diameter of fibres and toughness was found, (r = 0,50).

In the literature there are different data about this relations. Some authors quote that there is expressed effect of content of connective tissue on toughness (Moran and Smith, Hinner et al., cit. by Scznescniak et al., than Boccard, Boccard et al.), while some others didn't found such relation (Herring et al., Schilling, Mullins et al., Carpenter et al., Rahelić and Rede.).

Similarly, opinions about the influence of thickness of fibres on toughness disagree.

Relation between the extreme mean values of absorbance of watery exract was smaller between different muscles (m.semimembr. and m.gastrocn., 1: 1,6) then between the samples of the same muscles (m.semimembr. 1: 2,3, and m.rectus fem., 1: 3,1). Hornsey, Lawrie and Briskey et al. found larger differences in myoglobin content in muscles from different parts of the body. Higher differences between bright and dark part of m.semit. found Cassens et al., cit. by Briskey, and Rahelić and Rede(19) (relations 1:3, and 3,9).

As the pigs from whose carcasses were taken the muscles for this examination were of very similar breeding, grown and fed under very similar conditions, these factors couldn't influence in greater extent on the differences in colour of muscles extract. While there were great differences between different parts of the same muscle it can be supposed that they are provoked by muscle metabolism. Findings of similar differences in the fat content in different parts of muscle strengthen this presumption.

In the literature there are different data about the influence of myoglobin content on the colour of muscle (Wismer-Pedersen, Romans et al., Mesle et al., Bendall and Lawrie, then Wilson et al. and Kesenheimer, cit. by Grau). On the basis of the results obtained in this work, correlation between absorbance of watery extract of muscles, (i.e.e extracted myoglobin) and colour, measured as reflectance, was low (r = —0,14).

Differences in fat content between mean values of different muscles were similar to these between the samples of the same muscles (about 2,5 %). Between water content in different samples of the same muscles were found greater differences than between extreme values of different muscles.

According to the results, differences between mean values for fat and water content in different muscles of ham were not great, and therefore, could not provoke significant difference in quality of muscles of the same ham. Correlation between water content and colour of muscles, determined by reflectance, was high ($r = 0,83$), but between water content and absorbance of water extract was low ($r = 0,14$).

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