POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES
Pol. J. Food Nutr. Sci. 2004, Vol. 13/54, No 1, pp. 75–79

COMPARISON OF THE TEXTURE AND STRUCTURE OF SELECTED MUSCLES OF PIGLETS AND WILD BOAR JUVENILES*

Kazimierz Lachowicz, Joanna Żochowska, Małgorzata Sobczak
Department of Meat Technology, Agricultural University, Szczecin

Key words: structure, texture, muscles, piglets, wild boar juveniles

The texture and histology of selected muscles (*m. longissimus dorsi*, *m. quadriceps femoris*, *m. biceps femoris*, and *m. semimembranosus*) of piglets and wild boar juveniles were compared. The muscle texture was determined with the TPA test performed with an Instron 1140 apparatus. Structural elements (muscle fibre cross-section area, peri- and endomysium thickness, area of intramuscular fatty tissue) were measured in muscle samples using a computer image analysis program. The young wild boar muscles showed higher values of textural parameters. The muscle fibre cross-section area and the area of intramuscular fatty tissue of the juvenile wild boar muscles were lower than those in the piglet meat, while the peri- and endomysium were thicker. Of the piglet and young wild boar muscles tested, the highest hardness, springiness, and chewiness were found in BF which, at the same time, showed the highest fibre cross-section area and the thickest peri- and endomysium. The highest thermal drip loss was typical of BF, both in piglets and wild boars, the lowest thermal drip being found in LD, a muscle with the most delicate histological structure. The juvenile wild boar muscles showed a higher thermal drip loss than the piglet muscles.

INTRODUCTION

Texture is a multiparametric characteristic, important for meat and meat products, that has a significant effect on consumer acceptance of a product [Szcześniak, 1971; Surmacka-Szcześniak, 1990]. By definition, texture is related to the nature and interrelationships between the structural elements of a meat product [Bourne, 1982].

Numerous authors found muscles of slaughter animals to differ in terms of both textural parameters [Dransfield, 1977; Harris & Shorthose, 1988; Carmac *et al.*, 1995; Shackelford *et al.*, 1989] and structure [Dransfield, 1977; Liu *et al.*, 1996]. Correlations between fibre diameter, amount of collagen or perimysium thickness on the one hand and meat toughness on the other were demonstrated by, *i.a*. Dransfield [1977], Kołczak *et al.* [1992], Lepetit and Culioli [1994], and Liu *et al.* [1996].

The histochemical composition of wild boar meat differs somewhat from the histochemical composition of pork, the difference stemming, *i.a*. from different life conditions experienced by wild boars and pigs [Petkow, 1985; Prost *et al.*, 1985; Rede *et al.*, 1986; Ristic *et al.*, 1987; Korzeniowski *et al.*, 1991]. Therefore it may be assumed that muscles of wild boars and pigs will differ both in terms of their textural parameters and histology.

The study presented here was aimed at comparing selected muscles of piglets and wild boar juveniles in terms of their texture and structure.

MATERIALS AND METHODS

The study involved selected muscles of wild boar juveniles, shot during spring and summer in the Western Pomeranian District, and those of domestic piglets. Half-carcasses (15–17 kg each) of the experimental animals, kept at the cold room at 4°C for 48 h from the moment of shooting or slaughtering, served to obtain 10 loins and 10 hams each, of pH 5.7–5.9. Each element was skinned, debonned, and cleaned of external fat. The following muscles were dissected out of the hams: *biceps femoris* (BF), *semimembranosus* (SM), and *quadriceps femoris* (QF), while the *longisimus dorsi* (LD) muscle was cut out from the loin. When trimmed, each muscle weighed about 550–650 g.

About 1.2 cm thick slices were cut perpendicularly to the fibres from each muscle. Subsequently, samples for structural analyses were cut out from the slices. The remaining two parts, after weighing, were brought together so that their cut surfaces touched, and were placed in elastic thermally shrinking nets, tightly wrapped in thermoresistant plastic sheets, and cooked in water at 85°C until the geometric centre of a sample was heated to 68°C. The temperature was controlled with a PT215 thermometer. The cooked samples were cooled under tap water to about 12°C, re-weighed, wrapped in plastic sheet to protect from desiccation and cold-stored for 12 h.

The following assays were made:

Structure. Histological assays were made on samples cut out from the mid-part of the BF, SM, QF, and LD muscles of both groups of animals, three cuts being taken from each type of meat. The samples were dehydrated in alcohol, fixed in the Sannomiya solution, and embedded in paraffin blocks. The blocks were sectioned with a microtome. The sections were placed on slides and contrast-stained with hematoxylin and eosin [Burck, 1975]. The MultiScan computer image analysis software was used to evaluate

Author's address for correspondence: Kazimierz Lachowicz, Zakład Technologii Mięsa, Akademia Rolnicza w Szczecinie, ul. Kazimierza Królewicza 3, 71-550 Szczecin; tel.: (48 91) 423 10 61 ext. 294; e-mail: lachow@fish.ar.szczecin.pl

such structural elements of the muscle tissue as the fibre cross-section area, peri- and endomysium thickness, and the area of intramuscular fatty tissue.

Texture. Texture assays were made on thermally treated samples of muscles brought to about 18°C. After removal of the plastic sheets, 20±2 mm thick slices were cut out from each sample to determine their texture on an Instron 1140 apparatus interfaced with a computer. The force was applied at a rate of 50 cm/min. The texture was evaluated using the TPA test. The test involved driving a 0.96 cm diameter shaft twice into a 20±2 mm high sample down to 70% of its height (14 mm). The force-deformation curve obtained served to calculate meat hardness, cohesiveness, springiness and chewiness [Bourne, 1982]. The procedure was repeated 9–14 times on each sample batch.

Thermal drip. Thermal drip loss (%) was calculated from the difference in weight before and after thermal treatment.

Statistical treatment. Statistical treatment of data (STATISTICA v. 5.5A) involved the calculation of mean values for each muscle and each animal group. The Student's t-test (at α=0.05) was used to determine the differences between the muscles within a group and between animal groups for each muscle.

RESULTS AND DISCUSSION

Of all the piglet muscles tested, the highest values of hardness, springiness and chewiness were recorded in the BF muscle, the lowest values being typical of the LD muscles (Table 1). The QF muscle showed the highest cohesiveness. No significant differences in the textural parameters were found between QF and SM.

The juvenile wild boar BF, showed also the highest hardness, cohesiveness, springiness and chewiness, the lowest values of those parameters (except cohesiveness) being recorded in LD (Table 1). QF and SM were intermediate in terms of their textural parameters. Similar correlations in muscles of wild boars were reported by Żmijewski & Korzeniowski [2001], who observed that the LD muscle showed lower shear forces than ham muscles. Thus, regardless of the animal group, BF was the toughest muscle, and LD – the least tough one.

A similar hardness ordering of ham muscles was reported by Pezacki [1997], whereas other workers [Dransfield, 1977; Shackelford *et al.*, 1989; Carmac *et al.*, 1995] showed BF to be tougher that either QF or SM.

A comparison between the textural parameters of piglet and young wild boar muscles showed the latter to produce higher values of the parameters tested. For example, the juvenile wild boar BF and LD were by about 10% harder than the corresponding muscles of piglets; which agrees with the results obtained by Townsend *et al.* [1978; 1979] who observed that wild boar hams and loins were tougher than those obtained from domestic pigs and pig-wild boar hybrids.

Regardless of the animal group, significant differences in structural elements were recorded between BF on the one hand and QF, SM, and LD on the other (Table 2).

The histological analysis showed – regardless of the animal group – BF to be characterised by the highest mean fibre cross-section area and the thickest peri- and endomysium. Lower values of structural elements, compared with BF, were shown by the other muscles. A comparison of intramuscular fat amount showed that the SM piglet muscle was characterised by the highest, and LD by the lowest fat content. However, no significant differences in the intramuscular fat content were found between wild boar muscles.

A comparison between the structural elements of piglet and juvenile wild boar muscles showed that BF was characterized by the least delicate histological structure.

A comparison of the values of muscle structure elements in both groups of animals showed that the young wild boar muscles consisted of fibres with o lower cross-section areas, and of thicker peri- and endomysium. Their muscles had also less intramuscular fat than the piglet muscles. (Table 2). The highest differences in the mean fibre cross-section area and intramuscular fat content were found between juvenile wild boar and piglet SM muscles. As regards connective tissue thickness, the largest differences between the experimental animals were observed for the LD muscle. The available literature provides no information about a comparison of muscle structure element values in both groups of animals – juvenile wild boars and piglets. However,

TABLE 1. Mean values of textural parameters of the LD, QF, BF, and SM muscles of piglets and juvenile wild boars.

Animal group	Muscle	Hardness (N)	Cohesiveness (-)	Springiness (cm)	Chewiness (N×cm)
Piglets	LD	21.90^{a}_{1}	0.536^{a}_{1}	0.88^{a}_{1}	10.42^{a}_{1}
	QF	24.26^{a}_{1}	0.551^{a}_{1}	0.99^{a}_{1}	13.41^{a}_{1}
	BF	40.13^{b}_{1}	0.487^{a}_{1}	1.04^{b}_{1}	20.51^{b}_{1}
	SM	24.65^{a}_{1}	0.544^{a}_{1}	0.98^{a}_{1}	13.08^{a}_{1}
Wild boar juveniles	LD	24.35^{a}_{1}	0.555^{a}_{1}	0.90^{a}_{1}	12.24^{a}_{1}
	QF	26.93^{a}_{1}	0.551^{a}_{1}	1.00^{a}_{1}	14.93^{a}_{1}
	BF	43.42^{b}_{1}	0.566^{a}_{1}	1.02^{a}_{1}	25.01^{b}_{1}
	SM	29.28^{a}_{1}	0.510^{a}_{1}	0.98^{a}_{1}	14.48^{a}_{1}

a – numbers in columns, marked with identical superscripts are not significantly different within an animal group (p≥0.05)
1 – numbers in columns, marked with identical subscripts are not significantly different between animal groups (p≥0.05)

TABLE 2. Mean values of muscle structural elements of the LD, QF, BF, and SM muscles of piglets and juvenile wild boars.

Muscle	Piglets				Juvenile wild boars			
	Muscle fibre cross-section area (μm^2)	Perimysium thickness (μm)	Endomysium thickness (μm)	Area of intramuscular fatty tissue (μm^2)	Muscle fibre cross-section area (μm^2)	Perimysium thickness (μm)	Endomysium thickness (μm)	Area of intramuscular fatty tissue (μm^2)
LD	862.24^{a}_{1}	12.28^{a}_{1}	1.55^{a}_{1}	11668^{a}_{1}	716.49^{a}_{1}	19.00^{a}_{1}	2.09^{a}_{1}	3410^{a}_{2}
QF	929.18^{a}_{1}	14.16^{a}_{1}	1.64^{a}_{1}	13983^{b}_{1}	768.12^{a}_{1}	19.03^{a}_{1}	2.13^{a}_{1}	2918^{a}_{2}
BF	1487.06^{b}_{1}	18.66^{a}_{1}	1.94^{a}_{1}	17330^{a}_{1}	1120.96^{b}_{2}	22.62^{a}_{1}	2.52^{a}_{1}	3022^{a}_{2}
SM	1155.02^{c}_{1}	13.30^{a}_{1}	1.73^{a}_{1}	48652^{c}_{1}	829.54^{a}_{2}	18.75^{a}_{1}	2.26^{a}_{1}	2817^{a}_{2}

a – numbers in columns, marked with identical superscripts are not significantly different within an animal group ($p \geq 0.05$)
1 – numbers in columns, marked with identical subscripts are not significantly different between animal groups ($p \geq 0.05$)

numerous authors comparing different species of animals (hogs and cattle) reported higher cross-section areas or fibre diameters and thicker peri- and endomysium in BF than in SM or QF [Dransfield, 1977; Rahelic *et al.*, 1979; Sobczyk *et al.*, 1999]. Difference in the structural parameters according to Kuhn *et al.* [1993] could be caused by different contents of red and white fibres in the muscles under consideration.

The coefficients of correlations between the textural and structural parameters of the muscles tested (Table 3) showed that, regardless of the animal group, muscle hardness and elasticity was directly proportional to the fibre cross-section area and thickness of peri- and endomysium, and inversely - to the intramuscular fat content. Similar correlations in muscles of cattle and pigs were reported by, *i.a*. Dransfield [1977], Kołczak *et al.* [1992], Kłosowska *et al.* [1994], Lepetit and Culioli [1994], and Lachowicz *et al.* [1998].

Of the samples tested, the highest thermal drip losses were shown – regardless of the animal group – by BF, and the lowest – by LD (Figure 1). Piglet muscles showed generally a higher thermal drip than the wild boar meat, which may result from muscle structural differences between the animal groups.

To sum up, it can be concluded that BF is characterised by fibres of higher cross-section areas as well as by thicker perimysium and endomysium; it is also harder and more springy than QF, SM and LD. Higher hardness of wild boar muscles could be connected with thicker peri- and endomysium, despite their lower fibre cross-section areas, compared with piglet muscles.

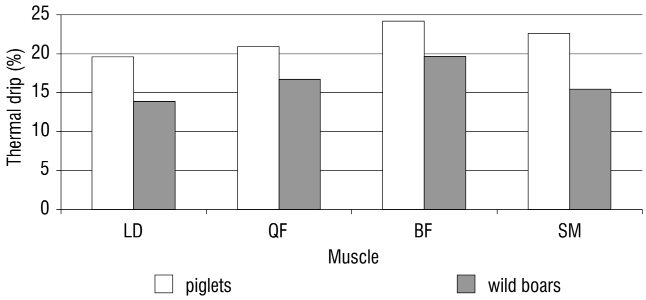

FIGURE 1. Thermal drip from selected muscles (LD, QF, BF, and SM) of piglets and young wild boars.

CONCLUSIONS

1. The highest values of hardness, springiness and chewiness were recorded in BF, regardless of the animal group tested. However, the juvenile wild boar muscles showed higher values of textural parameters, compared with piglet muscles.

2. Both in piglets and wild boar juveniles, the highest mean cross-section area and the thickest peri- and endomysium were typical of BF, the lowest values being recorded in LD and QF.

3. Compared with piglet muscles, those of juvenile wild boars showed a lower mean fibre cross-section area, thicker peri- and endomysium, and a lower amount of intramuscular fat.

4. The highest thermal drip, both in piglets and young wild boars, was typical of BF, the lowest losses being

TABLE 3. Coefficients of correlations between structural and textural parameters and thermal drip in selected muscles of piglets and wild boar juveniles.

Animal groups	Parameter	Hardness (N)	Cohesiveness (-)	Springiness (cm)	Chewiness (N·cm)	Thermal drip (%)
Piglets	Perimysium thickness	0.984*	-0.883*	0.833*	0.993*	0.876*
	Endomysium thickness	0.948*	-0.829*	0.871*	0.964*	0.992*
	Fibre cross-section area	0.936*	-0.852*	0.804*	0.934*	0.987*
	Area of intramuscular fatty tissue	-0.249	0.390	0.170	-0.170	0.199
Wild boars	Perimysium thickness	0.957*	0.612*	0.556*	0.972*	0.878*
	Endomysium thickness	0.985*	0.210	0.692*	0.951*	0.867*
	Fibre cross-section area	1.000*	0.343*	0.703*	0.985*	0.913*
	Area of intramuscular fatty tissue	-0.272	0.545*	-0.800*	-0.246	-0.432*

* – significant at $p \leq 0.05$

recorded in LD. However, higher thermal drip losses were observed in piglet muscles, compared with the corresponding muscles of juvenile wild boars.

* Paper presented at the VI International Scientific Conference "The effect of genetic and non-genetic traits on the quality of pork meat", 24–25 April 2003, Siedlce, Poland.

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Received February 2003. Revision received May and accepted August 2003.

PORÓWNANIE TEKSTURY I STRUKTURY WYBRANYCH MIĘŚNI PROSIĄT I MŁODYCH DZIKÓW

Kazimierz Lachowicz, Joanna Żochowska, Małgorzata Sobczak

Zakład Technologii Mięsa, Akademia Rolnicza, Szczecin

Porównano teksturę i budowę histologiczną czterech wybranych mięśni (*m. longissimus dorsi*, *m. qudriceps femoris*, *m. biceps femoris* i *m. semimembranosus*) prosiąt i dzików. Badanie tekstury przeprowadzono na aparacie Instron 1140, stosując test TPA. Na próbach mięśni dokonano pomiaru elementów struktury (powierzchnia włókien mięśniowych, grubość peri- i endomysium, powierzchnia tłuszczu śródmięśniowego) przy pomocy komputerowej analizy obrazu. Stwierdzono, że mięśnie młodych dzików wykazywały wyższe wartości parametrów tekstury. Ich mięso charakteryzowało się także mniejszą powierzchnią włókien, mniejszą ilością tłuszczu śródmięśniowego oraz grubszym peri- i endomysium w stosunku do mięsa z prosiąt (tab. 2). Spośród badanych mięśni prosiąt i dzików najwyższą twardość, sprężystość i żuwalność wykazywały mięśnie BF, dla których jednocześnie stwierdzono większe pole przekroju poprzecznego i grubsze peri- i endomysium w porównaniu do mięśni QF, SM i LD (tab. 1). Najwyższy wyciek cieplny stwierdzono dla mięśni BF zarówno prosiąt jak i dzików, najniższy zaś dla mięśnia o najbardziej delikatnej budowie histologicznej – LD. Mięśnie dzików charakteryzowały się wyższym wyciekiem cieplnym w porównaniu z mięśniami prosiąt (rys.1).