PROXIMATE COMPOSITION AND COLLAGEN CONTENT OF BEEF AND PORK MEAT CUTS

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Background

Both physical and chemical composition parameters and pH of beef- and pork-cuts are highly important for the meat processor, since such parameters are closely connected with the ability of the meats to retain water and fat.

One concern in finely comminuted emulsion-like products such as frankfurter and mortadellas is with levels of collagen free proteins (CFP) and fat. These compounds affect directly emulsion stability and fat and water retention during processing. Meat connective tissue is constituted mainly of collagen that is part of muscle and adipose tissue. Collagen is characterized by a high content of glycine, proline and hydroxyproline and total lack of sulfur containing aminoacids and tryptophane.

Meats with high collagen content or containing tough collagen are used in sausage processing, where collagen is comminuted by the action of grinders, cutters or mills (Bailey and Ligth, 1980; Olivo and Shimokomaki, 2002). The addition of cooked pigskin to sausages also increases its collagen content. Sausage manufacturers use meat with high collagen content although they are aware that its amount in the sausages should be limited to prevent defects like gelatin release, difficulty in peeling, shrinkage, and poor texture (Rao and Henrickson, 1983; Kenney et al., 1992; Olivo and Shimokomaki, 2002). It is clear that the determination of collagen content and proximate composition in meats is essential to predict sausage and other meat processed products quality and for the use of least cost formulation formulae. In Brazil there is a lack of available information on the proximate composition of the main beef and pork cuts used to produce sausages. This knowledge would help industry to better formulate meat products and help inspection services to enforce legislation concerning meat products composition.

Objectives

The purpose of this work was to determine moisture, fat, total protein, collagen content, and pH of meat cuts of hybrid pork and bovine (Nelore) used in the processing of sausage and other meat products.

Materials and methods

Three castrated Nelore (Bos indicus) 30 to 36 months of age, pasture fed, with an average weight of 437,5 kg (±16,2) were slaughtered in intervals of 15 days. The half-carcasses were chilled at 0 ± 4°C for 24 hours. The half carcasses were split into forequarters and hindquarters between the 5th and the 6th ribs. The forequarter beef meat cuts chuck, shoulder, brisket, neck, inside skirt (diaphragm), thick skirt, neck trimmings, foreshank, and plate were analyzed.

Three hybrid male pigs cross from Large White x Pietrain males with Large White x Landrace females and with a live weight of approximately 125-130Kg were slaughtered on the same day. After chilling in storage room kept at 0 ± 4°C for 24 hours, the half carcasses were cut into picnic shoulder, fresh ham, loin, tender loin, shoulder butt, belly, spareribs, neck trimmings and skin. The whole cuts of beef were ground three times in a Hermann grinder with 5mm holes plates. The pork cuts were ground two times in the same grinder with holes plates of 3mm. The cuts were not dressed, to simulate industry procedures. Physico-chemical analysis: moisture (oven at 102-105°C), total protein (Kjeldahl, Nx6,25), fat (diethyl ether extractable) and ash contents were determined following Instituto Adolfo Lutz procedures (São Paulo, 1985). pH values were measured with a spear-tip electrode attached to a digital pH-meter (HANNA Instruments – HI9321 microprocessor). The hydroxyproline assay was carried out according to the method described by AOAC (1996). Hydroxyproline was quantitatively determined, in order to measure the collagen content. Samples were hydrolyzed with 6N HCl for 8h at 110°C. After hydrolysis, 4-hydroxyproline was converted to pyrrole with chloramine T in acetate-citrate buffer pH 6.0, and pyrrole was converted to a red-coloured complex (absorption at 558nm) by reaction with Ehrlich reagent [p-(dimethylamino) benzaldehyde in perchloric

acid/2-propanol]. Total collagen protein was determined by multiplying hydroxyproline contents by 8. The physico-chemical analyses were carried out in duplicate for each pork and beef cut, the average being calculated from the three animals. Statistical analysis: all data underwent analysis of variance and Tukey's Test to determine differences ($p<0.05$) between pairs of means, using GraphPad InStat tm, Copyright 1990-1993, V2.01.

Results and discussion

The weights of the hot half carcasses of the three bovines were 124.6, 130.6, and 135.4 Kg. The weights of the chilled forequarters were respectively 41.1, 46.5, and 51.6 Kg. On Table 1 are shown the means for the proximate composition parameters, hydroxyproline, collagen and relative collagen and pH. Significant differences ($p<0,05$) were observed for all parameters among the different meat cuts except for ash content, which was not significantly different between the different meat cuts. For the three forequarter beef meat cuts of the categories chuck, shoulder, brisket, neck, inside skirt (diaphragm), thick skirt, neck trimmings, foreshank and plate, ranges of percent moisture were 66.5 (plate) to 75.4% (neck); fat, 4.0 (neck) to 15.9% (plate); total protein, 16.4 (plate) to 19.9% (foreshank); ash, 0.8 (plate) to 1.0% (diaphragm); hydroxyproline, 0.19 (diaphragm) to 0.61% (foreshank); collagen (COL) from 1.5 to 4.9%; relative collagen from 8.4 (diaphragm) to 24.77% (foreshank); pH varied from 5.73 (brisket) to 6.00 (plate). Largest variation in composition was found for the brisket, which presented the largest coefficient of variation for most of parameters evaluated. The diaphragm meat was the one with the smallest coefficient of variation for most of the products evaluated.

The swines' hot half carcasses weighted 43.4, 46.2, and 49.0 Kg. The proximate composition, hydroxyproline content, collagen content, relative collagen content, and pH are presented on Table 2. There were significant differences among different cuts for all parameters studied. In the evaluations of pork cuts from picnic shoulder, fresh ham, loin, tender loin, shoulder butt, belly, spareribs, neck trimmings and skin, large variation was found for moisture 20.6 (neck trimmings) to 73.2% (tender loin), fat 5.2 (tender loin) to 75.6% (neck trimmings), total protein 5,4 (neck trimmings) to 20,8% (tender loin), ash 0.3 (neck trimmings) to 1.2%(tenderloin), hydroxyproline 0.08 (tenderloin) to 1.28% (skin), collagen (COL) from 0.6 to 10,2%, relative COL 3.0 (tender loin) to 66.1%(skin), and pH 5.79 (belly) to 6.24 (shoulder butt). The largest variances between the animals in the determinations were those for neck trimmings, while the smallest were those for picnic shoulder and loin. It is important to underline that the variations observed reflect variations between samples from the animals and not analytical. The pork-cuts (except the skin) presented the greatest content of fat and the lowest of water, hydroxyproline and COL, if compared with those of beef-cuts meat.

Conclusions

As expected, the moisture, fat, protein, and collagen content and pH of the different meat cuts from pigs and bovines forequarters showed a large variability. The pig cuts comparable to those of beef had lower moisture and hydroxyproline (collagen) content and higher fat content. It is believed that the meats composition mean values determined in this study can be used in formulating meat products to comply with pertinent Brazilian legislation.

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Table 1. Proximate composition, pH and hydroxyproline contents of beef cuts

Beef cuts		Determinations*							
		Moisture (%)	**Fat (%)**	**Total Protein (%)**	**Ash (%)**	**Hydroxy-proline (%)**	**COL [a] (%)**	**COL [b] rel. (%)**	**pH**
Chuck	**Average**	**74.7^{a}**	**5.8^{b}**	**18.4^{ab}**	**0.9^{a}**	**0.3^{bcde}**	**2.4^{bcde}**	**13.3**	**5.9^{ab}**
	SD	*1.9^{a}*	*1.7*	*0.3*	*0.1*	*0.04*	*0.3*		*0.02*
	CV(%)	*2.5*	*29.7*	*1.4*	*6.5*	*14.1*	*13.9*		*0.34*
Shoulder	**Average**	**74.6^{a}**	**4.8^{b}**	**19.6^{a}**	**0.9^{a}**	**0.4^{bc}**	**3.1^{bc}**	**16.0**	**5.83^{ab}**
	SD	*14*	*1.7*	*0.7*	*0.1*	*0.1*	*0.6*		*0.10*
	CV(%)	*1.9*	*34.6*	*3.7*	*10.6*	*20.0*	*20.4*		*1.72*
Brisket	**Average**	**72.6^{ab}**	**7.8^{b}**	**18.3^{ab}**	**1.0^{a}**	**0.3^{cde}**	**2.0^{cde}**	**11.1**	**5.73^{c}**
	SD	*3.8*	*4.4*	*1.3*	*0.2*	*0.1*	*0.5*		*0.06*
	CV(%)	*5.2*	*55.7*	*7.2*	*16.8*	*25.6*	*25.6*		*1.05*
Neck	**Average**	**75.4^{a}**	**4.0^{b}**	**19.3^{a}**	**0.9^{a}**	**0.4^{bcd}**	**2.9^{bcd}**	**14.9**	**588^{ab}**
	SD	*1.5*	*1.3*	*0.2*	*0.04*	*0.1*	*0.5*		*0.06*
	CV(%)	*2.0*	*32.3*	*1.2*	*4.3*	*18.0*	*18.0*		*1.02*
Diaphragm	**Average**	**73.0^{ab}**	**7.2^{b}**	**18.2^{ab}**	**0.98^{a}**	**0.2^{e}**	**1.5^{e}**	**8.4**	**5.87^{ab}**
	SD	*0.2*	*0.3*	*0.2*	*0.02*	*0.02*	*0.1*		*0.04*
	CV(%)	*0.3*	*4.0*	*0.9*	*2.0*	*9.4*	*9.2*		*0.68*
Thick skirt	**Average**	**74.9^{a}**	**6.4^{b}**	**17.1^{b}**	**0.9^{a}**	**0.2^{de}**	**1.9^{de}**	**10.3**	**5.97^{ab}**
	SD	*0.5*	*1.5*	*0.4*	*0.1*	*0.03*	*0.3*		*0.05*
	CV(%)	*0.6*	*23.8*	*2.3*	*9.2*	*15.8*	*16.0*		*0.84*
Neck trimmings	**Average**	**70.9^{ab}**	**9.9^{ab}**	**18.8^{ab}**	**0.9^{a}**	**0.4 ^{b}**	**3.0^{b}**	**18.2**	**5.77^{bc}**
	SD	3.2	4.0	0.9	0.1	0.03	0.2		0.03
	CV(%)	*4.5*	*40.9*	*4.8*	*8.7*	*6.1*	*6.1*		*0.52*
Foreshank	**Average**	**74.5^{a}**	**5.1^{b}**	**19.9^{a}**	**0.9^{a}**	**0.6^{a}**	**4.9^{a}**	**24.8**	**5.88^{ab}**
	SD	*0.9*	*1.3*	*0.8*	*0.1*	*0.06*	*0.5*		*0.16*
	CV(%)	*1.2*	*25.3*	*3.9*	*6.8*	*9.6*	*9.6*		*2.72*
Plate	**Average**	**66.5^{b}**	**15.9^{a}**	**16.4^{b}**	**0.8^{a}**	**0.4^{b}**	**3.3^{b}**	**19.8**	**6.00^{a}**
	SD	*3.7*	*5.4*	*0.8*	*0.06*	*0.03*	*0.2*		*0.06*
	CV(%)	*5.6*	*34.2*	*4.8*	*7.2*	*6.9*	*7.1*		*1.00*
Minimum value		66.5	4.0	16.4	0.8	0.2	1.5	8.4	5.73
Maximum value		75.4	15.9	19.6	0.98	0.6	4.9	24.8	6.00
Median		74.5	6.8	18.2	0.9	0.4	2.9	14.9	5.87
Mean		**73.0**	**7.7**	**18.2**	**0.9**	**0.4**	**2.8**	**15.2**	**5.87**
S.D.		2.8	3.8	1.0	0.05	0.1	1.0	5.2	0.09
C.V. (%)		3.9	48.9	5.7	5.6	36.0	36.1	33.9	1.45

* Means of three forequarters

COL [a] = collagen content estimated from hydroxyproline content X 8 **COL [b] rel**. = (COL/ total protein) x 100

S.D.= Standard deviation **C.V.**= Coefficient of variation

Table 2. Proximate composition, pH and hydroxyproline contents of pork cuts

Pork cuts		Determinations*							
		Moisture (%)	**Fat (%)**	**Total Protein (%)**	**Ash (%)**	**Hydroxy-proline (%)**	**COL [a] (%)**	**COL [b] rel. (%)**	**pH**
Chuck	**Average**	**71.8^{a}**	**7.4^{ef}**	**20.1^{ab}**	**1.1^{b}**	**0.2^{cd}**	**1.2^{cd}**	**5.9**	**5.89^{ab}**
	SD	*0.8*	*1.3*	*0.2*	*0.1*	*0.01*	*0.1*		*0.19*
	CV(%)	*1.1*	*17.5*	*1.1*	*2.8*	*9.5*	*9.3*		*3.23*
Shoulder	**Average**	**70.1^{ab}**	**10.6^{e}**	**18.6^{bc}**	**1.0^{bc}**	**0.2^{b}**	**1.8^{b}**	**9.7**	**6.12^{ab}**
	SD	*0.3*	*0.2*	*0.1*	*0.02*	*0.04*	*0.3*		*0.25*
	CV(%)	*0.4*	*2.0*	*0.7*	*2.0*	*18.7*	*18.9*		*4.08*
Brisket	**Average**	**64.0^{c}**	**18.8^{d}**	**16.9^{cd}**	**1.0^{cd}**	**0.2^{bc}**	**1.4^{bc}**	**8.4**	**6.24^{a}**
	SD	*1.2*	*1.8*	*0.6*	*0.1*	*0.01*	*0.1*		*0.39*
	CV(%)	*1.8*	*9.4*	*3.6*	*5.3*	*6.2*	*5.6*		*6.25*
Neck	**Average**	**68.0^{b}**	**12.3^{e}**	**19.8^{ab}**	**1.0^{bc}**	**0.2^{bc}**	**1.2^{bc}**	**6.3**	**5.80^{b}**
	SD	*0.8*	*0.3*	*0.1*	*0.02*	*0.01*	*0.04*		*0.15*
	CV(%)	*1.2*	*2.6*	*0.5*	*2.0*	*3.2*	*3.2*		*2.59*
Diaphragm	**Average**	**73.1^{a}**	**5.3^{f}**	**20.8^{a}**	**1.2^{a}**	**0.1^{d}**	**0.6^{d}**	**3.0**	**5.80^{b}**
	SD	*0.5*	*0.8*	*0.1*	*0.1*	*0.02*	*0.1*		*0.10*
	CV(%)	*0.7*	*16.0*	*0.3*	*4.3*	*19.5*	*19.4*		*1.72*
Thick skirt	**Average**	**55.2^{d}**	**30.0^{c}**	**14.9^{e}**	**0.8^{e}**	**0.2^{bc}**	**1.6^{bc}**	**10.9**	**5.79^{b}**
	SD	*0.9*	*2.3*	*0.3*	*0.03*	*0.01*	*0.1*		*0.05*
	CV(%)	*1.5*	*7.8*	*1.8*	*3.8*	*4.0*	*4.3*		*0.86*
Neck trimmings	**Average**	**20.6^{f}**	**75.6^{a}**	**5.4^{f}**	**0.3^{g}**	**0.2^{bc}**	**1.7^{bc}**	**31.9**	**6.05^{ab}**
	SD	1.7	2.3	0.8	0.04	0.1	0.4		0.02
	CV(%)	*8.3*	*3.1*	*15.5*	*12.9*	*23.2*	*23.7*		*0.33*
Foreshank	**Average**	**38.0^{e}**	**46.0^{b}**	**15.5^{de}**	**0.4^{f}**	**1.3^{a}**	**10.2^{a}**	**66.1**	**6.13^{ab}**
	SD	*0.5*	*3.0*	*1.7*	*0.03*	*0.3*	*1.9*		*0.06*
	CV(%)	*1.3*	*6.5*	*11.1*	*6.8*	*18.6*	*18.6*		*0.98*
Plate	**Average**	**62.5^{c}**	**19.7^{d}**	**17.1^{cd}**	**0.9^{d}**	**0.2^{bc}**	**1.4^{bc}**	**8.3**	**5.91^{ab}**
	SD	*1.9*	*2.0*	*0.7*	*0.04*	*0.02*	*0.2*		*0.14*
	CV(%)	*3.0*	*10.1*	*4.1*	*4.4*	*10.7*	*11.4*		*2.37*
Minimum value		20.6	5.3	5.4	0.3	0.1	0.6	3.0	5.79
Maximum value		73.1	75.6	20.8	1.2	1.3	10.2	66.1	6.24
Median		64.0	18.8	17.1	1.0	0.2	1.4	8.4	5.91
Mean		**58.1**	**25.1**	**16.6**	**1.0**	**0.3**	**2.4**	**16.7**	**5.97**
S.D.		17.8	22.9	4.7	0.3	0.4	3.0	20.3	0.17
C.V. (%)		30.6	90.9	28.2	34.9	125.9	125.8	121.7	2.83

*Means of three pig forequarters

COL [a] = collagen content **COL [b]** rel. = (COL/ total protein) x 100

SD = standard deviation **C.V.**= coefficient of variation

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