FUNCTIONAL PROPERTIES OF OFFAL

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SUMMARY

Of the offals compared, cattle spleen showed a WHC (inversely related to cooking loss value: 21.0%) and an emulsion stability under heat treatment at 70°C (98%) and 100°C (95.2%) significantly higher ($P < 0.05$) than the rest. Corresponding values were: lungs, 22.0; 70.2; 78.5; kidneys, 30.8; 61.0; 69.3; pig stomach, 54.4; 50.6; 63.0; cattle testicles, 26.5; 96.8; 95.0; beef control, 44.8; 95.6; 88.6.

Average gel strength of the cooked homogenates were: spleen, 91.2 g cm^{-2}; lungs, 571.8; kidney, 250.8; pig stomach, 665.8; and beef control, 2535.1.

Lungs showed the best overall functionality and pig stomach the poorest. Spleen performed very well as to WHC and stability to thermal treatment, but its gel strength was rather low.

Results suggest that there might be an advantage in the utilization of mixtures of offals in adequate proportions, so as to make the best possible use of their individual contribution to the functionality of the mixture.

INTRODUCTION

The utilization of edible offal as raw material in the manufacture of a variety of meat products is common practice in Cuba. However, this is usually done as though the material acted only as a filler, disregarding its potential functionality.

A more rational utilization of offal as raw material for sausages and other meat products requires knowing not only its proximate composition, but also its functional behaviour in meat systems.

There is little argument about the importance of water holding capacity (WHC) in this respect, cooking losses, some organoleptic properties and to some extent fat binding being all WHC-dependent (Hamm 1981).

Among those functional properties related to fat binding, emulsifying capacity and emulsion stability have been traditionally measured. The first one, however, is of rather little practical significance, as meat systems seldom approach fat saturation.

The determination of emulsion stability before and after heat treatment is far more meaningful from a practical standpoint (Bogh-Sorensen 1985), particularly in view of our present knowledge on the nature of meat emulsions (Hamm 1981; Acton et al. 1983).

In other respect, the behaviour of the gel formed during cooking is determinant as to the textural properties of the product (Lanier 1986). Gel strength determinations can be informative in this regard.

The aim of this paper is to measure some of the main functional properties of several offals from pigs and cattle: WHC (as cooking loss), emulsion stability during cooking and gel strength of a cooked homogenate of the material, as well as several traits of offal composition.

MATERIALS AND METHODS

Cattle lungs, spleen, kidneys and testicles and pig stomach were obtained. Four composite samples of each type of offal were assembled, each combining offal from six animals.

Trimmed samples were minced twice through a 3 mm plate. pH (ISO 1974); WHC-related cooking loss (Honikel et al. 1981) and moisture content (AOAC 1980) were determined. The remaining of the samples was kept in plastic bags at -18°C.

Emulsion stability at 80 and 100°C was determined according to Girard et al. (1985). For this purpose, emulsions were prepared with pork fat, adjusting the fat:protein:water ratios at 2:1:6. Free fat (ISO 1973), crude protein (total N X 6.25: ISO 1978a) and collagen (hydroxiproline X 8: ISO 1978b) were also determined in the offal raw materials.

Homogenates were prepared by blending with water and sodium chloride (2% of the total paste), in such proportions as to maintain a protein:water ratio of 5:1, similar to that used by Montejano et al. (1984). Three 50 g portions of the homogenate were weighed into 100 mL centrifuge tubes and put into a water bath at 75°C until a

Table 1.-Average cooking loss values for tested offal and beef. Standard deviations in parentheses.

	Spleen	Kidney	Lungs	Pig stomach	Beef	Std. error
Cooking loss (%)	21.0^{a} (1.0)	30.8^{b} (0.8)	22.0^{a} (2.4)	54.4^{c} (0.1)	44.8^{d} (1.8)	1.86***

*** P<0.001

a,b,c,d Mean values without letter in common differ at P<0.05 (Duncan's multiple F test).

Table 2.- Average values of water and fat separation and emulsion stability on cooking at 70° and 80°C. Standard deviations in parentheses.

	70°C			100°C		
	Water sep. (ml)	Fat sep. (ml)	Stabil. (%)	Water sep. (ml)	Fat sep. (ml)	Stabil. (%)
Spleen	--	--	98.0^{a} (1.0)	--	--	95.2^{a} (1.7)
Kidney	12.0 (1.5)	7.5 (0.7)	61.0^{b} (2.2)	10.2 (0.4)	5.5 (0.7)	69.3^{bc} (2.0)
Lungs	10.5 (2.9)	4.5 (1.9)	70.2^{c} (3.1)	6.4 (2.4)	3.8 (0.5)	78.5^{d} (4.6)
Pig stomach	18.6 (0.3)	5.9 (1.0)	50.6^{e} (1.8)	12.4 (0.5)	5.2 (0.2)	63.0^{bc} (1.6)
Beef	1.6 (--)	--	95.6^{a} (0.2)	5.6 (0.9)	--	88.6^{a} (2.3)
Standard error			3.87*			

*P<0.05

a,b,c,d,e Emulsion stability means without letter in common differ at P<0.05 (Duncan's multiple F test).

Table 3.-Average values of gel strength of cooked offal homogenates. Standard deviations in parentheses.

	Spleen	Kidney	Lungs	Pig stomach	Beef	Std. error
Gel strength ($g\ cm^{-2}$)	91.2[a] (9.6)	250.8[a] (51.3)	571.8[b] (128.2)	665.8[b] (53.0)	2535.1[c] (136.5)	146.2***

*** $P<0.001$

a,b,c Mean values without letter in common differ at $P<0.05$ (Duncan's multiple F test).

Table 4.-Proximate composition, collagen content and pH of offal. Average values. Standard deviations in parentheses.

	pH	Moisture	Fat	Protein	Collagen	% Collagen in protein
Spleen	6.14 (0.06)	78.2 (0.4)	1.4 (0.4)	19.0 (0.6)	1.1 (0.3)	5.8
Kidney	6.40 (0.23)	79.0 (1.7)	3.6 (1.4)	15.3 (1.1)	1.5 (0.1)	9.8
Lungs	6.05 (0.07)	79.0 (0.4)	1.9 (0.3)	17.3 (0.4)	4.2 (0.3)	24.3
Pig stomach	6.35 (0.05)	81.1 (2.0)	4.0 (1.1)	13.1 (0.5)	3.6 (0.5)	27.5
Testicles	6.32 (0.03)	86.8 (0.4)	1.7 (0.1)	10.3 (0.7)	0.8 (0.09)	7.9
Beef	5.88 (0.02)	76.0 (0.5)	1.5 (0.02)	22.8 (1.7)	1.5 (0.2)	6.8

core temperature of 70-72°C was reached. They were then chilled in water at 3-4°C.

Gel strength was measured by the maximum force required for an Instron flat-ended punch, 11 mm in diameter, to penetrate the sample at a constant crosshead speed of 50 mm/min.

For cooking loss determination, homogenates were made keeping a water:protein ratio of 6.2:1, which was the minimum possible for pig stomach, the offal with the second largest water:protein ratio. Testicles had to be excluded from these comparisons, as their water:protein ratio was by far too large. Testicle emulsions and homogenates were prepared, though, with no water addition and their properties measured.

Two 5 g portions of each of such homogenates were cooked at 100°C for 20 min. and their cooking loss was measured.

ANOVA tests were used throughout, followed by Duncan's test where necessary.

RESULTS AND DISCUSSION

Cooking losses of the different materials (Table 1) differed significantly ($P<0.001$) from one another, except spleen and lungs, which showed the highest WHC, with weight losses approximately half those of meat. Pig stomach performed the poorest.

Practically all offals showed a better WHC than meat, a fact also showing in the data reported by Oliveros et al. (1985) and which might be related to the higher pH of offal as compared to meat.

Table 2 shows the results of stability tests on the meat pastes tested. Testicle paste, although is not shown for comparison for the reasons given above, was very stable, giving emulsion stability values of 96.8 and 95.0% at 70 and 100°C, respectively, comparable only to those obtained with spleen.

The stability of the spleen emulsion was practically perfect, water and fat separation not being measurable. The measured value for emulsion stability is not 100% because of evaporative weight losses during cooking. Results at 70 and 100°C did not differ significantly from those of meat, which separated water, but not fat.

Differences in emulsion stability between different offals might be partly due to differences in collagen content, as illustrated by their different behaviour at the two cooking temperatures. At the higher cooking temperature, collagen would swell, contributing to the weight of the cooked paste and helping to produce a more stable gel structure.

It can be seen in the Table that materials relatively richer in collagen, such as pig stomach and lungs tend to improve their emulsion stability as cooking temperature rises, whereas that of spleen and beef, which are lower in collagen, diminishes.

For different offals, emulsion stability will decrease in the order of decreasing WHC. Table 3 presents the results of gel strength measurement, the great difference between offals and meat being worth noticing. The gel-forming ability of myofibrillar proteins is well known (Tsai et al. 1972), as well as the fact that offals protein contains a much smaller myofibrillar fraction than that of meat (Oliveros et al. 1982). Pig stomach, the highest ranking offal tested as to gel strength of the cooked homogenate, gave a result 4 times lower than that of beef.

Data on proximate composition, collagen content and pH of offals are shown in Table 4. Apart from rather noticeable differences in protein content, their composition is quite similar. The relatively high proportions of collagen in the total protein for lungs and pig stomach can be noted.

CONCLUSIONS

Within the group of offals tested, WHC and emulsion stability variations were closely correlated, whereas gel strength did not follow a comparable pattern. No clear relationships were observed between functionality and proximate composition.

Lungs showed the best overall functionality and pig stomach the poorest. Spleen performed very well as to WHC and emulsion stability, but its gel strength was rather low.

Results suggest that there might be an advantage in the utilization of mixtures of offals in adequate proportions, so as to make the best possible use of their individual contribution to the functionality of the mixture.

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