# USE OF COLLAGEN-RICH OFFAL IN MEAT PRODUCTS

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## SUMMARY

Cooking yield of batters made from previously cooked pork rind and beef snout (89.8 and 83.7 % at 80°C; 79.7 and 71.6 % at 121°C, respectively) was higher than those of the batters made from the uncooked materials. Sensory differences between model systems with either raw or previously cooked collagenous ingredients were not significant.

Batters with mixes of either cooked pork rind and beef snouts with sodium caseinate or dried blood plasma had the highest cooking yields at 25 or 32 % substituted meat proteins (85.5 and 84.9 %; 93.7 and 93.6 %, respectively at 80°C). Their organoleptic characteristics were satisfactory. Batters with mixes of collagen-rich offal and soya flour showed too low cooking yields. Results indicate that it is more convenient to use these collagenous materials when previously cooked, and that higher levels of substitution of meat can be reached by combining them with either sodium caseinate or dried plasma.

## INTRODUCTION

Many reports have been published about the use of connective tissue in meat systems with regard to its properties (Puolanne and Ruusunen, 1981; Jones, 1982; Müller and Wagner, 1985; Visser et al, 1985; Sadowska et al, 1979; Sadowska and Rudzki, 1985; Sadowska, 1987) and digestibility (Laser-Reutersward et al, 1982; Laser Reutersward, 1985; Laser-Reutersward et al, 1985, a,b). The replacement of up to 20 % of the lean meat with fibrous bovine hide collagen has been tested in a variety of meat products by Henrickson's working group in Oklahoma State University (Rao et al, 1982; Chavez et al, 1985; Arganosa et al, 1987).

The nutritive value of connective tissue alone is limited because of its inadequate amino acid balance, it being low in methionine and devoid of tryptophan (Eastoe, 1967). However, it is a valuable source of nitrogen for protein synthesis in the organism specially if it is complemented with other proteins.

At present, connective tissue is considered a source of protein of good digestibility which can be used in meat products without seriously compromising their quality and consequently, the use of collagen-rich offal in meat products represents an attractive goal for sausage manufacture.

The purpose of this work was to evaluate the utilization of pork rind and beef snouts in meat batters, as regards the previous cooking or not of those materials, and the effect on the quality of model meat products when relatively large amounts of these cooked offal are added in mixes with non-meat extenders.

## MATERIALS AND METHODS

Pork rinds and beef snouts were processed in two ways:

Raw: Chopped with ice (1/3 of their weight) in the cutter and grinding through a plate with orifices of 1.5 mm diameter.

Cooked: Cooked in water at 100°C during 30 and 60 min respectively and ground as described.

Replicate batches of batters, 5 kg each, were prepared with pork, pork fat and water (fat:protein:water, 2:1:6) and 2 % sodium chloride (controls). In experimental variants, either pork rind of beef snout, either raw or cooked were substituted for 25 % of the meat protein. All meat batters were prepared in the same way: mixing in the cutter all ingredients with one half of the ice; then passing the mix twice through a KS micro-cutter. In the first pass, the plate used had holes of 2 mm diameter and for the second pass 1.4 mm. The remainder of the ice was added in the second pass. The final batter temperature was 13°C.

Batters were filled into cans (ca. 170 g). Ten cans were cooked at 80°C for 60 min. and another ten cans at 121°C for 40 min. Afterwards, they were chilled at 4°C. Cooking yields of batters were determined by measuring the % recovery after cooking and two days of chilled storage of the samples. The mean values of four samples were calculated in every case.

Organoleptic properties were evaluated by a 12 member panel, in a scoring test with a seven-point scale (1=extremely poor; 7=excellent) for appearance, texture, flavor and general quality.

The consistency of cooked meat batters was measured by the maximum force required to penetrate the sample with a spherical ended punch, 16 mm in diameter, in an Instron Universal Testing Machine, at a crosshead speed of 50 mm/min, at room temperature. The ratios between the values of maximum penetration force in the cooked meat batters and those of the control were calculated.

Other batters were prepared with mixes of either pork rind or beef snouts, previously cooked, with either soy flour, sodium caseinate or dried blood plasma substituting for 25 or 32 % of the meat proteins in the original mix.

The composition of these mixes was established by optimizing through linear programming the nutritional value of their proteins (Fernández et al, 1987) with the amino acidic profile of pork as a standard, and taking into account the proportions in the availability of raw materials as restrictions. Caseinate and soy flour were limited to 2 and 4 % max., respectively, in the formulae.

| Raw material | Mix 1 | Mix 2 | Mix 3 |
|---|---|---|---|
| Cooked pork rind | 53 | 59 | 59 |
| Cooked beef snouts | 23 | 29 | 29 |
| Semi-defatted soy flour | 21 | - | - |
| Sodium caseinate | - | 12 | - |
| Dried blood plasma | - | - | 12 |

The moisture, fat and protein contents of the mixes were as follows:

| | Mix 1 | Mix 2 | Mix 3 |
|---|---|---|---|
| Moisture (%) | 51.3 | 56.5 | 55.8 |
| Protein (%) | 30.9 | 34.7 | 35.3 |
| Fat (%) | 9.3 | 7.8 | 7.8 |

Meat batter cooking yields, organoleptic properties and consistency were determined as described.

ANOVA test was used throughout, followed by Duncan's multiple range test where necessary.

## RESULTS AND DISCUSSION

Table 1 shows the cooking yields of batters with raw previously cooked pork rind and beef snouts. With regard to control the cooking yields of batters with cooked rind at both temperatures did not differ significantly (P<0,05) but those of the batter with cooked snouts did (P<0,05). Batters with raw offal showed significant differences (P<0,05) from the control.

Cooking yields of batters with cooked offal were higher than those of the batter with raw offal at both temperatures. In general, during the previous cooking of collagen rich offal, the collagen is solubilized partially.

Table 1. Mean values of cooking yields of meat batters with pork rind and beef snout, either raw or cooked.

| Meat Batters | Cooking yields (%) 80°C | | 121°C | |
|---|---|---|---|---|
| Control | 91.6 | a | 85.1 | bc |
| Raw rind | 85.0 | bc | 74.0 | e |
| Cooked rind | 89.8 | ab | 79.7 | cd |
| Raw snout | 76.4 | de | 67.3 | f |
| Cooked snout | 83.7 | c | 71.6 | ef |
| Standard error | | | 1.849 * | |

* P<0,05

a,b,c,d,e,f Mean values without letter in differ at P<0,05

Cooking yields diminished significantly (P<0,05) in all cases at 121°C, but more largely in the rich collagen offal batters, because above 90°C collagen is solubilized considerably (Visser et al, 1985) and this process is accelerated by cooking under pressure at 115 - 125°C (Bendall, 1946).

Batters with raw and cooked offal were organoleptically similar to control (Table 2). The differences between the scores of the batters were not relevant (<1), although there was a light tendency toward a higher marks for raw offal batters.

Table 2. Mean values of sensory quality attributes of meat batters made with raw and cooked rich-collagen offal

| Meat Batters | Appearance | | Texture | | Flavor | | Gen.Quality | |
|---|---|---|---|---|---|---|---|---|
| | 80°C | 121°C | 80°C | 121°C | 80°C | 121°C | 80°C | 121°C |
| Control | 5.4 | 5.0 | 5.5 | 4.9 | 5.1 | 5.1 | 5.3 | 5.0 |
| Raw rind | 5.1 | 4.6 | 5.1 | 4.7 | 5.2 | 4.9 | 5.1 | 4.7 |
| Cooked rind | 4.8 | 4.5 | 4.9 | 4.7 | 5.1 | 4.8 | 5.0 | 4.6 |
| Raw snout | 5.3 | 5.2 | 5.1 | 5.2 | 5.2 | 5.2 | 5.1 | 5.1 |
| Cooked snout | 4.8 | 4.8 | 4.7 | 4.6 | 5.0 | 4.8 | 4.9 | 4.7 |

Table 3. Ratios between the values of maximum penetration force in the meat batters and those of the control

| Meat Batters | Ratios | |
|---|---|---|
| | 80°C | 121°C |
| Raw rind | $0.65^{c}$ | $0.60^{c}$ |
| Cooked rind | $0.56^{c}$ | $0.63^{c}$ |
| Raw snout | $0.86^{b}$ | $1.12^{a}$ |
| Cooked snout | $0.54^{c}$ | $0.66^{c}$ |
| Standard error | 0.059* | |

* P<0,05

a,b,c Mean values without letter in common differ at P<0,05

Table 3 shows the ratios between the values of maximum penetration force in the batters and the control at both temperatures, which did not differ significantly (P<0,05) between them, except for the batters with raw snouts. The addition of collagen-rich offal produced softening (ratio values <1) in the batters respect to the control, but it did not produce it in the raw snouts batters at 121°C.

The softening of batters is probably due to the diminution of the proportion of myofibrillar proteins in the meat system, whose gel forming ability by heating is well known (Tsai et al, 1972) and the gel structure provides firmness and resilience to texture of meat emulsion type products.

The different behavior of batters with raw snouts could be due to the fact that they are not softened previously by cooking and also, perhaps, because contain muscle portions and therefore a certain amount of non-denaturalized myofibrillar proteins, which will form gel during cooking of the batters.

Table 4.- Mean values of cooking yields of meat batters with the mixes of either pork rind or beef snouts previously cooked with either soy flour (mix 1), sodium caseinate (mix 2) or dried blood plasma (mix 3).

| Meat Batter | | Cooking yields (%) 80°C | 121°C |
|---|---|---|---|
| Control | | 89.1 ab | 78.7 d |
| Mix 1 | 25 % | 80.4 cd | 67.8 f |
| | 32 % | 76.2 de | 68.0 f |
| Mix 2 | 25 % | 85.5 bc | 72.9 ef |
| | 32 % | 84.9 bc | 72.6 ef |
| Mix 3 | 25 % | 93.7 a | 87.4 b |
| | 32 % | 93.6 a | 86.2 bc |
| Std.error | | 1.855 * | |

* P< 0,05

a,b,c,d,e,f Mean values without letter in common differ at P<0,05

Table 4 shows the cooking yields of meat batters prepared with mixes of either pork rind and beef snouts, previously cooked with either soy flour (Mix 1), sodium caseinate (Mix 2) or dried blood plasma (Mix 3). Cooking yields of batters with Mix 2 or Mix 3 at 25 and 32 % substitution levels did not differ significantly ($P<0,05$) from that of the control at 80°C, but they were significantly different ($P<0,05$) at 121°C, whereas those of batter with Mix 1 differed significantly ($P<0,05$) of cooking yields of control at both substitution levels and temperatures. The good stability of batter with Mix 2 was due to the excellent emulsifying properties of caseinate (Comer, 1979), which acts as a coadjuvant of meat proteins, emulsifies free fat and saves salt soluble proteins for water binding (Van de Hoven, 1987).

Table 5. Mean values of sensory quality attributes of meat batters make with mixes 1, 2 and 3

| Meat Batters | | Appearance | | Texture | | Flavor | | Gen.Quality | |
|---|---|---|---|---|---|---|---|---|---|
| | | 80°C | 121°C | 80°C | 121°C | 80°C | 121°C | 80°C | 121°C |
| Control | | 5.4 | 5.2 | 5.2 | 4.8 | 5.2 | 5.0 | 5.2 | 5.0 |
| Mix 1 | 25 % | 5.3 | 4.8 | 5.0 | 4.7 | 4.9 | 4.6 | 5.1 | 4.9 |
| | 32 % | 5.2 | 5.2 | 5.2 | 4.8 | 4.9 | 4.9 | 5.0 | 5.0 |
| Mix 2 | 25 % | 5.3 | 5.1 | 5.2 | 4.7 | 5.1 | 4.9 | 5.1 | 5.0 |
| | 32 % | 5.2 | 5.0 | 5.2 | 4.8 | 5.0 | 4.9 | 5.0 | 4.9 |
| Mix 3 | 25 % | 5.0 | 4.8 | 4.9 | 4.7 | 5.0 | 4.8 | 4.9 | 4.7 |
| | 32 % | 4.8 | 4.7 | 4.8 | 4.6 | 4.8 | 4.7 | 4.8 | 4.6 |

Batters with Mix 3 had cooking yields higher than those of control because blood-plasma can reduce shrinkage, on account of its gel-forming ability on heating as well as its good emulsifying properties (Wismer Pedersen, 1982).

In batter with Mix 1, although it was expected a positive effect of soy flour because of its high water holding capacity, this effect was not apparent, perhaps because the amount of soy flour protein in the mix was not enough to counterbalance the diminution in the amount of meat proteins.

In Table 5 results of the evaluation of sensory quality attributes of batters with mixes and the control are presented. The differences between the scores of the batters and between these and the control were smaller than 1. Results indicated an acceptable quality. However, in batters with Mix 3 there was a tendency towards lower scores. Table 6 shows ratio values of maximum penetration force in the batters respects to those of the control. In batters with Mix 1 at the 25 % and 32 % substitution levels, the ratios at both temperatures did not differ significantly ($P<0,05$). However, at the 25 % level ratios were about 1, whereas at 32 % they were lower, specially at 80°C. It is not clear the reason why the mixture of collagen with soy flour counteracts effectively the diminution in meat protein at 121°C. Perhaps it was due to a synergistic effect of soy/muscle gelation noted in some model studies at temperatures (80-85°C) at which soy protein becomes readily denatured (Foeding and Lanier, 1987).

Table 6. Ratios between the values of maximum penetration force in the meat batters with mixes 1, 2 and 3 and those of the control.

| Meat Batters | | Ratios * 80°C | Ratios 121°C |
|---|---|---|---|
| Mix 1 | 25 % | 0.94 abc | 0.98 abc |
| | 32 % | 9.72 cd | 0.85 abcd |
| Mix 2 | 25 % | 1.04 ab | 1.00 ab |
| | 32 % | 0.93 abcd | 0.96 abc |
| Mix 3 | 25 % | 1.06 a | 0.77 bcd |
| | 32 % | 0.80 abcd | 0.67 d |
| Std.error | | 0.081 * | |

* P<0,05

a,b,c,d Mean values without letter in common differ at P<0,05

The ratio values of batters with Mix 2 indicated a consistency (related to bite) similar to that of the control at both temperatures and ratios did not differ significantly (P<0,05). This, despite the diminution in myofibrillar proteins, of which the structure of the matrix formed depends, due to gelation. Jongsma and van Pikjeren (1985) found that sodium caseinate significantly improves gel strength of various meat protein fractions, although it does not gel on heating. Ratios of batters with Mix 3 at the 25 and 32 % substitution levels did not differ significantly (P<0,05) at 80°C or at 121°C.

At the 25 % level there was a significant difference (P<0,05) between the ratios at 80 and 121°C. The consistency at this level at 80°C was superior to that of the control, but not at the 32 % level. At 121°C the consistency at both substitution levels was lower than that of the control and those of the levels at 80°C. The results are contradictory because it could be expected less affectation of the consistency of the batters with Mix 3 at 121°C. Plasma proteins form gels above 80°C, increasing the firmness of a plasma containing meat emulsion (Poulsen, 1978).

## CONCLUSIONS

Previously cooked collagen-rich offal were more convenient for addition to meat batters because they give higher cooking yields than that of batters with raw offal, without affecting the organoleptic properties.

Mixes of either cooked pork rind or beef snouts with sodium caseinate or dried blood plasma substituting for up to 32 % of the meat proteins in batters gave good results. Batters with these mixes had the highest cooking yields and their organoleptics characteristics were satisfactory.

Batters with addition of soy flour mix showed rather low cooking yields, which it made it inadequate for substitute meat on batters.

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