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BIND AND COOKING LOSS IN HIGH MANNURONATE ALGINATE / CALCIUM RESTRUCTURED BEEF AS AFFECTED BY GUM AND WATER LEVELS

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BACKGROUND

Restructuring meats by the alginate/calcium (AC) binder provides products with satisfactory bind in both raw and cooked state. Product cohesiveness is achieved by a chemically set calcium alginate gel after mixing meat pieces with sodium alginate, calcium carbonate and an acidulant (Means and Schmidt, 1986; Ensor et al., 1990). Presumably, binding also involves protein-polysaccharide interactions, i.e. meat proteins and the AC gel interact by electrostatic- and hydrogen bonding forces, as suggested by model studies (Ustunol et al., 1992).

Traditionally, restructured meat products are prepared by adding salt and phosphate to extract salt soluble proteins, whereafter meat binding is obtained by a heat set gel. Recent studies have shown that this method results in significant lower cooking loss as compared with the AC binding technique (Schaake et al., 1993; Shand et al., 1993). The addition of several types of polysaccharide gums to AC restructured meats to lower cooking loss has been attempted, but only a few gums decreased cooking loss without adversely affecting product bind (Shand et al., 1993). Nielsen et al. (1995) observed that addition of a kappa carrageenan/locust bean gum mixture (C/LBG) effectively reduced cooking loss in AC restructured beef, and at the same time showed compatibility with the AC binding matrix. In the latter study, a high mannuronate (M) alginate type was used, as opposed to the normally applied alginate type with a high guluronate (G) content.

The objective of this study was to evaluate bind and cooking loss of finely ground high mannuronate AC restructured beef as affected by addition of varying levels of C/LBG and water. Furthermore, the effect of C/LBG levels on cooking loss was examined with or without the presence of alginate in the medium.

METHODS

Experimental design Two experiments were performed with finely ground AC restructured beef: In Exp.1, four water levels and three C/LBG levels were examined in a complete randomized factorial arrangement of treatments (4 x 3). In Exp.2, three C/LBG levels with or without alginate were applied, i.e. a 3 x 2 factorial design. All formulations were replicated three times, and data were analyzed by analysis of variance.

Materials M. semitendinosus from 2-4 year old cows was purchased at a local wholesaler 2-4 days post mortem, trimmed of visible fat and connective tissue, cut in small pieces (approx. 75 g) and randomly assigned for storage in polyethylene freezer bags (400-600 g portions) at -18°C for max. three weeks. Before use, bags were thawed at 5°C for 48 hours, and ground finely through a plate with 4.5 mm diameter holes. Additives used were: Sodium alginate, 0.75% in Exp.1 and 0% or 0.75% in Exp.2 (Sobalg Fd 176, M/G ratio = 1.5; Danisco Ingredients, Brabrand, Denmark); kappa carrageenan/locust bean gum mixture (C/LBG), 0%, 0.25% or 0.50% (Gelodan CC 310, 70% kappa carrageenan/30% locust bean gum; Danisco Ingredients, Brabrand, Denmark); calcium carbonate, 0.20%; glucono-delta-lactone (GDL), 0.80%; distilled water, 0%, 10%, 20% or 30% in Exp.1 and 10% in Exp.2.

Processing 300.00 g w/w formulations were prepared by mixing ground meat with additives using a hand mixer, as previously described (Nielsen et al., 1994). After setting, some samples were vacuum-packed, heated at 80°C for 30 min in a waterbath and cooled in running tap water. For raw and cooked breaking strength measurements, three cylindrical cores (diameter = 24 mm, height = 21 mm) were removed with a stainless steel borer from the raw and cooked samples, respectively.

Analysis Sample cores were compressed 80% by a 35 mm diameter plate attached to an Instron crosshead (1kN load cell, crosshead speed 60 mm x min^{-1}). Raw and cooked breaking strength was measured as force at first peak. Cooking loss was calculated as a percent of sample raw weight, and raw pH was measured with a standard pH meter.

RESULTS AND DISCUSSION

As shown in Table 1, raw breaking strength was not affected by addition of 10% water ($P<0.05$), but higher levels (20% or 30%) resulted in significant decreases. In AC structured beef rolls, Shand et al. (1993) observed that 30% added water reduced raw bind, while addition of 15% water had no effect. Apparently, high levels of water tend to dilute the AC binder thereby reducing cohesion between meat particles. No effect on raw breaking strength was detected when levels of C/LBG increased from 0% to 0.50% ($P>0.05$) (Table 1), as was also observed in a previous study by Nielsen et al. (1995), showing that the AC binding mechanism was not disturbed by the presence of C/LBG. Similarly, Shand et al. (1993) showed that raw bind was maintained by addition of up to 1.0% kappa carrageenan, gellan gum or low methylester pectin to AC structured beef rolls, while all other gums tested (0.5% or 1.0%) significantly reduced raw bind. Presumably, gums compatible with AC binding of restructured meats such as C/LBG act as fillers in the binding matrix, resulting in a filled gel as proposed by Tolstoguzov and Braudo (1983).

TABLE 1.
RAW AND COOKED BREAKING STRENGTH AND COOKING LOSS AS AFFECTED BY VARYING LEVELS OF WATER AND C/LBG [1]

WATER (%)	R.B.S. (N)	C.B.S. (N)	LOSS (%)
0	30.2a	35.4b	15.5a
10	30.5a	38.3a	15.8a
20	25.4b	35.4b	17.9a
30	14.7c	32.1c	27.5b
C/LBG (%)	**R.B.S. (N)**	**C.B.S. (N)**	**LOSS (%)**
0	24.9a	39.9a	21.7a
0.25	25.3a	35.8b	18.7b
0.50	25.4a	30.2c	17.2b

[1] Values are averaged across C/LBG levels (top) and water levels (buttom)
Means in a colomn with unlike superscripts are different (P<0.05) regarding top and buttom, respectively
R.B.S. and C.B.S. = raw and cooked breaking strength, respectively.

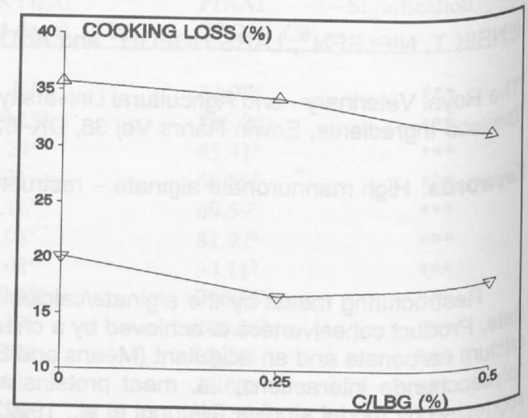

FIG.1. COOKING LOSS AS AFFECTED BY LEVELS OF C/LBG AND ALGINATE. ▵ = 0% ALGINATE AND ▿ = 0.75% ALGINATE.

Cooked breaking strength was reduced when levels of C/LBG increased from 0% to 0.50% (P<0.05%), whereas more inconsistent results were achieved when levels of added water was elevated (see Table 1). The lowering of cooked breaking strength by C/LBG may partly be explained by a softening of the gelled meat mass due to decreased cooking loss when elevating the levels of C/LBG (Table 1). In addition, as bind of finely ground cooked samples probably involves both AC gelation and the formation of a heat set protein gel due to increased extraction of myofibrillar proteins, elevated C/LBG levels may contribute to increased interference between the two gelation mechanisms. Recent studies in our laboratory not yet published showed that C/LBG increased cooked bind when coarsely ground meat was used. Shand et al. (1993) observed that cooked bind of coarsely ground AC structured beef rolls was not affected by addition of kappa carrageenen and gellan gum (both up to 1.0%), while other gums tested had a pronounced negative effect on cooked bind. Moreover, the same authors found that addition of 15% or 30% water markedly reduced cooked bind.

Up to 20% water could be added to the gelled meat system without significant increase in cooking loss (P>0.05) (Table 1). As shown in Fig.1, reduction of cooking loss was predominantly due to addition of 0.75% alginate, although part of the cooking loss reduction originated from C/LBG addition, i.e. the present results showed that the alginate binder was approx. four times as effective in reducing cooking loss as 0.50% C/LBG. The high efficiency of alginate to reduce cooking loss may be owing to the excellent water binding properties of the hydrocolloid combined with the inhibition of water migration by the AC gel network. No significant differences in pH values, approx. 5.40, were observed when ingredients levels differed (data not shown).

CONCLUSIONS

High mannuronate AC restructured beef formulated with C/LBG was able to absorb at least 20% of added water, which was mainly due to the alginate binder. However, if significant reductions of raw breaking strength have to be avoided, only 10% of water should be added. C/LBG did not affect raw breaking strength, but reduced cooked breaking strength probably caused by the use of finely ground meat.

LITERATURE

ENSOR, S.A., SOFOS, J.N. and SCHMIDT, G.R. 1990. Optimization of algin/calcium binder in restructured beef. J. Muscle Foods **1**, 197-206.

MEANS, W.J. and SCHMIDT, G.R. 1986. Algin/calcium gel as a raw and cooked binder in structured beef steaks. J. Food Sci. **51**, 60-65.

NIELSEN, H.T., HØEGH, L. and MØLLER, A.J. 1994. High mannuronate alginates as binders in restructured beef. J. Muscle Foods, in press.

NIELSEN, H.T., HØEGH, L. and MØLLER, A.J. 1995. Quality characteristics of high mannuronate alginate restructured beef with added gums. Meat Focus International **4**, part 1.

SCHAAKE, S.L., MEANS, W.J., MOODY, W.G., BOYLE, E.A. and AARON, D.K. 1993. Boning methods and binders affect bind and sensory characteristics of structured beef. J. Food Sci. **58**, 1231-1236.

SHAND, P.J., SOFOS, J.N. and SCHMIDT, G.R. 1993. Properties of algin/calcium and salt/phosphate structured beef rolls with added gums. J. Food Sci. **58**, 1224-1230.

TOLSTOGUZOV, V.B. and BRAUDO, E.E. 1983. Fabricated foodstuffs as multicomponent gels. J. Texture Studies **14**, 183-212.

USTUNOL, Z., XIONG, Y.L., MEANS, W.J. and DECKER, E.A. 1992. Forces involved in mixed pork myofibrillar protein and calcium alginate gels. J. Agric. Food Chem. **40**, 577-580.