THE EFFECT OF SODIUM CHLORIDE IN ALGIN/CALCIUM RESTRUCTURED MEATS, EFFECTS OF RIGIDITY AND SENSORY PROPERTIES OF A RESTRUCTURED CHICKEN PRODUCT

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Background

Restructured meat products are made by extracting myofibrillar proteins using salt, phosphates, and mechanical action, which form a heat-set protein gel between meat pieces when cooked. Alternatively, a 'cold set' alginate/calcium binding mechanism may be used where low salt (NaCl) levels are possible (Jolley and Purslow, 1988). Alginates are linear polysaccharides composed of mannuronic and guluronic acids. The effect of NaCl on the rigidity of calcium alginate gels depends on the type of alginate and the presence or absence of glucono-delta-lactone (GDL) (Means and Schmidt, 1986; Means, *et al.*, 1987). The effect of various levels of NaCl, similar to those used on the rigidity of unheated algin/calcium restructured chicken patties were examined using alginates differing in their guluronic acid ratios. Organoleptic assessment of raw and cooked chicken patties containing algin/calcium additions were also conducted to see if the algin/calcium could replace polyphosphate in a salt-containing product and secondly, to compare the eating quality of poultry products containing different alginate types.

Materials and Methods

Deboned fresh chicken breast fillets (75.5% moisture, 4.5% fat, 22% protein, 1% ash), 24h *post mortem* within a pH of 6.0 were minced through a 3mm plate and divided into batches. Alginate (1% w/w) was dispersed over 2.4kgs of the mince using a sieve and mixed in a domestic mixer for approximately 30sec. Calcium sulphate ($CaSO_4$) and GDL (0.18% and 0.21% w/w, respectively), were added and the mixed for 30sec. Levels of sodium chloride (NaCl) and polyphosphate were added followed by a further 30sec of mixing. Patties (51.6mm dia, 25mm thick) were formed, halved vertically, covered and held for 24h or 96h at <4°C prior to assessment. Texture (rigidity) of raw and cooked products was assessed by uniaxial parallel plate compression. Chicken formulations (n=11) were prepared to evaluate the effects of alginate type (1% w/w of either low guluronic acid (LGA), high guluronic acid (HGA), GDL (0 or 0.25%) and NaCl (0 or 0.25%)) in a factorial design (Table 1). Additional treatments included NaCl (1.0 or 1.5%) and polyphosphate (0.5%). A control treatment, with no additives, was also included. Water (5%) was added to all product mixes. Patties were cooked using an electric pan at 100°C x 20min (10min each side). Cook yield was calculated by weight difference after cooking. A trained in-house panel (n=11) scored poultry products using an eight point scale for overall texture, juiciness, and flavour (8=extremely: tough, juicy and intense to 1=extremely: tender, dry and bland, respectively) with each panellist testing five coded samples at each sitting (n=3).

Results

Increasing NaCl levels (1 to 1.5%) decreased rigidity modulus of alginate samples (Table 2). NaCl addition alone increased rigidity moduli after 24h, and increased as salt concentration increased. Products prepared with HGA alginate were more rigid than the LGA products or controls containing either salt and phosphate or no additives. Cooking resulted in a ten-fold increase in rigidity modulus, with lower rigidity values obtained in products containing 1.5% *versus* 1% salt with the exception of the HGA treatments without GDL. HGA products gave greatest rigidity while LGA alginates with 1.5% salt gave the lowest rigidity results similar to controls containing no additives (Table 2). The most tender products were those prepared with the LGA alginate and GDL. NaCl level had little influence on tenderness, except in the case of products containing HGA without GDL. Alginate type influenced juiciness scores with treatments containing LGA alginate receiving higher scores for juiciness and flavour *versus* HGA alginate, the former result correlating with yield data (Table 1). Generally, LGA products received higher organoleptic scores *versus* HGA products. Rigidity values correlated (R^2=0.78) significantly ($p<0.001$) with juiciness scores. Products containing 0.25% GDL had higher flavour scores with scores decreasing as salt levels increased. Patties with HGA alginate were more rigid than products containing polyphosphate. pH decreased in an almost linear fashion with salt addition for every combination of alginate type and level of GDL. pH values at 0 and 1.5%

NaCl, respectively, were as follows: LGA, 0% GDL - 5.9, 5.65; LGA, 0.25% GDL - 5.65, 5.45; HGA, 0% GDL - 5.8, 5.55; HGA, 0.25% GDL - 5.65, 5.45. The pH of samples after 24h was consistently lower than that after 96h. Cooking increased pH by 0.1-0.3 pH units. % Cook yield was higher in LGA products *versus* HGA treatments (Table 2). Optimum yield (76%) was obtained for patties containing LGA alginate, 1.5% NaCl and 0% GDL. Products manufactured with LGA were generally unaffected by the level of NaCl or the presence or absence of GDL. Products containing HGA reduced yield by 4% with the addition of 0.25% GDL and by 2% where NaCl levels were increased from 1.0-1.5%. Yield was higher in patties containing alginates *versus* patties prepared without additives. Product containing polyphosphate and NaCl at 1% gave similar yields to LGA products (76%), although the product containing phosphate and NaCl at the higher level (1.5%) had an improved yield.

Conclusion

The eating quality of restructured meat products made with alginates of different guluronic acid components warrants further study with an overriding promise of satisfactory handling ability in the uncooked chilled product. Correlation between juiciness and rigidity modulus suggests that it may have potential to act as a predictor of this sensory attribute. Potentially, the replacement of polyphosphate via alginate in salt-containing products appears feasible. Overall, the LGA alginate containing products performed well in comparison with polyphosphate products in terms of yield and eating quality, especially in the presence of GDL. While HGA products gave lower yields than the patties with added polyphosphate, they were nevertheless comparable in eating quality.

References

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Table 1 Formulae used in the preparation of poultry products

No	Meat (g)	water mls	NaCL(g)	Phos (g)	LGA (g)	HGA (g)	GDL (g)	$CaSO_4$ (g)
1	2375	125	-	-	-	-	-	-
2	2338	125	0.025	0.0125	-	-	-	-
3	2508	125	0.037	0.0125	-	-	-	-
4	2333	125	0.025	-	0.0062	-	0.00625	0.0045
5	2321	125	0.037	-	0.0062	-	0.00625	0.0045
6	2333	125	0.025	-	0.0062	-	0.00625	0.0045
7	2321	125	0.037	-	0.0062	-	0.00625	0.0045
8	2333	125	0.025	-	-	0.0062	0.00625	0.0045
9	2321	125	0.037	-	-	0.0062	0.00625	0.0045
10	2333	125	0.025	-	-	0.0062	0.00625	0.0045
11	2321	125	0.037	-	-	0.0062	0.00625	0.0045

Table 2 Results from cooked poultry patties for the organoleptic attributes of tenderness (T), juiciness (J), flavour (F) and physical properties of cook yield (CY) as well as pH and rigidity modulus (x 10^3) Nm^{-2} for raw (r) and cooked (c) products

No	T	SD	J	SD	F	SD	CY	pHc	R c	PHr	Rr
1	6.3	0.6	4.18	0.9	6.0	1.00	61.0	6.23	19.2	6.06	1.20
2	6.2	1.1	5.27	0.9	5.8	0.87	75.5	6.26	23.4	6.11	1.24
3	6.0	1.0	6.60	0.7	4.2	0.87	78.5	6.22	27.1	6.06	1.49
4	6.3	0.9	6.20	1.1	6.3	0.65	74.0	6.14	31.5	6.02	2.34
5	6.3	0.6	6.70	0.9	6.0	0.44	76.0	6.08	19.4	5.84	1.70
6	7.0	0.6	6.40	0.9	7.0	0.90	75.0	5.98	27.7	5.71	3.88
7	7.2	0.6	6.30	0.8	7.0	1.00	74.5	5.94	16.8	5.60	2.29
8	6.5	0.7	5.70	0.6	5.8	0.50	71.0	6.11	34.5	5.84	3.39
9	5.7	1.0	4.80	0.9	5.5	0.50	69.0	6.11	44.0	5.65	1.98
10	6.1	0.7	4.40	0.8	7.0	0.90	67.0	5.99	47.7	5.76	4.41
11	6.0	0.6	4.30	0.9	7.0	0.63	65.0	5.96	36.9	5.69	3.10