PHYSICOCHEMICAL AND SENSORY PROPERTIES OF LOW-FAT PORK PATTIES CONTAINING CARRAGEENAN, KONJAC FLOUR, LOCUST BEAN GUM AND SOY PROTEIN ISOLATE

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Background

The demand for low-fat meat products has risen in recent years because the excess dietary fat is highly correlated with coronary heart disease. Fat content is related to juiciness and texture in both ground and whole-muscle meat products. Although the simple reduction of fat would be the most efficient method of producing low-fat animal products, the palatability of ground meat is directly related to its fat content (Egbert and Huffman, 1991). Kregel et al. (1986) reported that patties ranging in the fat level from 21.0 to 28.5% were juicier than those containing 9.5% fat. Of fat substitutes, polysaccharide gums have been incorporated into processed meats to stabilize emulsions, thicken foods and form gel networks. Lin and Keeton (1998) reported that yields and textural properties of low-fat (5 or 10%) precooked ground beef patties containing alginate/carrageenan combinations were similar to those with regular beef patties (20% fat). Since konjac flour, a glucomanan polysaccharide gum, can react with other polysaccharide gums to have synergistic effect, konjac blends (KB) have been combined to serve as multi-ingredient fat substitutes in low-fat meat applications. Chin et al. (1998) reported that prehydrated konjac blends in bologna model systems produced a more swollen protein matrix and had higher texture profile analysis(hardness) values than dry addition. Soy proteins have been used in higher fat ground beef products to aid in moisture and fat retention and to increase yields (Brewer et al., 1992). The multiple combination of polysaccharide gum could improve the functional and textural characteristics in the ground meat as compared to single addition. However, the studies of low-fat pork patties(5% fat level) containing singly or combination source of different prehydrated fat replacers were limited.

Objective

The objective of this study was to investigate the effects of fat replacers such as prehydrated carrageenan, konjac flour, locust bean gum and soy protein isolate on the physico-chemical and sensory characteristics of ground low-fat pork patties.

Materials and Methods

Preparation of raw materials: Fresh pork fore legs were trimmed free of fat and ground through a 1.32cm plate and the pork trimmings were reground through a 0.48cm plate. Proximate composition analysis was determined for the ground pork in order to formulate a low-fat (5% fat) and a regular fat batches (25% fat). A fat replacers such as konjac flour (K), carrageenan (C), locust bean gum (L) and soy protein isolates (S) were prepared by prehydration of each with distilled water (1: 9 for K, C, L; 1: 4 for S). Each blend and spices were combined into the meat batches and mixed. The hydrated single fat replacer was added at a 0.5% level and the combination of two fat replacers was added at a 1% level on a total weight basis. Individual patty (80g) was formed (8.3 cm × 1.3 cm) and the patty samples were kept frozen at −20°C until used (<2 weeks).

Pork patty cooking: Frozen patties were cooked on an electric griddle (National Presto Industries. Inc., USA). Total cooking time was determined in preliminary trials for each treatment so that the internal temperature of the patty reached at 71°C; a thermocouple was connected to monitor the internal temperature using a hand-held digital thermometer (Fisher Scientific, USA). Percent cooking yield was calculated as the difference in weight between individual raw and cooked patties. Cooked patties were individually bagged and held at −20C for about 30min and then vacuum packaged. Patties were stored at −20°C until all analyses were performed.

Analytical methods: Chemical compositions were analyzed by AOAC (1990). The calories were measured by calorimeter and determination of Water holding capacity(WHC) was conducted by the method of Ryoichi et al.(1993). The hardness was determined by an Instron Universal Testing Machine (Model 4465). Color values were measured by a chroma meter (Minolta Co. CR 301) for lightness (L), redness (a) and yellowness (b) of CIE. The sensory characteristics of the control and low-fat patties were determined by eight trained panelists for flavor and juiciness using a 6-point scale (6=very intense, very juicy, very springy; 1=very weak, very dry, not springy).

Statistical analysis: Data were analyzed using the SAS program (1990) and means were separated by the Student-Newman-Keuls' test. Dunnett's T-test compared the sensorial properties of each treatment with the control (Lentner and Bishop, 1993).

Results and Discussion

All patties manufactured with prehydrated fat replacers were lower in calories (43~46%) and higher in fat retention when compared to the control (Table 1). The cooking yields were high in patties containing 5K, 5S, 5KC and 5KL and WHC were high in patties containing 5K and 5KC when compared to the other treatments and the control. Pork patties containing prehydrated fat replacers showed higher L values than the control. Pork patties having two combination of fat replacer were harder than those with a single fat replacer or the control. The patties containing combination of two fat replacers were generally higher in cooking yield and WHC than those with a single fat replacer within the same fat level. When a single fat replacer was incorporated into the formulation, konjac flour and locust bean gum appeared to improve texture slightly more than carrageenan. However, carrageenan functionality appeared to be improved when it was used with konjac flour. Chin et al. (2000) reported that the multiple addition of konjac and carrageenan produced harder and springer gel which were able to hold more moisture in meat model system. The control which represent regular pork patties available on the retail market had low cooking yield, WHC and hardness values as compared to patties containing single or combination of fat replacers. In sensory evaluation, 5K and 5KC were juicier than the control; however, 5KC had lower flavor intensity than the control(p<0.05) (Table 2).

Conclusions

Fat replacers such as konjac flour, carrageenan, locust bean gum and soy protein isolate added into the formulation with combination basis appeared not only to reduce fat but also to improve the physical properties that increase WHC and cooking yield when they were prehydrated and used in pork patties. However, changing the hydration ratio of the fat replacers could be used to improve the sensory characteristics in further research. Therefore, product development research should continue into formulation methods that achieve the desired fat reduction with the combination of fat replacers in order to develop low-fat meat products that maintain good organoleptic properties as well as satisfactory consumer perceptions of the products.

Table 1. Effect of carrageenan, konjac flour, locust bean gum and soy protein isolate on physico-chemical characteristics of cooked ground pork patties.

Forms[u]	Calorie (cal/100g)	Proximate Composition (%)						CY[v] (%)	WHC[w] (%)	CIE			Fat Retention (%)	Texture
		Raw			Cooked									
		Protein	Fat	Moisture	Protein	Fat	Moisture			L	a	b		Hardness
CTL	3532.33[a]	16.43	22.49	56.49	22.35	24.26	49.52	74.38[c]	56.95[b]	50.07[b]	6.98[ab]	16.07[a]	53.49[b]	1.20[d]
5S	2017.50[b]	20.19	5.25	73.45	24.77	7.34	66.61	77.87[a]	58.03[ab]	53.16[ab]	7.70[ab]	15.23[a]	63.53[a]	1.87[bc]
5C	1925.50[b]	18.22	5.09	73.85	25.58	7.13	65.09	75.59[bc]	56.73[b]	58.26[a]	5.98[b]	16.40[a]	62.63[a]	1.91[bc]
5K	1938.50[b]	19.17	4.95	74.10	20.79	7.01	68.45	77.82[a]	58.05[a]	50.63[b]	8.88[a]	17.88[a]	58.29[a]	1.77[c]
5L	1934.00[b]	19.86	5.11	74.04	27.56	7.22	66.56	76.30[ab]	57.39[ab]	52.95[ab]	8.31[a]	17.09[a]	62.95[a]	1.97[abc]
5KC	1981.67[b]	18.95	6.08	74.80	23.9	8.23	64.16	78.23[a]	62.71[a]	51.28[b]	7.47[ab]	16.82[a]	60.18[a]	2.21[a]
5KL	1906.33[b]	18.56	6.19	74.55	24.55	7.93	65.08	77.63[a]	59.85[ab]	57.52[a]	6.98[ab]	17.20[a]	56.61[a]	2.12[ab]
5CL	1889.67[b]	18.44	4.82	74.46	23.98	7.30	65.15	77.28[ab]	58.24[ab]	52.79[ab]	7.04[ab]	17.03[a]	56.65[a]	2.09[ab]

[u]Form: CTL - control; 25% fat - 5% fat pork patty incorporated with prehydrated konjac flour (K), soy protein isolate (S), carrageenan (C), locust bean gum (L); [v]CY - cooking yield; [w]WHC - water holding capacity; [a-c] Means with a same superscript within a column are not significantly different (p<0.05)

Table 2. **Sensory properties of the control and low-fat cooked ground pork patties.**

Parameter	Forms	CTL	5K	5C	5S	5L	5KC	5KL	5CL
Flavor[x]	Mean	3.59	3.05	3.05	3.29	3.36	2.92	3.46	3.13
	Dunnett's[y]		-	-	-	-	***	-	-
Juiciness	Mean	3.21	3.77	3.41	3.43	3.18	3.88	3.42	3.58
	Dunnett's		***	-	-	-	***	-	-
Springness	Mean	2.36	3.32	3.18	3.29	3.22	3.46	3.25	3.33
	Dunnett's		***	***	***	***	***	***	***

[x] is based on a 6-point scale (1=very weak, very dry, not springy; 6=very intense, very juicy, very springy)
[y]Significant comparisons (p<0.05) are indicated by an asterisk (CTL vs. treatment).

References
1. AOAC. 1990. Official Method of Analysis. 15th ed., Association of Official Analytical Chemists, Washington D.C.
2. Brewer, M. S., Floyd, K. M. and Britt, C. 1992. Fat, soy and carrageenan effects on sensory and physical characteristics of ground beef patties. J. Food Sci. 57(5): 1051-1055.
3. Chin, K. B., Keeton, J. T., Longnecker, M. T. and Lamkey, J. W. 1998. Functional, textural and microstructural properties of low-fat bologna with a konjac blend. J. Food Sci. 63(5): 801-807.
4. Chin, K. B., Keeton, J. T., Longnecker, M. T. and Lamkey, J. W. 1998. Functional, textural and microstructural properties of low-fat bologna with a konjac blend. Food Sci. and biotechnol. 9(6): 368-371.
5. Egbert, W. R. and Huffman, D. L. 1991. Development of low-fat ground beef. Food Technol. 45(6) pp.64-73
6. Kregel, K. K., Prusa, K. J., and Hughes, K. V. 1986. Cholesterol content and sensory analysis of ground beef as influenced by fat level, heating and storage. J. Food Sci. 51: 1162-1165, 1190.
7. Lentner, M. and Bishop, T. 1993. Meat separation procedures. Ch. 3, In Experimental Design and Analysis, 2nd ed., p. 93-94. Valley Book Company, Blacksburg, VA.
8. Lin, K. W. and Keeton, J. T. 1998. Textural and physicochemical properties of low-fat, precooked ground beef patties containing carrageenan and sodium alginate. J. Food Sci. 63(4): 571-574.
9. Ryoichi, S., Degychi, T. and Nagata, Y. 1993. Effectiveness of the filter paper press method for determining the water holding capacity of meat. Fleischwirtsch, 73:1399.
10. SAS. 1990. SAS User's Guide, Statistics. SAS Institute Inc. Cary, NC.