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TEXTURAL AND SENSORY EVALUATION OF SALTED LOW-FAT BEEF SAUSAGE WITH ADDED WATER AND GUMS

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INTRODUCTION

Sausages are popular meat products which are consumed by millions of consumers worldwide. However, increased concerns about the potential health risk associated with the consumption of high-fat sausage have led meat processors to seek new formulations to develop reduced-fat sausages. Several attempts, aimed at mimicking the attributes of texture, juiciness, and flavor lost when fat is removed, have been made by using various additives capable of binding water and restoring texture and mouthfeel sensations. Among the additives are starch, fibers, soy flour, whey proteins, caseinate, and egg solids (Sofos et al., 1977; Trout et al., 1992). Recently, there has been increased interest in using polysaccharide gums derived from seaweed, plants and bacteria as water-binding agents in low-fat hamburgers and low-salt sausages (Egbert et al., 1991). Currently, few gums are being used in high-salt beef sausages due, in part, to the lack of understanding of the functional behavior of gums in these products. The objectives of the present study were to explore the feasibility of replacing the fat in traditional beef sausage with water by using selected polysaccharide gums, and to evaluate textural and flavor attributes of low-fat sausages at different salt levels and pH's.

MATERIALS AND METHODS

Sausage manufacture. Vacuum-packaged whole USDA Choice beef sirloin tips were purchased from a local retail store. All visible fat was trimmed to obtain >95% lean meat. Proximate analysis for protein, fat and moisture was performed to ensure meat batch-to-batch uniformity. Sausage formulations included a control and six gum treatments which contained 0.5% κ-, ι-, and λ-carrageenan, calcium alginate, locust bean gum, and combined (half:half) locust bean gum and xanthan gum and 23 % added water (based on batter wt). Salt (NaCl) at 1 and 2.5% levels were added to the control and each of the six treatments. To determine the effect of pH on gum action, the pH of all 2.5% salted sausage batters was adjusted using 2N lactic acid/NaOH to obtain final pH's 5.3, 5.6, and 6.2 in cooked products. Formulated meat was blended for 5 min in a KitchenAid mixer, and then stuffed into 5.7-cm diameter cellulose casings. After setting for 16 h at 4°C to allow an ingredient equilibrium, sausage rolls were cooked in a 107°C oven for 1 h, and then at 121°C until the internal temperature of meat reached 68°C.

Cooking yield. The weight of each roll was measured before and after cooking to determine cooking yield, which is defined as: final wt ÷ initial wt then multiplying by 100%.

Textural evaluation. Meat samples (2x2x2 cm cubes) were obtained from the center of each sausage roll (which was chilled overnight at 4°C after cooking) and then rewarmed to 20°C. Samples were compressed to 40% of their original height in two consecutive cycles at a crosshead speed of 50 mm/min. Peak force from the first compression was defined as "hardness", and the differential between the first and second resilient peak forces was expressed as "fracturability".

Organoleptic characteristics. An eight-member taste panel consisting of faculty, staff and graduate students rated each cooked sausage sample on 10 sensory traits: tenderness, juiciness, chewiness, crumbliness, slipperiness, springiness, firmness, flavor intensity, mouthfeel, and overall acceptability. Each trait was presented with a 13 cm line with "extremely low" (0 point) on the left end, and "extremely high" (5 points) on the right end. Panelists marked the line at the intensity level they felt appropriate.

Statistical analysis. A randomized block design was used to evaluate the compressive force, fracturability, cooking yield, and the taste panel results. The General Linear Model procedure of the SAS program was used to perform statistical analysis.

RESULTS AND DISCUSSION

Proximate analysis indicated that all meat batters had essentially the same (P > 0.05) protein (15.66%), fat (2.88%), and moisture (78.06%) content. Lightly salted (1%) sausages had significantly lower (P < 0.05) cooking yields than more highly salted (2.5%) sausages (Table 1). Except for κ- and ι-carrageenan, all gums improved cooking yield of sausages formulated with 1% salt, indicating that these gums were effective in binding water. Alginate, locust bean gum, and xanthan gum were particularly effective probably due to their ability to form strong hydrogen bonds with water. The increase in the salt content resulted in higher cooking yield with or without gum treatments. Gums improved cooking yield more on 2.5%-salt sausages than on 1%-salt sausages. This can be understood because myofibrillar proteins extracted by 2.5% salt can form a gel which enables water entrapment in sausage (Acton et al., 1983). At the 2.5% salt concentration, cooking yield improved as the pH was raised, apparently due to increased charges in both proteins and the polysaccharides.

Table 1 - Effect of gum treatment, salt level, and pH adjustment on cooking yield (%) of low-fat beef sausages.[1]

Treatment	1.0% salt pH 5.6	2.5% salt pH 5.3	2.5% salt pH 5.6	2.5% salt pH 6.2
Control	65.5d		84.1ab	84.1b
κ-Carrageenan	64.6d	73.7b	85.6ab	87.5ab
ι-Carrageenan	62.7d	72.6c	83.4b	90.6a
λ-Carrageenan	72.6c	73.8b	85.9ab	87.4a
Alginate	80.0a	85.7a	85.2ab	90.3a
Locust bean gum	77.2bc	81.8ab	88.6a	87.1ab
Locust bean + xanthan	72.5c	81.5ab	85.3ab	89.3a

[1]Means in the same column with no common letter differ significantly (P < 0.05).

Addition of κ- and ι-carrageenan increased ($P < 0.05$) hardness of 1%-salt sausage (Table 2), suggesting improved meat-binding by the gums (Egbert et al., 1991). However, at this salt level, alginate, locust bean gum and xanthan gum markedly weakened sausage structure, making the meat samples practically unable to be measured using the Instron. This trend was also observed in sausages containing 2.5% salt at pH 5.6. When the pH was raised to 6.2, hardness of these sausages increased ($P < 0.05$) and again, κ- and ι-carrageenan were the most effective gums. All the gum treatments within the same salt/pH group exhibited little disparity ($P > 0.05$) with respect to sausage fracturability, suggesting that all samples underwent a similar irreversible structural damage during the first compression.

Panelists assigned higher tenderness and juiciness scores to alginate-, locust bean gum- and xanthan gum-treated, 1%-salt sausages, and lower scores to κ- and ι-carrageenan-added sausages (Table 3), consistent with the Instron textural analysis. Sausages containing alginate, locust bean gum and xanthan gum were perceived less crumbly ($P < 0.05$) than control. Sausages containing 2.5% salt were given higher ratings than were 1%-salt sausages for most sensory attributes evaluated. For instance, most 2.5%-salt samples were more tender, springy, flavorful, juicier, and less crumbly than 1%-salt samples. The behavior of gums at both salt levels was apparently similar. Slipperiness seemed to be a particular problem for alginate, and xanthan and locust bean gums, and this defect might hinder the application of the gums at the 0.5% level.

Table 2 - Compressive forces required to cause 40% deformation and structural damage of low-fat beef sausages.[1]

Treatment	Force at 40% compression (N)			Fracturability		
	1.0% salt pH 5.6	2.5% salt pH 5.6	2.5% salt pH 6.2	1.0% salt pH 5.6	2.5% salt pH 5.6	2.5% salt pH 6.2
Control	25.2c	32.2ab	-	3.6a	3.4a	
κ-Carrageenan	30.3b	34.3ab	42.5ab	4.2a	3.5a	3.9a
ι-Carrageenan	36.3ab	27.9bcd	43.5a	4.6a	3.6a	4.8a
λ-Carrageenan	24.3c	22.3cde	34.0cd	3.9a	3.3a	4.7a
Alginate	-	24.0def	32.2d	-	3.5a	5.7a
Locust bean gum	-	22.9def	41.0abc	-	3.5a	5.1a
Locust bean + xanthan	-	17.4e	35.1bcd	-	3.3a	7.7a

[1]Means in the same column with no common letter differ significantly ($P < 0.05$); higher numbers indicate harder (firmer) product, suggesting improved bind.

CONCLUSIONS

Most polysaccharide gums studied increased cooking yield without compromising sensory attributes of whole beef sausage. The specific effect of gums on sausage characteristics depended on salt levels and pH. However, all gum-added, low-fat sausages were similarly acceptable, suggesting that these gums may be utilized in meat processing, at both 1 and 2.5% salt levels, to improve cooking yield and modify product physical properties and organoleptic characteristics.

Table 3 - Mean sensory scores (0 = extremely low; 5 = extremely high) on low-fat beef sausages (pH 5.6) assigned by taste panel.[1]

Treatment	Tenderness	Juiciness	Chewiness	Crumbliness	Slipperiness	Springiness	Firmness	Flavor intensity	Mouthfeel	Overall acceptability
1.0% Salt										
Control	3.3de	2.1de	2.0abc	3.4a	1.1def	1.4de	1.2d	1.2d	0.9de	1.1b
κ-Carrageenan	3.2e	1.6e	2.6abc	2.9abc	0.8fg	1.7cd	1.7d	1.7d	1.6c	1.6b
ι-Carrageenan	3.1e	1.6e	2.5abc	3.1ab	0.6g	1.6de	1.7d	1.7d	1.6cd	1.6b
λ-Carrageenan	3.6bcde	2.5cde	2.5abc	2.6c	1.6cde	1.5de	1.4d	1.4d	1.4cde	1.3b
Alginate	3.8abcd	2.6cde	2.0bc	2.7bc	2.4abc	0.9ef	0.6e	0.6e	1.1cde	0.9b
Locust bean	3.4cde	2.7bcd	2.5abc	2.7bc	2.0bcd	1.3de	1.1de	1.1de	1.5cd	1.3b
L. bean + Xanthan	3.7abcd	2.7bcd	1.7c	2.9bc	3.0a	0.6f	0.6e	0.6e	0.7e	0.8b
2.5% Salt										
Control	3.5cde	3.3abc	3.0a	0.4f	0.9efg	3.0ab	3.6a	3.6a	3.4ab	3.2a
κ-Carrageenan	3.5bcde	3.3abc	2.6ab	0.7ef	1.5cdef	3.5a	3.5a	3.5a	3.3ab	3.1a
ι-Carrageenan	4.2ab	3.3abc	2.6ab	0.4f	1.7cde	3.4a	3.6a	3.6a	3.7a	3.3a
λ-Carrageenan	4.0abc	3.7ab	2.5abc	0.7ef	2.3abc	2.8ab	3.1ab	3.1ab	2.9b	3.0a
Alginate	3.6bcde	3.4abc	2.4abc	1.5d	2.3abc	2.9ab	3.3a	3.3a	3.4ab	3.4a
Locust bean	3.9abcd	3.8a	2.2abc	1.3d	2.0bcd	2.5b	2.7bc	2.7bc	0.9cde	2.8a
L. bean + Xanthan	4.3a	3.7ab	2.1bc	1.1de	2.7ab	2.4bc	2.4c	2.4c	2.8b	2.7a

[1]Means in the same column with no common letter differ significantly ($P < 0.05$).

REFERENCES

Acton, J.C., Ziegler, G.R., and Burge, D.L., Jr. 1983. Functionality of muscle constituents in the processing of comminuted meat products. CRC Crit. Rev. Food Sci. Nutr. 18:99.

Egbert, W.R., Huffman, D.L., Chen, C.-M., and Dylewski, D.P. 1991. Development of low-fat ground beef. Food Technol. 45(6):64.

Sofos, J.N., Noda, I., and Allen, C.E. 1977. Effects of soy proteins and their levels of incorporation on the properties of wiener-type products. J. Food Sci. 42:879.

Trout, E.S., Hunt, M.C., Johson, D.E., Claus, J.R., Kastner, C.L., and Kropf, D.H. 1992. Characteristics of low-fat ground beef containing texture-modifying ingredients. J. Food Sci. 57:19.

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