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Microbiology and Composition of Snack Sausages

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ABSTRACT

Chemical, bacteriological and processing characteristics of experimental and commercial snack sausages were investigated. Snack sausages are narrow diameter (ca. 10-12 mm), all-beef products which are relatively dry and shelf-stable, and which may or may not be fermented. The bacterial flora of each product consisted of gram-positive, catalase-positive sporeforming rods (bacilli), reflecting a time-temperature effect of heating/smoking which destroyed most other organisms. The products have low moisture content (av. 20.6%), water activity (av. 0.78), and moisture/protein (M/P) ratio (av. 0.81/1). Judged by the sausage classification system of Acton and Dick relating moisture content to M/P ratio, the snack sausages are fully dry products. The yield of snack sausage prepared in our pilot plant was 39.6% but increased to 51.4% when the initial fat content of the meat mixture was increased from 7.2 to 25.7%.

Snack sausages comprise a group of narrow diameter (ca. 10-12 mm), all beef, relatively dry, shelf-stable products which may or may not be fermented. There is little in the literature about their processing, microbiology, chemistry or composition. Komarik et al. (*3*) described the processing of a fermented, nondried, spicy snack sausage. Previous work from our laboratory (*7*) described the influence of internal product temperature on destruction of salmonellae and staphylococci during thermal processing of a nonfermented snack sausage.

As a part of a continuing interest of our laboratory in the microbiology and technology of sausage products, we have investigated the general microbiology and composition of commercial and pilot-plant-produced snack sausages. The results of these investigations are presented here.

MATERIALS AND METHODS

Preparation of snack sausage

All-beef nonfermented snack sausage was prepared in our pilot plant as described previously (*7*). The process consisted of heating and smoking the product in a smoke house for 3-1/2 h at an internal product temperature of 57.8 C followed by 4 days of drying at 21 C and 50-55% relative humidty. To determine the influence of initial fat content on the finished product, snack sausage mixtures containing 7.2, 18.5, and 25.7% fat (low, medium, and high fat; designated experimental 1, 2, and 3, respectively) were prepared by mixing various amounts of beef fat and lean from the side of a choice grade beef carcass.

Commercial snack sausages

Samples of the various commercial snack sausages were purchased from retail sources. Except for product F, which was labeled "Keep Refrigerated," all were considered shelf-stable products and sold without refrigeration.

Microbiology

Microbiological analyses were carried out on the commercial and experimental snack sausages as described previously (*9*). The different colony types on the various media were examined by gram stain and catalase tests. These two tests were found to be extremely useful because previous experience with a dry sausage, pepperoni (*6*), indicated that the selective agars were not sufficiently specific for the various microbial types in sausage products.

Compositional analyses

Moisture, ash, fat, and protein content of commercial and experimental snack sausages were determined on twice-ground (1/8-inch plate) samples by standard procedures (AOAC, *2*). The pH, titratable acidity, and water activity (a_w) were determined as described previously (*6*).

RESULTS AND DISCUSSION

Some physical and chemical characteristics of 10 commercial and three experimental snack sausages are given in Table 1. Starter culture was used in products A and B, and their low pH values of 4.7 and 4.8, respectively, indicate that fermentation had occurred. The product H-2 also had a low pH, 4.7; in this instance the fermentation was probably carried out by the natural flora including lactic acid bacteria. With the exception of product H-1 and G, with pH values of 5.2 and 5.4, respectively, all other products had relatively high pH values, 5.9 to 6.4. The acid content tended to agree with pH values, low pH values had higher acid levels and vice versa.

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The moisture content of the commercial products ranged from 10.6 to 49.1% and fell into two groups: five products at 18.5% and below and five at 27.3% and above. The experimental products had very low moisture levels. The a_w and the moisture/protein (M/P) ratio tended to parallel the moisture level but not in all instances. This same pattern was observed in pepperoni (*6*). The M/P ratio is an indication of the shelf stability of the product. For example, the maximum M/P ratio expected for pepperoni is 1.60/1 (Laboratory Guide Book, USDA, CMS, Technical Services Division), and, as a general rule, pepperoni is considered to be shelf-stable. With the exception of Company F, which suggests that its product be refrigerated, all other snack sausage processors consider their products to be shelf-stable. Their low M/P ratios support this, with the exception of product H-2.

Product H-1 may owe its shelf stability to the fact that the products of Company H are heavily smoked. Product H-2, though it has a high moisture content, M/P ratio, and a_w, is very acidic (pH 4.7, 1.02% acid); thus its shelf stability is probably due to the combination of smoke and acid.

Acton and Dick (*1*) recently proposed a classification system for dry sausages based on M/P ratio and percent moisture. We applied their system to the data given in Table 1. In their system, all experimental and most of the commercial snack sausages would be classified as fully dry, product H-2 would be semi-dry; and product F (labeled "Keep Refrigerated") and H-1 would be medium dry. Since the data for M/P ratio and moisture content of the individual snack sausages fall very close to the regression line of Acton and Dick, their classification system would also seem valid for snack sausage products.

Results of the bacteriological analysis of commercial and experimental snack sausages are in Table 2. In general, total counts (on APT agar) were low, and, except for two products (B and E), the flora detected consisted of bacilli (gram-positive, catalase-positive, sporeforming rods). Judged by colony morphology, on EMB, MSA, and especially APT agar, the organisms were *Bacillus subtilis* (*4*).

TABLE 1. *Physical and chemical analysis of commercial and experimental snack sausages.*

Commercial products	pH	Acid[a] %	A_w	Moisture %	Fat %	Ash %	Protein %	Moisture/protein ratio
Company A[b]	4.8	0.79	—	14.0	58.9	4.3	16.5	0.85/1
Company B[b]	4.7	0.88	0.66	10.6	59.4	4.4	26.5	0.40/1
Company C-1[c]	5.9	0.51	—	10.9	53.3	6.6	26.5	0.41/1
Company C-2	5.9	0.29	0.69	11.4	59.3	4.4	20.5	0.56/1
Company D	6.1	0.27	0.82	18.5	48.3	5.2	21.7	0.85/1
Company E	6.1	0.25	0.86	27.3	42.2	6.2	22.2	1.23/1
Company F	6.4	0.17	0.92	34.7	37.6	3.7	19.2	1.81/1
Company G	5.4	0.45	0.87	29.0	35.6	5.6	25.5	1.14/1
Company H-1	5.2	0.57	0.83	38.7	14.6	6.8	22.9	1.69/1
Company H-2	4.7	1.02	0.88	49.1	18.8	5.8	21.8	2.25/1
Experimental-1	5.6	0.80	0.70	18.1	19.7	7.1	52.4	0.35/1
Experimental-2	5.6	0.72	0.69	16.4	37.1	5.9	40.4	0.41/1
Experimental-3	5.7	0.52	0.69	15.3	44.1	5.0	33.2	0.46/1

[a]Acidity was expressed as percent lactic acid.
[b]A lactic acid starter culture was listed on the manufacturer's label.
[c]This product contained soy protein.

TABLE 2. *Numbers and types of viable microorganisms present in commercial and experimental snack sausages.*

Commercial	Numbers/g found on				Major bacterial types found on			
	APT[a]	ROG[a]	EMB[a]	MSA[a]	APT	ROG	EMB	MSA
Company A[b]	2.1×10^4	$<1 \times 10^2$	1.0×10^3	2.3×10^4	1[c]		1	1
Company B[b]	5.4×10^4	1.3×10^5	5.0×10^3	2.3×10^5	4,1	4	3	1
Company C-1	1.5×10^3	4.0×10^2	$<1 \times 10^2$	1.0×10^3	1	4		1
Company C-2	2.0×10^2	$<1 \times 10^2$	$<1 \times 10^2$	$<1 \times 10^2$	1			1
Company D	3.4×10^3	$<1 \times 10^2$	4.0×10^2	2.8×10^3	1		1	1
Company E	1.5×10^2	$<1 \times 10^2$	2.0×10^4	1.0×10^5	2,1		2	2
Company F	2.0×10^2	$<1 \times 10^2$	$<1 \times 10^2$	$<1 \times 10^2$	1			
Company G	9.7×10^3	$<1 \times 10^2$	$<1 \times 10^2$	2.3×10^2	1			1,2
Company H-1	7.0×10^4	$<1 \times 10^2$	2.6×10^4	4.0×10^3	1		1	1
Company H-2	1.3×10^3	$<1 \times 10^2$	9.4×10^3	4.9×10^3	1		1	1
Experimental-1	4.2×10^3	$<1 \times 10^2$	3.7×10^3	3.2×10^3	1		1	1
Experimental-2	2.4×10^3	$<1 \times 10^2$	5.8×10^3	2.8×10^3	1		1	1
Experimental-3	4.7×10^3	$<1 \times 10^2$	2.7×10^3	2.0×10^3	1		1	1

[a](APT) Difco APT agar; (ROG) Difco Rogosa SL agar; (EMB) Difco Eosin Methylene Blue agar; (MSA) Difco Phenol Red Mannitol Salt agar.
[b]A lactic acid starter culture was listed on the manufacturer's label.
[c]1 = Catalase- and gram-positive sporeforming rods; 2 = catalase- and gram-positive cocci; 3 = catalase-positive, gram-negative rods, not typical coliforms; 4 = catalase-negative, gram-positive cocci.

Lactic acid bacteria were detected in only two products: product B (prepared with starter culture, 1.3×10^5/g) and C-1 (4×10^2/g). The small numbers of lactic organisms probably resulted from time-temperature effects of heating which destroyed virtually all the microflora except bacilli.

The fat content of the three experimental snack sausages appeared to have no influence on their bacteriology. The numbers and types of organisms were similar (Table 2). This provides further support for our earlier study (*8*) which indicates that differing fat levels had no influence on thermal destruction of non-pathogenic bacteria in sausages. In addition, we found that differing fat levels had no influence on thermal destruction of salmonellae and staphylococci during processing of snack sausage in our pilot plant (*7*).

To study the influence of fat on yield of product, snack sausages were prepared with initial fat content of 7.2, 18.5, and 25.7%. The yield of these three products was 68.2, 71.6, and 75.1% after the heating/smoking step, and 39.6, 46.1, and 51.4% after the drying step, respectively. Thus, increasing the initial fat content of the sausage mixtures increased the yield of snack sausage. This same relationship had been noted during processing of pepperoni (*5*); when the initial fat level of the pepperoni mix was increased from 13.3 to 25.1%, the yield of pepperoni after drying increased from 48.0 to 58.3%.

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