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Consumer evaluation of cold smoked fat in beef sausages

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Abstract

The two primary methods of infusing smoke flavor into meat products is through natural smoke and liquid smoke with each type comprising of different smoke compounds resulting in differences in organoleptic properties. The different specific smoke compounds absorb differently in water and fat. Limited research has been conducted on smoking fat, and how it alters the organoleptic properties of fat. The objective of this research was to determine if cold smoking fat prior to addition into sausages would generate a smoky flavor that the consumers would accept. The consumers rated cold smoke fat samples the lowest ($P < 0.05$) for like of flavor and overall like with no difference ($P > 0.05$) between the natural smoke and liquid smoke samples. Like of flavor was correlated ($P < 0.05$) to overall like ($r = 0.87$), like of texture ($r = 0.63$), and like of juiciness ($r = 0.53$). There were a greater ($P < 0.05$) percentage of consumers who liked the flavor of the natural smoke (80.8%) and liquid smoke (68.5%) sausages compared to cold smoke fat sausages (49.3%). Consumers who ranked the natural smoke or cold smoke fat treatment the highest for like of flavor did not like the flavor of the other treatments. Whereas, consumers who ranked the liquid smoke treatment the highest for like of flavor where neutral for the flavor of natural smoke treatment, and did not like the flavor of the cold smoke fat treatment.

Introduction

Smoking food has been a food processing method for thousands of years and is frequently used to impart a smoke flavor to meats. Smoke is derived from the thermal decomposition of wood which generates numerous compounds (Fiddler *et al*., 1966; Gilbert and Knowles, 1975; Maga and Chen, 1985; Maga, 1987; Guillén and Ibargoitia, 1996), all of which could contribute to organoleptic properties of smoked meat (Maga, 1987; Kostyra and Barylko-Pikielna, 2006).

Over the past few decades traditional smoking has been replaced by the use of smoke flavorings (Simon *et al*., 2005). However, smoke flavorings, such as liquid smoke, does not contain the same compounds as natural smoke since liquid smoke is filtered to remove toxic and carcinogenic impurities (Pszczola, 1995; Lingbeck *et al*., 2014). The difference in composition between traditional smoke and liquid smoke could alter the organoleptic properties and ultimately consumer preference.

One of the main purposes of smoking meat is to impart a smoke flavor, thus, consideration of the smoke compound types that impact flavor is important. Although the primary contributors in smoke that provide smoke flavor and aroma have not clearly been determined (Maga, 1987), evidence from researchers (Fiddler *et al*., 1966; Bratzler *et al*., 1969; Kornreich and Issenberg, 1972; Fujimaki *et al*., 1974; Korhonen *et al*., 1978; Daun, 1979) demonstrates that phenols are the primary flavor contributors. Thus, increasing phenol content in smoked meats could potentially enhance the smoky flavor of the product. Research has indicated that some phenols are more readily absorbed in lipids compared to water (Doerr and Fiddler, 1970; Issenberg *et al*., 1971). This would indicate that fat on meat products could have greater concentrations of phenols compared to lean tissue which is what was observed by Korhonen *et al*. (1978) in smoked hams.

The method of smoking can also influence phenol content of smoked food products. Cold smoking meat products is a process where the meat is smoked at temperatures typically under 30^{o}C,below the temperature that causes proteins to coagulate, whereas, hot smoking (traditional smoking) is typically done at temperatures above 65^{o}C (FAO, 2012). Research has indicated that cold smoking increases phenol content of smoked products (Maga, 1987), and smoke flavor intensity is positively correlated with fat content in cold smoked salmon

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Table 1. Smokehouse oven cycles for the trial

Natural Smoke Sausages			Liquid Smoke Sausages & Cold Smoke Fat Sausages		
Process Step	Dry Bulb, °C	Time, min.	Process Step	Dry Bulb, °C	Time, min.
Condition	43.3	5	Condition	43.3	5
Pre-Dry	48.9	15	Pre-Dry	48.9	15
Pre-Dry	54.4	15	Pre-Dry	54.4	15
Smoke	60.0	15	No-Smoke	60.0	15
Smoke	62.8	25	No-Smoke	62.8	25
Smoke	68.3	25	No-Smoke	68.3	25
Color Set	71.1	25	Color Set	71.1	25
Finish	79.4	Core 71.1°C	Finish	79.4	Core 71.1°C

(Mørkøre *et al*., 2001).

Therefore, the research objective was to determine if cold smoking fat prior to addition into sausages would generate a smoky flavor that the consumers would accept. The research hypothesis was that cold smoking fat prior to addition into sausages would increase the smoky flavor, due to increased phenol content, which would positively influence consumers' perception of sausage flavor.

Materials and Methods

Vacuum packaged beef briskets (Institutional Meat Purchase Specification item number 120) were purchased for the study to generate fully cooked sausages with different forms of smoke flavor added. The smoke flavor treatments were as follows: 1) natural smoke (hot smoked during cooking), 2) liquid smoke (liquid smoke included as an ingredient), and 3) cold smoke fat (cold smoked fat included as an ingredient).

Sausage production

The external fat was removed from the briskets to generate lean and fat trimmings. The grinding of lean and fat trimmings occurred separately with the grinding process consisting of first grinding with a 9.5 mm plate, followed by mixing, then fine grinding with a 4.8 mm plate. The ground trimmings were utilized to produce three batches of sausage with each batch containing 4.04 kg of fine ground lean trimmings, and 0.50 kg of fine ground fat trimmings. Each batch contained the same proportion of the following ingredients: water, sodium nitrite, sodium erythorbate, sodium phosphate, salt, sugar, nutmeg, white pepper, paprika, garlic powder, ginger and coriander. The liquid smoke batch had 0.0068 kg (1.5% of meat/fat block component) of liquid smoke (Liquid Smoke S-10, Excalibur Seasoning Company, Pekin, Illinois, U.S.A.) mixed into the batch. The 0.50 kg of fine ground fat trimmings for the cold smoke fat batch was cold smoked prior to the addition into the batch. The fine ground fat was placed on metal screens in plastic containers that had ice on the bottom, and a lid on top. A smoke generator (SmokePistol, Outcooker Products, Inc., Coral Springs, Florida, U.S.A.) with hickory pellets (SmokeBullet, Outcooker Products, Inc., Coral Springs, Florida, U.S.A.) was used to force smoke into the container. The fine ground fat was cold smoked for 45 min. All batches were hand mixed, and stuffed into natural hog casings.

Cooking of all sausages occurred in a smokehouse oven (KOCH Grand Prize II, KOCH Supplies, North Kansas City, Missouri, U.S.A.). The cooking cycle for the all sausages was similar (Table 1), and all sausages were cooked to an internal temperature of 71.1°C. All sausages were cooked on the same day, but at two different times. The natural smoke sausages were cooked in the smokehouse oven separately utilizing hickory sawdust for generation of smoke, and the liquid smoke and cold smoke fat sausages were cooked in the smokehouse oven together without any smoke generation.

Consumer taste panel

Seventy three individuals were recruited through advertising on campus to serve as panelists for the consumer taste panel. As consumer panelists arrived at the facility, the fully cooked sausage links were warmed in pots of water with each treatment using a separate pot. The water was brought to a boil, the pot was removed from the heating source, sausage links were added to the pot, and the pot was covered. The sausage links were allowed to rest in the hot water for 7 min. Sausage links were then cut into 1.27 cm pieces with each end being discarded. The panelists were seated into individual booths and were given four samples, one from each treatment and a warm-up sample. The warm-up samples were from the natural smoke batch, and the warm-up sample data was not utilized in the statistical analysis. Sausage samples were placed on styrofoam trays with position number one designated for the warm-up sample, and

Table 2. Least square means of consumer taste panel ratings for smoke flavor treatments

	Natural Smoke	Liquid Smoke	Cold Smoke Fat	SEM	P-value
n	73	73	73		
Overall Like[a]	6.98[z]	6.88[z]	5.69[y]	0.289	< 0.0001
Like of Texture[a]	7.24	7.36	6.69	0.300	0.0812
Like of Juiciness[a]	6.44	6.67	5.97	0.219	0.0732
Like of Flavor[a]	6.91[z]	6.33[z]	5.29[y]	0.299	< 0.0001

[a] 1 = Dislike Extremely; 10 = Like Extremely

[y, z] Within a row, means without a common superscript differ (P < 0.05).

each treatment sample was randomly assigned to positions two through four. Panelists were instructed to consume samples in order (1 - 4) and to take a bite of unsalted cracker and a drink of apple juice before each sample. Panelists were asked to rate each sample for overall like, like of texture, like of juiciness, and like of flavor on a 10-point scale (1 = dislike extremely to 10 = like extremely).

Statistical analysis

The initial analysis of the consumer taste panel data occurred using Mixed Model procedure of SAS (SAS Inst. Inc., Cary, North Carolina, U.S.A.) with treatment as a fixed effect and panelist as a random effect. Least square means were separated using PDIFF option with differences detected at the P < 0.05 level. Correlations between overall like, like of texture, like of juiciness, and like of flavor were analyzed using CORR procedures of SAS. To determine the percentage of consumers who generally like the flavor of the sausage (like of flavor scores from 6 to 10), Chi Square procedures of SAS was utilized, and statistical differences were determined using the t-test procedure of SAS.

To determine if the consumer's preference for one treatment was related to one of the other treatments, the following analysis occurred. Consumer taste panel data was categorized based on which treatment each panelist scored the highest for like of flavor. If panelists had identical highest score for like of flavor for two samples, that individual's data was removed. A z-score was calculated for each individual's response to compare their ratings to the average rating for each treatment. The z-score was calculated using the following equation: $z = (x - \mu) \div \sigma$, where x was the individual observation, μ is the mean of the population tested, and σ is the standard deviation of the population tested. The z-score data was analyzed using Mixed Model procedure of SAS with treatment, high score category, and treatment x high score category as fixed effects, and panelists as a random effect. Least square means were separated using PDIFF option with differences detected at the P < 0.05 level.

Results and Discussion

The consumers rated the cold smoke fat samples the lowest (P < 0.05) for like of flavor and overall like with no difference (P > 0.05) between the natural smoke and liquid smoke samples (Table 2). The sausage attributes of texture and juiciness tended (P < 0.10) to be influenced by treatment. The cold smoke fat samples tended to have the lowest ratings for like of texture (P = 0.08) compared to the natural and liquid smoke samples, and tended to have lower (P = 0.07) like of juiciness ratings compared to liquid smoke samples. Previous research (Moskowitz and Krieger, 1995) has indicated that liking ratings for different sensory attributes are highly correlated to each other. Beilken *et al*. (1990) evaluated various frankfurters and reported that juiciness was positively correlated with flavor intensity (r = 0.76), and flavor was highly related to smokiness (r = 0.83). Similar results were seen in the current study with the like of flavor being correlated (P < 0.05) to overall like (r = 0.87), like of texture (r = 0.63), and like of juiciness (r = 0.53). Furthermore, like of texture was correlated (P < 0.05) to overall like (r = 0.68) and like of juiciness (r = 0.68), while like of juiciness was correlated (P < 0.05) to overall like (r = 0.58). Considering that liking ratings tend to be correlated to each other, emphasis on treatment affects on flavor maybe the most beneficial as consumer satisfaction is driven by taste in processed pork (Resano *et al*., 2011), and beef (Igo *et al*., 2013). However, research has indicated that liquid smoke can alter texture and juiciness of a product. Martinez *et al*. (2004) evaluated two liquid smoke products with different quantities of phenolic compounds and carbonyl derivatives and reported that the liquid smoke products influenced texture differently in both pork loins and bacon. Sink and Hsu (1979) reported that phenol content influenced the softness of frankfurters while Maga (1988) reported that phenolic derivatives influence the water holding capacity of meat. However, Morey *et al.* (2012) reported that liquid smoke levels of 0, 2.5, 5, and 10% did not affect texture or juiciness of chicken-pork frankfurters. In the current study, there may not have been a large enough difference in smoke compounds between the treatments to

Table 3. The percentage of consumers who rated treatment samples in the like and dislike category[a]

	Natural Smoke (N)	Liquid Smoke (L)	Cold Smoke Fat (F)	N vs. L	N vs. F	L vs. F
n	73	73	73			
Like of Flavor						
Rating = 6, %	80.8	68.5	49.3	0.0880	< 0.0001	0.0184
Rating = 5, %	19.2	31.5	50.7			
Overall Like						
Rating = 6, %	82.2	74.0	52.0	0.2329	< 0.0001	0.0059
Rating = 5, %	17.8	26.0	48.0			

[a] 10-point scale: 1 = dislike extremely; 5 = dislike some; 6 = like some; 10 = like extremely

Table 4. Z-scorea least square means for treatment categorized by consumer's treatment preference for like of flavor.

Treatment /	Natural Smoke (N)			Liquid Smoke (L)			Cold Smoke Fat (F)			
Highest Flavor Score	N	L	F	N	L	F	N	L	F	P-value
n	27	20	12	27	20	12	27	20	12	
Z-score[a]										
Like of Flavor	0.93^{y}	0.04^{x}	-0.23^{wx}	-0.32^{wx}	0.95^{y}	-0.34^{wx}	-0.66^{w}	-0.56^{w}	0.66^{y}	< 0.001
Overall Like	0.70^{z}	0.16^{y}	0.07^{xy}	-0.11^{xy}	1.13^{z}	-0.09^{xy}	-0.67^{w}	-0.49^{wx}	0.84^{z}	< 0.001
Like of Texture	0.55^{y}	-0.06^{wx}	-0.38^{w}	-0.10^{wx}	0.71^{y}	0.13^{wxy}	-0.20^{w}	-0.46^{w}	0.47^{xy}	< 0.001
Like of Juiciness	0.29^{xyz}	-0.21^{wx}	-0.05^{wxy}	-0.19^{wx}	0.77^{z}	-0.05^{wxy}	-0.46^{w}	-0.39^{w}	0.64^{yz}	< 0.001

[a] Z-score = $(x - \mu) \div \sigma$

[w, x, y, z] Within a row, means without a common superscript differ (P < 0.05).

influence texture and juiciness at a level noticeable for the consumer.

Although the cold smoke fat treatment had the lowest mean score for like of flavor (Table 2), there were consumers who liked the flavor of the cold smoke fat treatment. When evaluating the range in ratings (1 = dislike extremely; 10 = like extremely), the cold smoke fat treatment had a range from 1 to 10, and both the natural smoke and liquid smoke treatments had a range from 2 to 10. Given that the 10-point hedonic scale eliminates the neutral category, a score of five would indicate that the consumer disliked the sample while a score of six would indicate that the consumer liked the sample. The results indicate that 49.3% of the consumers liked the cold smoke fat treatment (Table 3). However, there were a greater (P < 0.05) percentage of consumers who liked the flavor of the natural smoke and liquid smoke sausages compared to the cold smoke fat sausages (Table 3).

Evaluation of how consumer's preference for one treatment influenced their scores of the other treatments is found in Table 4. The consumers who ranked the natural smoke treatment the highest for like of flavor (z-score = 0.93) did not like the flavor of the other treatments as indicated by negative z-scores (-0.32 and -0.66) for liquid smoke and cold smoke fat, respectively (Table 4), with the natural smoke z-score being greater (P < 0.05) than the z-scores for the other treatments. Similarly, the consumers who ranked the cold smoke fat treatment the highest for like of flavor (z-score = 0.66) did not like the flavor of the other treatments as indicated by negative z-scores (-0.23 and -0.34) for natural smoke and liquid smoke, respectively, with the cold smoke fat z-score being greater (P < 0.05) than the z-scores for the other treatments. However, the consumers who ranked the liquid smoke treatment the highest for like of flavor (z-score = 0.95) where neutral for the like of flavor of the natural smoke samples (z-score = 0.04), and disliked the flavor of the cold smoke fat samples (z-score = -0.56) with all z-scores differing statistically (P < 0.05).

Conclusion

The data indicates that the type of smoke flavor application is dependent upon the consumer's preference, because there was a group of consumers who liked each treatment. However, the majority of the consumers liked the flavor of either natural or liquid smoke sausages.

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