

Physical, Sensory, and Microbial Attributes of Reduced-Sodium All-Beef Frankfurters

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Introduction

The average daily intake of sodium in the American diet is 3,400 mg and exceeds the recommended intake of 2,300 mg. As a contemporary trend, there is an increasing demand from consumers for processed meats with reduced sodium levels. However, salt is an important element in meat products and affects many aspects related to microbial stability, flavor, water holding capacity, texture and taste of processed meat products. It will therefore be challenging to reduce the sodium content of processed meats while still maintaining their physical, sensory and microbial attributes.

Objective

To evaluate the physical, sensory, and microbial properties of reduced-sodium frankfurters through a texture profile analysis, sensory evaluation, and total microbial count in order to gauge the success of various approaches of reducing sodium in frankfurters safely while still maintaining their quality traits.

Material and Methods

The three sodium substitute ingredients investigated in this study included potassium chloride (KCl), natural flavor enhancer (NFE) modified soy sauce, and a KCl/potassium citrate (PC) blend. The ingredients were incorporated into beef frankfurter formulations (50% 90 lean/10 fat + 50% 50/50) to result in a 30% sodium reduction. After manufacture, treatments were evaluated for proximate moisture, pH, cook yield, texture, internal color, total plate count, and consumer sensory properties.

Formulation	*TRTs	NaCl	Salt Replacers
90/10 Beef Trim	50.00 %	C+	100%
50/50 Beef Trim	50.00 %	C-	70%
Water/Ice (50/50 mix)	20.00 %	TRT-1	50% 50% SoMinus PCM*
Salt	2.50 %	TRT-2	70% 30% KCl*
Salt Replacer	0.00 %	TRT-3	55% 15% NFE* + 15% KCl
Salt Free Seasoning***	1.74 %	TRT-4	40% 30% NFE
Sodium Phosphates	0.40 %		
Sodium Erythorbate	547 ppm		
Curing Salt (6.25% nitrite)	156 ppm		

* TRT: treatment, C+: positive control, C-: negative control, SoMinus PCM (Van Hees Inc., Cary, NC), salt reduction system, KCl KaliSel (Morton Salt Inc., Chicago, IL), NFE (Natural Flavor Enhancer) (22.5% NaCl, Kikkoman USA, Walworth, WI)



Samples Analyses

Moisture content: Oven drying method (AOAC, 2000a)

Color Measurements. Using a Minolta Chromameter (Model CR-300, Minolta Camera Co., Ltd., Osaka, Japan; 1 cm aperture, illuminant C, 2° observer angle)

PH Measurements. Sebranek et al. (2001)

Cook Yield = (cooked weight / raw weight) x 100

Texture profile analysis: Methods described by Wenther (2003)

Sensory Analysis: Consumer acceptance test with 100 panelists at the University of Wisconsin-Stout Sensory Analysis Laboratory.

Total Plate Count: AOAC (2000b).

Data Analysis: Randomized complete block using a mixed effects model. SAS (version 9.3, SAS Institute Inc., Cary, NC). Tukey-Kramer pairwise comparison (P<0.05)

Results

Table 1. Least square means for moisture content, pH 24 hours after manufacture and four months after, and cooking yield for emulsified ready-to-eat frankfurters

TRTs	Moisture Content %	pH 24Hrs after manufacture	pH 4 months after manufacture	Cooking Yield %
C-	55.83 ^c	6.28 ^b	6.28 ^b	88.09 ^a
C+	56.39 ^{bc}	6.22 ^{cd}	6.20 ^{cd}	89.48 ^a
TRT-1	55.87 ^c	6.35 ^a	6.35 ^a	88.82 ^a
TRT-2	59.84 ^{ab}	6.24 ^c	6.24 ^{bc}	88.58 ^a
TRT-3	61.01 ^a	6.21 ^d	6.21 ^{cd}	88.57 ^a
TRT-4	58.44 ^{abc}	6.18 ^e	6.18 ^d	88.88 ^a

Table 2. Least square means for objective internal color measurements, for emulsified ready-to-eat frankfurters. (L: lightness, a*: redness, and b*: yellowness)

TRTs	L	a*	b*
C-	64.57 ^b	17.03 ^a	9.25 ^c
C+	64.95 ^{ab}	16.85 ^a	9.18 ^c
TRT-1	65.35 ^{ab}	16.88 ^a	9.15 ^c
TRT-2	65.82 ^a	16.93 ^a	9.52 ^{bc}
TRT-3	65.76 ^a	16.70 ^a	9.90 ^b
TRT-4	64.70 ^{ab}	16.66 ^a	10.59 ^a

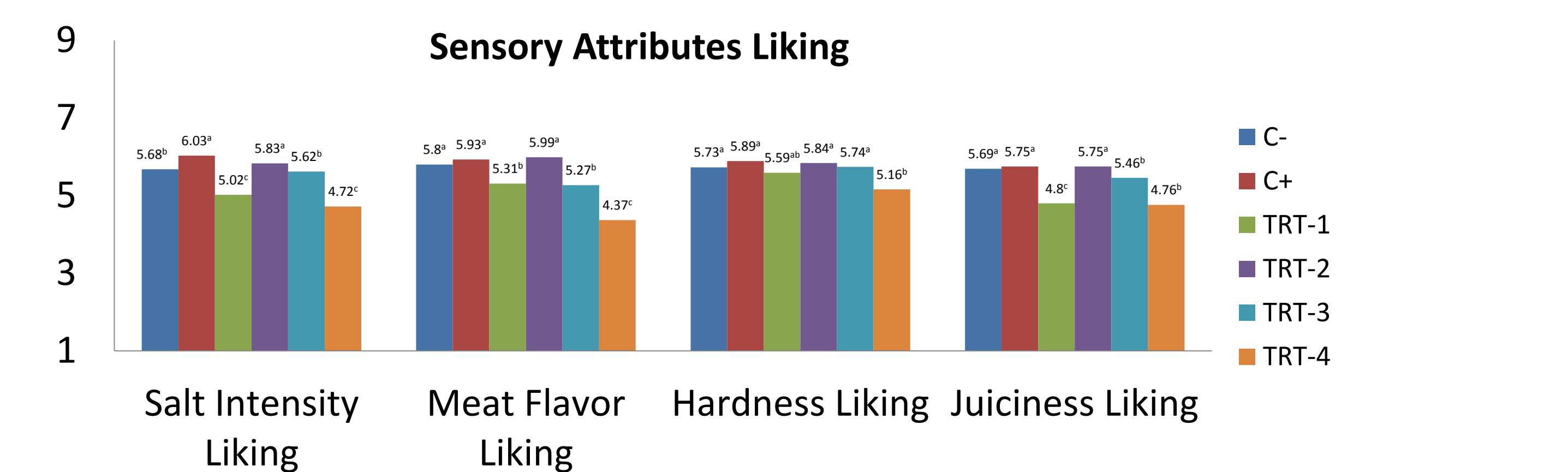
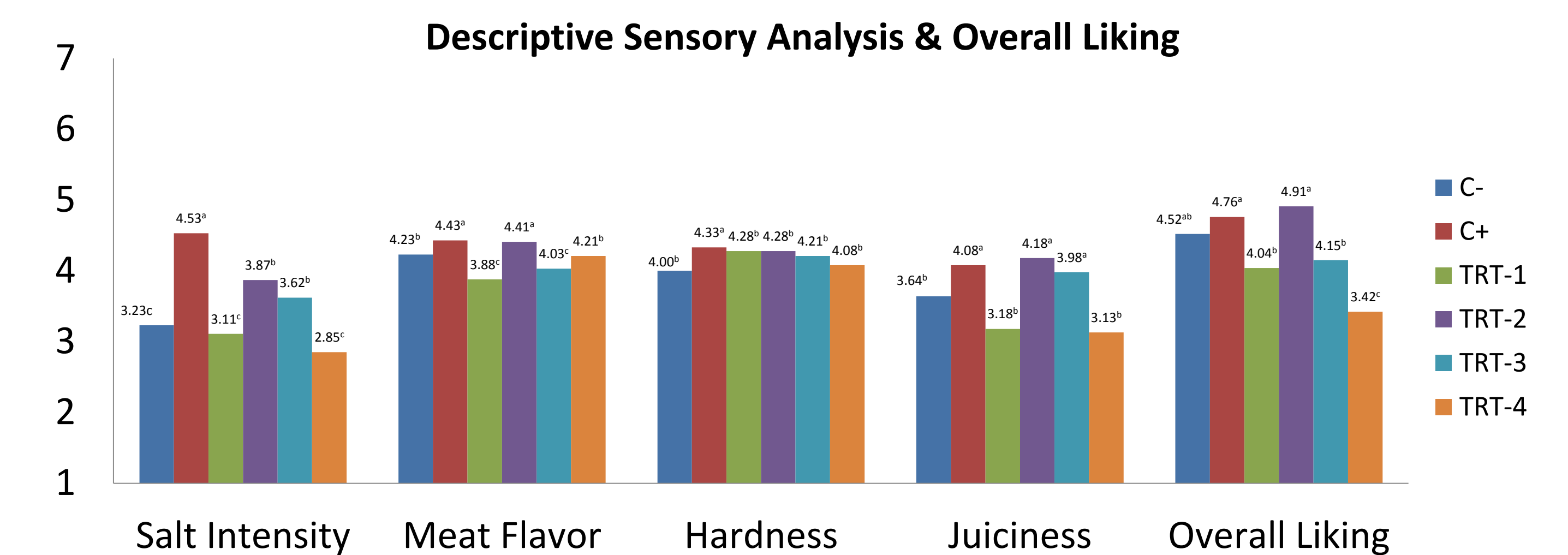
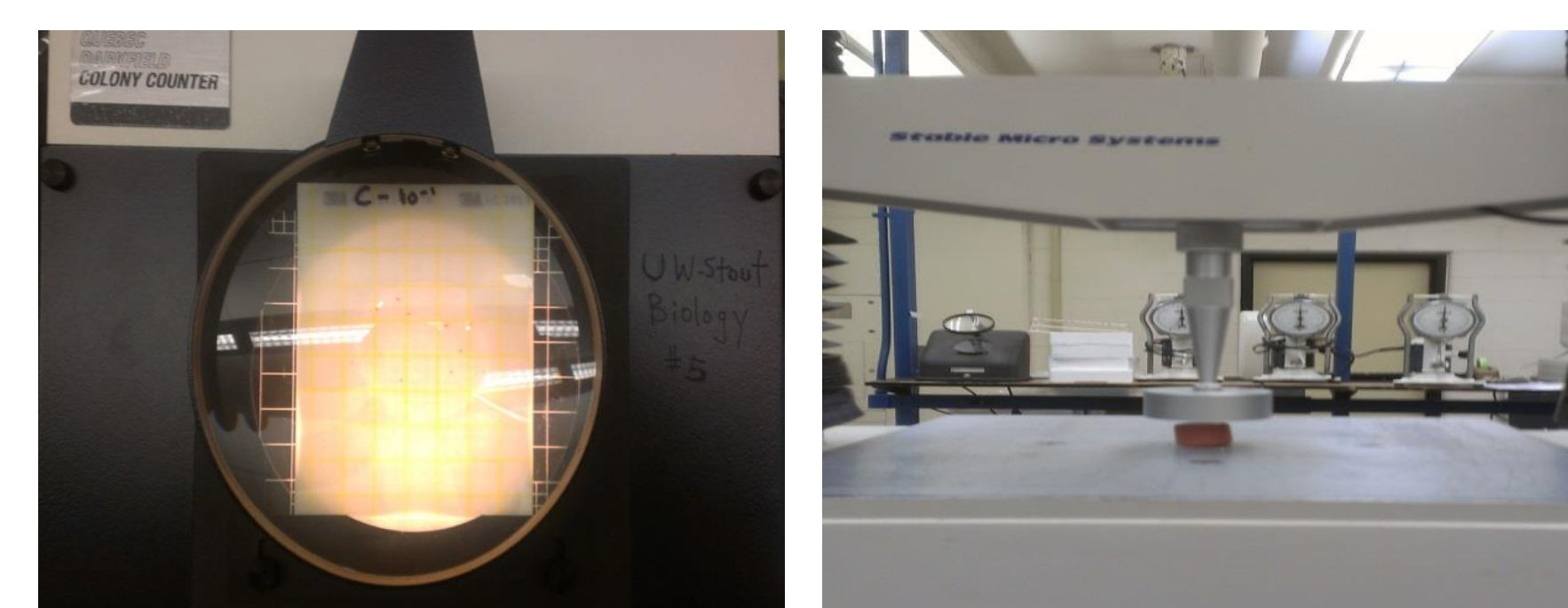


Table 3. Least square means for hardness, cohesiveness, springiness, and chewiness of emulsified frankfurters.

TRTs	Hardness (N)	Cohesiveness (%)	Springiness (mm)	Chewiness (N*mm)
C-	92.3 ^a	60.0 ^a	11.22 ^a	620.19 ^{ab}
C+	92.0 ^a	58.5 ^b	11.15 ^{ab}	600.15 ^b
TRT-1	94.7 ^a	58.5 ^b	11.16 ^{ab}	614.30 ^{ab}
TRT-2	95.7 ^a	59.5 ^{ab}	11.19 ^a	640.67 ^a
TRT-3	92.9 ^a	59.9 ^{ab}	11.13 ^{ab}	619.66 ^{ab}
TRT-4	94.9 ^a	59.2 ^{ab}	10.97 ^b	613.35 ^{ab}

Table 4. Least square means CFUs/g of emulsified frankfurters.

TRTs	CFUs/g
C-	1933 ^a
C+	133 ^b
TRT-1	467 ^b
TRT-2	667 ^b
TRT-3	200 ^b
TRT-4	333 ^b



- Minimal texture differences were observed among all treatments.
- The negative control had the highest (p<0.05) microbial count (2,000 CFU/g) after 30 days of storage.
- All other treatments showed minimal (<1000 CFU/g) microbial growth.
- Starting with a pH of 5.8 for raw beef, the final products' pH values ranged from 6.18 to 6.35 for all treatments.
- All treatments had high cook yields with no significant differences.
- The negative control had the lowest moisture content (55.83%), while the KCl + NFE treatment showed the highest (61%).
- Sensory evaluation displayed comparable results with a tendency against TRT-4 (30% NFE).

Conclusions

- All TRTs were comparable in terms of moisture content, internal color, pH, texture and cook yield values.
- NFE containing TRT-4 scored the lowest for most of the attributes and was the least probable to be purchased.
- Salt reduction did not greatly influence the growth of the spoilage organisms
- 30% sodium reduction can be achieved either by partial substitution or without (C-) and yet still maintain the quality attributes and acceptability of frankfurters.**

References

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