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CHARACTERISTICS OF LOW-FAT, HIGH ADDED-WATER FRANKFURTERS MANUFACTURED WITH PREBLENDS OF CONNECTIVE TISSUE AND ALKALINE PHOSPHATE

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BACKGROUND

Modified connective tissue (MCT) has been successfully incorporated into low-fat, high added-water (AW) processed meats as a means of water control and textural improvement. Certain phosphates are also known to improve water retention in meat products. The functionality of MCT was improved by preblending with a concentrated amount of sodium tripolyphosphate (STP; Eilert et al., 1994a).

OBJECTIVE

The objective of this study was to evaluate the characteristics of low-fat/AW and high fat (control) frankfurters manufactured with MCT/STP preblends. The hypothesis was that preblending MCT with STP would alter MCT characteristics which would improve the quality of the final product.

MATERIALS AND METHODS

The experimental design was a randomized complete block design replicated three times. Frankfurters were formulated at two USDA fat/added water levels: 30% fat/10% AW and 10% fat/25% AW. Each formulation was manufactured according to one of three MCT treatments: no phosphate, no MCT (CONT); phosphate and MCT added as separate ingredients (PCT); phosphate and MCT added as a preblend (PCTPB). Sodium tripolyphosphate (BK-STP, pH 10, BK Ladenburg Gmbh, Ladenburg, Germany) was incorporated into designated treatments.

Fresh beef connective tissue was frozen and flaked to a powder-like form. Preblends for the PCTPB treatments were prepared 18 h prior to frankfurter manufacture to facilitate production since Eilert et al. (1994a) found time after preblending did not effect results. A 3% phosphate solution was mixed then added in a 1:1 ratio with the beef MCT (20% of meat block) in a small, table-top bowl chopper. Phosphate addition did not exceed 0.5% in the finished product. Frankfurter batter was prepared in a bowl chopper, passed through an emulsion mill, stuffed, thermally processed to 70°C, and frankfurters vacuum packaged to be held for further testing.

Raw batter stability was determined according to the method of Townsend et al. (1968) which requires incremental heating of the batter in tubes, then decanting the losses for measurement. Frankfurter pH, proximate analysis and smokehouse yield was collected. Collagen solubility was determined by a modified hydroxyproline assay (Eilert et al., 1994b). Loss due to purge was measured after 42 days of storage.

A two-cycle Instron compression test was used to determine hardness (N/g), chewiness (N·m/g), cohesiveness (unitless ratio) and springiness (mm). Hunter color measurements were taken externally and internally on days 1, 15 and 30 of storage. The L*, a* and 650 nm/570 nm cured color reflectance ratios were recorded. A consumer acceptance panel was conducted to evaluate the attributes of flavor, texture and overall acceptability on an 8-point hedonic scale (8=like extremely; 1=dislike extremely).

RESULTS AND DISCUSSION

Moisture, protein and ash were significantly higher and fat lower in 10% fat/25% AW versus 30% fat/10% AW formulations (Table 1). No treatment differences were noted for moisture, fat or protein. The USDA added water values (Table 1) were close to the target formulations: 23.08% AW in the 30% fat/10% AW formulas and 11.15% AW in the 10 % fat/25% AW formulas.

Total collagen in the PCT and PCTPB frankfurters was greater than CONT ($P<0.01$), but preblending with the alkaline phosphate did not solubilize more collagen ($P>0.05$; Table 1). Eilert et al. (1994a) reported no difference in collagen solubility due to preblending MCT with an alkaline phosphate, yet, when they preblended with specially processed acidic phosphate, collagen solubility increased.

Emulsion stability fluid or gel loss did not differ due to formulation (Table 1). Fat loss was significantly lower for the 10% fat/25% AW formulations than the 30% fat/10% AW. Fluid and gel loss were significantly greater for PCTPB treatments ($P<0.01$) than the PCT treatments. Eilert et al. (1994a) reported increased water uptake and cook yields in preblends of MCT and STP. The inability of the (PCTPB) treatments to maintain fluid and gel during cooking may be explained by phosphate being isolated with MCT before addition to the emulsion. It may be bound to myofibrillar proteins of the MCT or hydrolyzed to orthophosphate, therefore, unavailable to influence the myofibrillar proteins of the meat batter to which the preblend is added. Addition of STP with MCT appears to control loss in emulsion stability.

Treatment did not affect smokehouse yield ($P>0.05$; Table 1). Alkaline phosphate would have been expected to improve smokehouse yields by moving pH away from the isoelectric point. The pH was higher ($P<0.05$) for phosphate-containing treatments versus CONT. Smokehouse yield was significantly higher ($P<0.01$) for the 30% fat/10% AW than 10% fat/25% AW formulas. Purge loss after 42 days of storage was not different ($P>0.05$) between treatments and did not exceed 1.01% (Table 1). The 10% fat/25% AW formulas had significantly higher purge loss ($P<0.01$) than the 30% fat/10% AW formulas.

Instron compression hardness was not affected by formulation or treatment ($P>0.05$). Cohesiveness was greater for the 10% fat/25% AW formulations but was not affected by treatment. Chewiness was lower for PCT and PCTPB compared to CONT. Springiness displayed a formulation by treatment interaction. Treatments at the 10% fat/25% AW level were not different, but springiness at the 30% fat/10% AW level decreased significantly in PCT and PCTPB, compared to the CONT. Preblending had no effect on any of the compression attributes. These minimal texture differences emphasize that 20% of meat block can be replaced by MCT without any detrimental effects to quality.

The 30% fat/10% AW formulations displayed lighter surfaces and interiors after phosphate and MCT addition; preblending further increased L* values. The effect of phosphate/MCT treatment on exterior and interior L* values was minimal in the 10% fat/25% AW formulas. Exteriors of the 10% fat/25% AW formulations were more red compared to the 30% fat/10% AW formulas. Exterior and interior redness was lower for PCT and PCTPB treatments compared to CONT and preblending had no effect on the 10% fat/25% AW formulations. Interior a* values increased during days of storage. The 650nm/570nm color ratio was generally higher for the 30% fat/10% AW formulas versus the 10% fat/25% AW formulas (P<0.01). Addition of MCT and phosphate decreased cured color intensity, but cured color improved during storage (P<0.01). Treatment effects were more pronounced in the 30% fat/10% AW formulas.

Consumer panelists did not detect flavor or texture differences due to the addition of phosphate and MCT or due to preblending of these ingredients. These treatments also did not affect overall acceptability. Texture and overall acceptability were significantly lower (P<0.01) for the 10% fat/25% AW products versus the 30% fat/10% AW products. When averaged over fat/AW formula, all products rated higher than 4.5 on an 8 point hedonic scale.

CONCLUSIONS

Preblending of MCT with a concentrated amount of alkaline phosphate provided few advantages to frankfurter quality. Phosphate and MCT added separately or as a preblend to frankfurter batter did not affect yield or purge. Preblending of phosphate and MCT increased emulsion stability fluid and gel loss. Cured color intensity was hindered by MCT and alkaline phosphate addition, but improved over time. Presence of these ingredients were not detectable by sensory panelists which allows utilization of MCT, a by-product of desinewing operations, in low-fat/AW and control formulations. The color issues require further investigation as well as application of MCT/phosphate preblending to other products. The benefits of preblending, while not synergistic in this study, may be product, phosphate type and phosphate concentration specific. Preblending may affect the availability of phosphate to act upon the myofibrillar proteins in the final meat batter. Alteration of MCT due to preblending may have occurred in some cases, but the effects became diluted and undetectable in the final product.

PERTINENT LITERATURE

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TABLE 1.
PROXIMATE COMPOSITION, COLLAGEN VALUES, EMULSION STABILITY SMOKEHOUSE YIELD, pH, AND PURGE LOSS

Variable	Units	Fat/AW 30/10	Fat/AW 10/25	S.E.	Treatment[2] CONT	PCT	PCTPB	S.E.
Fat	%	25.58*	11.24	0.29	18.52	18.08	18.63	0.35
Moisture	%	59.33*	72.94	0.19	65.90	66.37	66.14	0.24
Protein	%	12.05*	12.46	0.07	12.39	12.26	12.11	0.09
Ash	%	3.23*	3.46	0.06	3.19[a]	3.55[b]	3.30[a]	0.07
AW		11.15*	23.08	0.03	16.33	17.32	17.39	0.39
Soluble collagen	mg/g	2.01*	1.24	0.10	0.86[a]	2.00[b]	2.02[b]	0.13
Insoluble collagen	mg/g	19.49*	14.08	0.34	9.97[a]	20.73[b]	19.66[b]	0.41
Total collagen	mg/g	21.50*	15.33	0.38	10.83[a]	22.72[b]	21.68[b]	0.47
Emulsion Stability								
- Fluid loss	ml/100g	9.03	10.05	1.03	6.76[a]	8.10[a]	13.78[b]	1.26
- Gel loss	ml/100g	7.59	9.10	0.97	5.90[a]	6.84[a]	12.31[b]	1.19
- Fat loss	ml/100g	1.44*	0.94	0.05	0.86	1.25	1.47	0.19
Smokehouse yield	%	86.31*	78.62	0.43	82.41	82.12	82.86	0.52
pH		6.24*	6.21	0.01	6.09[a]	6.29[b]	6.30[b]	0.01
Purge loss	%	0.48*	1.39	0.10	0.93	1.01	0.87	0.12

[1] CONT = no phosphate, no MCT; PCT = phosphate, MCT, added separately; PCTPB = phosphate, MCT, preblended

[a,b] Mean values in a row within Treatment followed by different letters are significantly different (P< 0.05)

* Means within fat/AW level are significantly different (P<0.05)