

Technological characteristics of turkey breast rolls produced with fresh or thawed meat and different formulations

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Abbreviated title: Quality of turkey breast rolls

Summary

A study was conducted to evaluate the quality traits of turkey breast rolls prepared with fresh or thawed meat according to four product formulations. Turkey rolls (n=12/type of meat/formulation) were prepared by mixing grounded turkey breast meat (fresh or thawed) with a marinating solution prepared with equal amounts and types of water and non-meat ingredients except for one single functional ingredient: i) STPP: sodium tripolyphosphate (control group); ii) YEAST: yeast extract; iii) CARR: carrageenan; iv) COM: commercial mix containing sodium citrate, sodium carbonate, dextrose, and yeast extract.

In respect with fresh meat, thawed meat determined higher cooking loss and purge loss as well as higher product firmness (higher AK-shear value, gel strength and Texture Profile Analysis parameters). As for functional ingredients, STPP and COM determined a lower fluid losses assessed by filter paper press method and purge loss as well as a superior product firmness in respect with YEAST and CARR. COM determined a darker colour in respect with STPP, CARR and YEAST (L^* : 72.2 vs. 74.8 vs. 76.6 vs. 76.9, respectively; $P < 0.01$). Overall, this study indicated that both the type of meat and functional ingredients can dramatically influence processing yield and quality characteristics of turkey rolls. Frozen breast meat could be profitably used for restructured poultry products because of the firmer

texture. However, lower process yield and lower water holding capacity should be taken into account as possible drawbacks.

Keywords: turkey breast rolls, fresh meat, thawed meat, functional ingredients, quality traits

Introduction

The consumption of poultry furthered processed products has increased dramatically over the last decades. Today, besides nuggets and patties which are some of the most popular convenience poultry items available, many types of marinated products and fully cooked ready to eat injected whole muscle or restructured poultry meat products have been developed and successfully put on the market (Fletcher, 2004). Among these, turkey rolls are very popular items which are mainly sold as pre-sliced ready to use products. The many factors which can determine the final quality of turkey rolls can be grouped into three main categories: i) type and quality of employed raw materials (i.e. whole breasts vs. breast trimmings vs. chopped or grinded meat; fresh vs. frozen meat; etc.); ii) level of brine injection (i.e. 15% wt/wt) and brine formulation (non-meat ingredients); iii) processing variables (i.e. injection vs. tumbling vs. mixing; cooking method; etc.) (Barbut, 2002). Injection of different types of salts (i.e. sodium chloride, sodium tripolyphosphate, sodium citrate, etc.) into meat cuts is commonly practised to enhance the tenderness and juiciness of fresh meat products (Alvarado and McKee, 2007). In general, the addition of sodium chloride at the meat causes transverse expansion of the myofibrils due to increased ionic strength of the media, electrostatic repulsion and partially solubilization of proteins, which together promote uptake of water (Offer and Trinick, 1983). Moreover, addition of phosphates such as sodium tripolyphosphate increases water holding capacity due to protein extraction and shifting of the pH from the isoelectric point of the muscle's proteins (Barbut, 2002). Other ingredients have been purposed to replace phosphates in meat products due to their negative nutritional drawbacks. Sodium carbonate and bicarbonate are known to be superior marinating agents, which reduce drip loss and shear force and improve the yield of enhanced meat (Bertram *et al.*, 2008; Bianchi *et al.*, 2009). Carrageenan are very popular hydrocolloids extracted from red seaweed. The three main types of carrageenan are kappa (gelling), iota (gelling), and lambda (non-gelling). The most important characteristic of carrageenan is the ability to react with proteins to improve yield, texture, and sliceability in processed meat products. When raw material is heated, carrageenans solubilise forming a gel at 50 to

60°C. To maximize functionality, kappa-type carrageenan should be mixed with iota carrageenan to avoid syneresis (Daigle *et al.*, 2005). The unique combination of the raw meat characteristics, formulation and processing conditions can yield very different quality characteristics in the final product, having an impact on processing yields, product appearance, texture and sensory properties.

The aim of this study was to compare quality traits of turkey breast rolls prepared with fresh or thawed meat according to four product formulations.

Materials and methods

A batch of turkey breast meat was obtained at 24h *post mortem* from a flock of birds (BUT-Big6, males) reared and slaughtered under commercial conditions. The meat was roughly grinded and further processed into separate sessions to prepare a total of 96 turkey rolls. In order to study the effect of type of meat (fresh vs. thawed), in the first session one group was immediately used as fresh, whereas the other group was frozen and stored at -20°C for one month before thawing and further processing by following the same procedures.

In each session, 48 turkey rolls (n=12/formulation) were prepared according 4 different formulations by mixing (under vacuum) grounded turkey breast meat (68%) with a marinating solution containing equal amounts of water (15%) and non-meat ingredients (17%; including: egg albumen, starch, sodium chloride, sucrose, sodium ascorbate, sodium nitrite and flavours) except for one single functional additive: i) STPP: sodium tripolyphosphate (0.3%) (control group); ii) YEAST: yeast extract (0.6%); iii) CARR: kappa/iota carrageenan (0.3%); iv) COM: commercial mix containing sodium citrate, sodium carbonate, dextrose, and yeast extract (0.8%). Cooking loss (%) was determined by cooking the rolls under commercial conditions. Samples from each roll were subsequently obtained and used for analyses. Filter paper press (FPP) was determined using a modification of the method purposed by Hoffman *et al.* (1982) for raw meat. Briefly, turkey roll samples of 4.5 × 1.0 × 0.2 cm (length × width × thickness) were placed on a pre-weighed filter paper (Whatman #1 grade) and subsequently pressed for 5 min between 2 plexiglass plates, by using a load of 1 kg and FPP (%) was calculated as the weight loss based on initial weight. Purge loss (%) was determined after storing for 7 days at 4°C a 0.5 cm thick turkey roll slice packaged under vacuum (99.9%). Moreover, moisture (%) (AOAC, 1990), pH

(Jeacocke, 1977), and colour (CIELAB, 1976; lightness, L^* ; redness, a^* ; yellowness, b^* ; by Minolta CR-400) were determined. Finally, textural product characteristics of turkey rolls were evaluated using a Texture Analyser (TA.XT2, Stable Micro Systems) by assessing: i) Allo-Kramer shear values (kg/g; Papinaho & Fletcher, 1996); ii) gel strength (kg \times cm), using a 5 mm stainless steel spherical probe and a 5 kg load cell; iii) texture profile analyses (TPA). The TPA parameters were determined on core samples (3 cm diameter, 2 cm height) axially compressed (50 kg load cell; crosshead test speed 1 mm/s) to 50% of their initial height in a double compression cycle: hardness (kg, maximum force required to compress the sample), cohesiveness (A_2/A_1 , extent to which the sample could be deformed prior to rupture, where A_1 represents the total energy required for the first compression and A_2 the total energy required for the second compression), springiness (D_2/D_1 , the ability of sample to recover its original form after the deforming force is removed where D_1 represents the initial compression distance and D_2 the distance detected for the second compression), gumminess (hardness \times cohesiveness, the force needed to disintegrate a semisolid sample to a steady state of swallowing), chewiness (springiness \times gumminess, the work needed to chew a solid sample to a steady state of swallowing).

Data were analysed by two-way ANOVA (2×4 factorial design; GLM/SAS procedure) to test the effect of type of meat (fresh and thawed) and type of formulation (STPP, YEAST, CARR and COM) and their interaction on meat quality traits. Means were separated by Duncan's test.

Results and discussion

In Table 1 the influence of type of meat and type of formulation on quality characteristics of turkey rolls is reported. As regard to the type of meat, compared to fresh meat, the use of thawed meat determined a higher cooking loss (10.9 vs. 10.7%; $P < 0.01$) of turkey rolls as well as a higher purge loss (6.13 vs. 5.43%; $P < 0.01$) whereas the FPP was not influenced by the type of meat. Furthermore, turkey rolls prepared with thawed meat exhibited a higher pH (6.43 vs. 6.25; $P < 0.01$) and a darker colour in respect with those obtained with fresh meat (L^* : 75.3 vs. 75.0; $P < 0.01$). However, these colour differences are quite low in term of absolute values thus of relatively little practical or industry importance. As for product texture, the use of thawed meat produced a higher firmness of turkey rolls as indicated by the higher AK-shear value, gel strength and some TPA parameters (hardness and gumminess). The negative effects of

freezing/thawing on meat water holding capacity are well known and mainly related to the consequent damages occurring in muscle microstructure and cell walls determined by the water crystals formed during freezing and subsequent storing (James and James, 2002). The results obtained in this study on turkey rolls are consistent with those obtained by Pietrasik & Janz (2009) who reported that freezing and subsequent thawing of marinated beef was detrimental to water binding properties of the meat, and tended to increase shear force.

Regarding the type of formulation, as expected, the use of YEAST determined a higher ($P < 0.01$) cooking loss of turkey rolls in respect with STTP (control group), CARR and COM. This result can be attributed to the positive effect of sodium triphosphate and sodium carbonate (included in COM) to enhance the water holding capacity of the meat as well as to the gelling properties of carrageenan which can hold the water released by the meat during cooking as previously found by Daigle *et al.* (2005) in a similar study. To the other hand YEAST only acts as flavour enhancing ingredient. This result was consistent with that for meat pH which showed higher values in turkey rolls formulated with STTP and COM in respect with CARR and YEAST, confirming the ability of those ingredients to shift the meat pH further away from its protein isoelectric point. These results were confirmed by the assessment of water holding capacity (WHC) by means of filter paper press and purge loss which were lower in COM and STTP than YEAST. Whereas CARR showed intermediate behaviour. It is known that pH affects the WHC by its effect on electrostatic repulsion, and increase in the pH of meat products using phosphate and carbonate or bicarbonate salts improves the WHC substantially (Kauffman *et al.*, 1998; Wynveen *et al.*, 2001; Sindelar *et al.*, 2003 a,b; Bertram *et al.*, 2008). The appearance of turkey rolls was influenced to a large extent by the type of formulation. In fact, COM determined a remarkably darker colour in respect with STTP, CARR and YEAST (L^* : 72.2 vs. 74.8 vs. 76.6 vs. 76.9, respectively; $P < 0.01$). Those colour differences were so wide to be subjectively evidenced by panellists during sensory evaluations (results not included in this paper). The texture analyses evidenced a superior product firmness of STTP and COM rolls in respect with CARR and YEAST. This was consistently indicated by the majority of the textural measurements (AK-shear value; gel strength and TPA parameters) (Tab. 1). Finally, CARR presented the higher level of springiness. There were significant interactions between type of meat and formulation on FPP, pH, lightness, yellowness and gel strength.

Table 1: Influence of type of meat and formulation on quality characteristics of turkey breast meat rolls.

	Type of Meat (TM)		Type of Formulation (TF) ¹				sem	Probability		
	Fresh	Thawed	STPP	YEAST	CARR	COM		TM	TF	TM×TF
<i>Samples (n.)</i>	48	48	24	24	24	24				
Cooking loss (%) ²	10.7b	10.9a	10.6y	11.3x	10.6y	10.6y	0.1	**	**	ns
Moisture (%)	72.3	72.2	72.3	72.2	72.4	72.2	0.1	ns	ns	ns
Filter paper press (%)	8.52	8.95	8.23z	9.86x	9.06y	7.78z	0.18	ns	**	*
Purge loss (%)	5.43b	6.13a	5.49y	6.20x	5.66y	5.78y	0.08	**	**	ns
pH	6.25b	6.43a	6.35y	6.27z	6.26z	6.50x	0.01	**	**	**
<i>Colour parameters</i>										
Lightness (L*)	75.3a	75.0b	74.8z	76.9x	76.6y	72.2w	0.2	**	**	**
Redness (a*)	5.64	5.65	5.63y	5.86x	5.85x	5.23z	0.04	ns	**	ns
Yellowness (b*)	8.42b	8.89a	8.41z	9.24x	9.01y	7.95w	0.06	**	**	**
AK-shear (kg/g)	0.88b	1.01a	1.01y	0.81z	0.82z	1.13x	0.02	**	**	ns
Gel strength (kg×cm)	1.91b	3.05a	2.52y	2.26yz	2.17z	2.98x	0.08	**	**	**
<i>TPA parameters</i>										
Hardness (kg)	8.09b	8.91a	9.75x	7.08y	7.28y	9.88x	0.17	**	**	ns
Cohesiveness	0.37	0.37	0.38x	0.33y	0.37x	0.40x	0.01	ns	**	ns
Gumminess	3.02b	3.37a	3.73x	2.38y	2.73y	3.94x	0.09	**	**	ns
Springiness	0.081	0.079	0.076y	0.080y	0.089x	0.077y	0.002	ns	**	ns
Chewiness	0.10	0.11	0.11x	0.07y	0.11x	0.12x	0.01	ns	**	ns

¹ STPP: sodium tripolyphosphate (control group); YEAST: yeast extract; CARR: carrageenan; COM: commercial mix containing sodium citrate, sodium carbonate, dextrose, and yeast extract.

² determined on whole rolls

sem = standard error of the mean; * = P<0.05; ** = P<0.01; ns = not significant; ^{a-b}: P<0.05. ^{w-z}: P<0.05

Overall, this study indicated that both the type of meat and functional ingredients can dramatically influence processing yield and quality characteristics of turkey rolls. Considering the type of meat, according to product quality expectations, it might be evaluated that frozen/thawed breast meat could be profitably used for restructured poultry

products because of the firmer texture. However, there were some drawbacks represented by the lower process yield due to higher losses during cooking, a darker final product colour and a lower WHC. As for the type of formulation, the higher levels of WHC and a product firmness were obtained with the use of a commercial mix containing sodium carbonate as well as sodium tripolyphosphate but it was found a darker product colour which might negatively impact turkey rolls appearance. Carrageenan exhibited a good WHC and less firm texture in comparison with the previous ones, however it determined a lighter colour thus resulting as a good balance among the ingredients used in this research.

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