Cooked turkey roasts have different processing characteristics then cooked beef roasts

Code words

- Turkey
- Beef
- Cook yield
- Protein solubility

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Roasts were manufactured from lean beef and turkey by injecting with brine to 25% above green weight so the raw product contained 1.8% salt and 0.3% sodium phosphate. Meat muscle characteristics (pH and protein solubility) and processing characteristics were measured as cook yields and expressible moisture. The species significantly affects some basic properties of the meat. Turkey meat had significantly higher pH and extractible myofibrillar proteins than beef. The increased cook yield was correlated with higher pH and higher expressible moisture. The differences observed suggest that processors need to treat the starting materials differently.

Tumbling and injection are widely used in the industry to meet consumer demand for fast, convenient, consistent products. Injection and mechanical action increase speed and consistency when incorporating brine ingredients into meat products. The most appropriate technology must be used because meat from different species, and even different muscles within the same species, do not respond in the same way (Xargayó et al., 1998; Boles and Shand, 2002). Xargayó et al. (1998) reported that beef needed more pressure during the pre-massaging to get similar results to products made from pork and poultry. This finding suggests that processing procedures must be modified to make beef products similar to those from pork and poultry. The objective of this study was to better understand how muscles from two different species (beef and turkey) respond to the same processing technologies and try to explain any differences observed by evaluating muscle properties such as pH and protein solubility.

Materials and methods

Processing

Beef *semimembranosus* muscles were ordered from commercial processing facilities, as small meat processors would be able to, based on specifications. Specifications for the beef ordered were USDA Select, Yield Grade 2, weighing 6 to 8 kg from the same processing lot. Turkey *pectoralis major* muscles were obtained from the same production lot of slaughter. Visual inspection of the muscles was conducted to omit muscles that had gone through rapid pH decline. Before being cooked, meat samples were taken from each roast for functionality tests (10 different muscles for each, protein solubility and meat pH).

Received: 22 February 2007 | reviewed: 27 February 2007 | revised: 4 April 2007 | accepted: 10 April 2007

Roasts (5 per species) designated for injection treatment were injected to 25% above original weight with a hand injector. The brine was formulated so that the 125% pumped roast contained 1.8% salt and 0.3% sodium phosphate. Injected roasts were then tumbled intermittently for a total of 80 min (10 min on, 20 min off for 4 h). Roasts were put in cook-in bags and steam cooked to an internal temperature of 75 °C. The following processing and texture parameters were measured on each roast: cook yields (cooked weight/raw weight×100), expressible moisture, and peak shear force values.

Tab. 1: Effect of species on raw meat characteristics

Parameters	Species			
	Beef	SEM	Turkey	SEM
Raw pH	5.47[b]	0.02	5.85[a]	0.02
Injected pH	5.57[b]	0.05	5.92[a]	0.04
Sarcoplasmic (mg/g)[1]	5.58[a]	0.33	3.83[b]	0.10
Myofibrillar (mg/g)[2]	8.75[b]	0.59	10.74[a]	0.60
Total Protein (mg/g)[3]	8.84[b]	0.52	11.38[a]	0.56

[a,b] Means with different superscripts within a treatment differ significantly ($P<0.05$)
SEM – Standard error of the mean
[1] Sarcoplasmic Proteins extracted with 0.03 M potassium phosphate (low ionic strength buffer)
[2] Myofibrillar Proteins extracted with 0.1 M potassium chloride (high ionic strength buffer)
[3] Total proteins = Proteins extracted with 1.1 M potassium iodide

Source: Groenlund, Boles and Swan Fleischwirtschaft International 4/2007

▶ Analytical techniques

The pH and protein solubility of raw meat (Boles et al., 1992) and the expressible moisture (Shand, 2000) and maximum shear force (Boles and Shand, 2001) of cooked product were measured.

▶ Statistics

Data were analysed using analysis of variance of SAS (2001). Simple correlation coefficients were also calculated.

Results and discussion

▶ Meat pH

Non-injected raw beef *semimembranosus* muscle had a significantly lower pH than non-injected raw turkey *pectoralis major* muscle (Tab. 1). Rathgeber et al. (1999a) reported similar muscle pH for turkey while Boles and Shand (2001) reported similar pH for *semimembranosus* muscle. Injecting salt and phosphate increased beef and turkey pH only slightly (5.41 vs 5.57 beef, 5.86 vs 5.92 turkey). These data differ from Trout and Schmidt (1983) and Boles and Shand (2001; 2002), who reported that adding phosphate significantly increased in meat pH.

▶ Protein solubility

Species significantly affected solubility of low ionic strength, sarcoplasmic proteins, high ionic strength, myofibrillar proteins, and total protein from raw non-injected meat (Tab. 1). More sarcoplasmic protein was extracted from beef, which reflects beef having more myoglobin than turkey meat. On the other hand, more myofibrillar protein and total protein was extracted from turkey meat. Reports on the effect of protein solubility on cook yield have been mixed. Rathgeber et al. (1999b) found no relationship between protein extractability and cook yield of finely comminuted turkey products. Boles et al (1991, 1992) reported lower yields of hams accompanied by drastic reductions in both sarcoplasmic and myofibril protein solubility in meat from stress-susceptible pigs. Farouk et al (2002) found that finely comminuted beef sausages with reduced sarcoplasmic protein content had lower cook yield and gel strain, which they attributed to either extraction of proteins or reduced solubility due to changes in postmortem conditions.

Tab. 3: Simple correlation coefficients showing the relationship between raw meat characteristics and cooked parameters

Cooked meat characteristics	Raw meat characteristics			
	pH	Sarcoplasmic solubility	Myofibrillar solubility	Total protein solubility
Cook yield	0.84***	−0.75***	0.34	0.52*
Expressible Moisture	0.45*	−0.34	0.04	0.13
Shear Force	−0.43*	0.37	−0.12	−0.31
pH	0.95***	−0.77***	0.49*	0.57**

* $P<0.05$, ** $P<0.01$, *** $P<0.001$

Source: Groenlund, Boles and Swan Fleischwirtschaft International 4/2007

▶ Cook yield

Turkey roasts had a significantly ($P<0.05$) higher cook yield than beef roasts (Tab. 2). Cook yield was highest for injected turkey roasts. Furthermore, injecting brine had a greater impact on cook yield of turkey roasts (85.6 injected vs 81.5 not injected) than beef roasts (74.6 injected vs 73.3 not injected). These findings agree with other reports on the effect of salt and alkaline phosphate brines on cook yield (Maki and Froning, 1987; Boles and Shand 2001). The higher cook yield for turkey could be attributed to its higher pH (Swan and Boles, 2002) Another explanation, hypothesised by Boles and Shand (2001), is that beef has stronger collagen connections or slight differences in muscle structure that may make injection and/or retention of brine more difficult. This hypothesis agrees with data by Xargayó et al. (1998), who found that beef needed more force than pork and poultry during pre-tumbling to get similar injection levels and cook yield.

▶ Expressible moisture

Expressible moisture indicated how well a cooked product would hold moisture during post-processing storage and handling (Shand, 2000). Beef roasts had significantly less expressible moisture than turkey roasts (Tab. 2), but also had lower cook yields. Roasts injected with salt and phosphate had a significantly higher expressible moisture (indicating more free moisture in the product) than non-injected roasts (Tab. 2). In contrast, Maki and Froning (1987) reported that adding sodium tripolyphosphate to turkey decreased expressible moisture. Froning and Sackett (1985) also reported that adding salt and phosphate to turkey decreased expressible moisture. They noted a significant interaction between salt/phosphate and expressible moisture, and suggested that this interaction occurred because salt had a greater impact on expressible moisture than phosphate. All these studies used whole turkey carcasses while the present study used a single turkey muscle and each study used different injection levels and tumbling regimes, which could explain the different results. The increase in expressible moisture with increased cook yield indicated that other ingredients such as carrageenan or starch maybe needed to retain the moisture associated with higher cook yield with short tumbling times.

▶ Shear force

Treatment and meat species both significantly affected tenderness of the roasts (Tab. 2). Beef roasts had significantly higher shear values than turkey roasts, and injected roasts had significantly lower shear values than non-injected roasts. Boles and Shand (2001) reported that tenderness of beef roasts significantly improved if injected with salt and phosphates brines, along with reduced sample variability. There

Tab. 2: Effect of species and injection on the processing characteristics of cooked roasts

Parameters	Species				Treatment			
	Beef	SEM	Turkey	SEM	Injected	SEM	Non-Injected	SEM
Cook Yield[1]	73.95[b]	0.65	83.53[a]	0.77	80.1[a]	1.91	77.39[b]	1.43
Cooked pH[2]	5.62[b]	0.03	5.96[a]	0.02	5.83[a]	0.06	5.75[b]	0.06
Expressible moisture[3]	32.15[b]	1.54	36.53[a]	1.24	36.09	1.59	32.6	1.33
Shear Force (N)[4]	66.52[a]	6.43	49.07[b]	7.13	44.43[b]	5.61	71.16[a]	6.16

[a,b] Means with different superscripts within a treatment differ significantly ($P<0.05$)
[1] Cook yield = cooked weight/raw non-injected meat weight x 100
[2] pH of cooked meat
SEM – Standard error of the mean
[3] % moisture lost after centrifugation at 2400 x g
[4] N is the SI unit for force and can be converted to kg by dividing by 9.80655

Source: Groenlund, Boles and Swan — Fleischwirtschaft International 4/2007

was no significant interaction between injection and meat source, indicating that species rather than brine affected tenderness.

▶ Relationship between raw meat and processing parameters

Raw meat pH had the greatest impact on processing parameters (Tab. 3). Furthermore, cook yield was significantly correlated to meat pH ($r=0.84$). Boles and Shand (2001) also reported that increased cook yield of roast beef was associated with increased meat pH. Trout and Schmidt (1983), however, reported that small increases in pH associated with adding phosphate were expected to have only a small effect on water holding capacity (WHC) and thus cook yield.

Simple correlation coefficients indicated that the increase in expressible moisture is related to increased cook yield in both turkey and beef ($r=0.70$). Boles and Shand (2001) also observed a relationship between expressible moisture and increased cook yields of beef roasts. These samples were tumbled for a short time period, which may explain some of the difference in information reported on expressible moisture.

Shear values were only poorly correlated to raw meat characteristics, whereas Purchas et al (1999) reported a strong relationship between pH and shear values for beef *longissimus thoracis* steaks.

Turkey meat had a higher ultimate pH than beef, which affected some of the meat characteristics that can affect processing capabilities. For example turkey myofibrillar proteins were more soluble than those in beef and this increased solubility was associated with the higher pH ($r=0.49$). This difference in protein solubility could explain some of the differences seen in the processed products. The increased ability of the myofibrillar proteins to interact with the brine could help increase cook yield. Expressible moisture increased as cook yields increased. Therefore, other ingredients may be needed to reduce expressible moisture in highly extended meat products that are tumbled for short periods of time to maintain a texture closer to unprocessed product. More research is needed to determine the best way to manufacture roasts to maximise cook yield and minimise expressible moisture. This is especially important to processors manufacturing natural and organic products where fewer ingredients are allowed to be added.

Practical importance

The species significantly affects some basic properties of the meat. Ultimate pH of the meat is associated with protein solubility, which influences cook yield of processed roasts. Interaction of the meat pH with ingredients that traditionally are associated with increased pH (such as sodium phosphate) can help processors maximise yields of whole muscle products. The difference in processing yield between turkey and beef suggests that processors need to treat the two materials differently and that other ingredients may be needed to ensure beef products attain the cook yield observed for turkey products.

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