EFFECTS OF SODIUM TRIPOLYPHOPHATE AND SODIUM CHLORIDE INJECTION ON PROCESSING CHARACTERISTICS AND PHYSICAL PROPERTIES OF *SOUS VIDE* COOKED WHOLE BEEF MUSCLES.

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Background

Fresh lean meat contains about 75% water, the retention of this, and the added water during storage and further processing is of the great importance for the meat industry. Water retention is economically important because lose of water results in a decreased amount of marketable products. Moreover, water retention is essential for the meat product palatability attributes of tenderness and juiciness. Polyphosphates in combination with sodium chloride, increase the water binding ability of myofibrillar proteins of meat (Hamm, 1970). This results in reduced cooking weight losses and improved tenderness in processed poultry and red meat products (Trout and Schmidt, 1984; Boles and Shand, 2000). Little information about the effects of salts injection on the physical properties of *sous vide* cooked whole beef muscles is available in the literature.

Objective

To determine the effect of different sodium tripolyphosphate (STPP) and sodium chloride (SC) combinations and cooking temperatures on drip loss (DL), cooking weight loss (CWL) and tenderness of retail ready *sous vide* cooked whole beef muscles.

Methods

Beef *semitendinosus* muscles were excised from steer carcasses collected at a beef packaging plant 48 h after slaughtered. Muscles were trimmed free of fat and after that each muscle was weighed. A number of 288 muscles were injected with STPP or SC solutions or combinations of them to the level of 10% of the weight of trimmed raw muscle. Others muscles (144) were used as control samples (uninjected muscles). After injection, the muscles were weighed, vacuum packed and held at 1.0±0.5°C for three days to allow the equilibration of the injected solution throughout the piece. Control muscles were treated using the same procedure. Then, the bags were opened and the weight of each muscle was recorded. Finally, the control and injected muscles were vacuum packed in cook-in bags and cooked in a water cascading retort (Microflow Barriquand, Roanne, France) operating in either basket static mode or rotation mode. Time-temperature records of the muscles' slowest heating point (SHP) were used for the pasteurisation value (P_{70}^{10}) calculation. The thermal treatment was stopped when a pasteurisation value of P_{70}^{10}= 2 min was reached. After thermal treatment, samples were taken out from the retort and immersed in an ice-water bath until the temperature at SHP reached 26 °C. Then samples were stored in a storage room at 1.0±0.5 °C for 24 h before analysis.

Four major processing variables were investigated in this study. These were: 1- STPP concentration (g STPP/100 g muscle tissue), 2- SC concentration (g SC/100 g muscle tissue), 3- Cooking temperature (°C) and 4- Basket Rotation Speed (rpm). The ranges of each variable are shown in Table 1.

TABLE 1: Testing ranges of processing variables explored in this study.

Ranges	STPP Concentration (%)	SC Concentration (%)	Temperature (°C)	Basket Rotation Speed (rpm)
Low	0	0	55	0
High	0.5	1.4	75	20

A four-factor central composite design was adopted for the study. The design center-point (0.25%STPP, 0.70%SC, 65 °C and 10rpm) was replicated for measuring the random errors. The processing characteristics measured on each muscle were drip loss (weight lost during three days of chill storage, based on injected weight) and cooking weight loss (percentage of weight of trimmed raw muscle). Warner Bratzler shear (WBS) was also determined on ten cylinders (3 cm long; 1.27 cm diameter) from the core of muscle medial portion. pH value was also measured on a homogenate of the core of muscle medial portion.

Results and discussion

The preliminary results presented in this paper correspond to salts injection treatments listed in Figure 1 (numbers 1 to 6) and cooking temperatures of 55 °C, 65 °C and 75 °C, using a basket rotation speed of 10 rpm in all cases. Figure 1 shows the DL of injected and uninjected muscles held at 1.0±0.5°C for three days. Muscles treated with SC or STPP solutions (treatments 1 and 2, respectively) had higher DL than the control muscles (treatment 6) and muscles injected with solutions containing both salts (treatments 3, 4 and 5). For muscles injected with solutions of STPP or SC, was relatively more difficult to get water into the meat tissue related to muscles injected with STPP+SC solutions. It can be seen the synergetic effect on the DL decrease (a reduction of approximately 50% of DL value of treatments 1 and 2) achieved with both salts. The highest value observed in our results (1.42%, treatment 2) was lower than those values reported by Sheard et al. (1999) for pork loin portions 10% injected with 3% and 5% polyphosphate solutions and held at 1°C during three days (3.8±0.9% and 3.0±1.4%, respectively).

Figure 2 shows the CWL of injected and uninjected muscles cooked at different temperatures. It can be seen three groups of muscles in this figure. A first group correspond to control muscles; the mean CWL of these samples ranged between 14% and 16% (for 55 °C and 75 °C cooking temperature, respectively). A second group correspond to muscles injected with solutions containing only SC or STPP; this group presented similar mean CWL values for 55°C and 65°C (between 5.5 and 8.5%) and higher mean

CWL values for 75 °C (between 11 and 13%). In this group it is observed an important effect of cooking temperature above 65 °C. Finally, the third group correspond to muscles injected with STPP+SC solutions. It is very important the additive contribution of SC and STPP salts on CWL reduction. Moreover, in the third group it is possible to see an important effect of cooking temperature but there was not effect of salts' concentration. Whilst muscles cooked at 55 °C and 65°C had cooking weight losses very low, (close to 0% and 1%, respectively), muscles cooked at 75 °C showed values between 3 and 5%. The results obtained at 55 °C and 65°C indicate that the original weight of muscles is preserved, thus, the amount of water injected is similar to that one lost during chill storage and thermal treatment stages. Boles and Shand (2000) reported an increase in cook yield between injected (10%, 25% and 50%) and uninjected cooked roast beef. These authors observed a value of CWL of about 8% from cuts 10% injected and cooked at 73 °C (final end point temperature) and a value of cooking weigh loss of 32% from uninjected samples cooked following the same procedure. Possible mechanisms by which sodium chloride and alkaline phosphates improve the retention of moisture in meat have been extensively reviewed (Hamm, 1970; Trout and Schmidt, 1983). Critical minimal values of pH (5.95-6.35) and ionic strength (0.29-0.43) through individual or additive contributions of sodium chloride and polyphosphates are required for obtaining maximum cooking yield in restructured meat products (Trout and Schmidt, 1984). In our work, mean pH values ranged between 5.6 and 5.7 for control muscles, 5.7 and 5.8 for muscles injected with SC solution and 5.9 and 6.4 for samples injected with STPP solutions (alone or in combination with SC). It is clear that the minimal critical value of pH mentioned above is reached in the last case. Nevertheless, water retention is enhanced when STPP is combined with SC. Increased ionic strength would result in more solubilisation of muscles proteins (Offer and Trinick, 1983) and thus an increase in the water retention.

Figure 3 shows the WBS mean values of injected and uninjected muscles cooked at different temperatures. From the figure it is observed, on one hand, that salts injection decreased the WBS values of injected muscles with respect to those of control muscles. On the other hand, cooking temperature has not influence on the WBS values, even though working temperatures are in the protein denaturation range, the processing time at these temperatures would be too short to do viewable effects on Warner Bratzler Shear results. As it is known, SC produces protein solubilisation (Offer and Trinick, 1983) and thus an increase in meat tenderness. This can be seen in Figure 3 as a decreasing in the WBS values as the SC concentration increases. Moreover, a significant effect on meat tenderness increase have been reported for polyphosphate-treated samples. The increased tenderness of polyphosphate-treated samples can be attributed to the weakened muscle structure (depolymerisation of myosin filaments and also dissociation of actomyosin complex) and, also, to the higher water content of the cooked samples (Sheard et al., 1999).

Conclusions

Muscles injected with solutions of STPP or SC had higher drip loss than control or injected with STPP+SC muscles. There was a very important additive contribution of SC and STPP salts on CWL reduction. At cooking temperature of 55 °C and 65°C the original weight of muscles injected with STPP+SC is preserved. Salts injection decreased the WBS values of injected muscles with respect to those of control muscles. Cooking temperature had not an important effect on beef tenderness.

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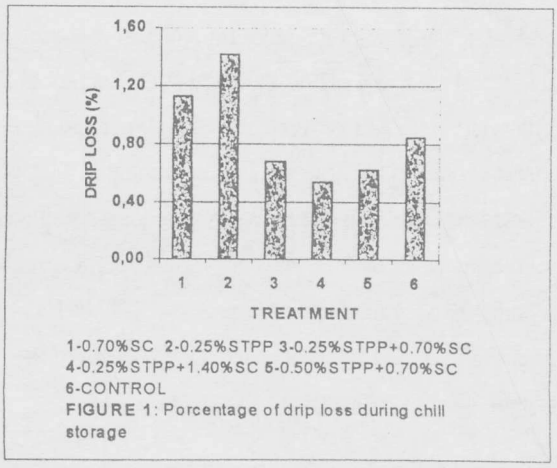

FIGURE 1: Porcentage of drip loss during chill storage

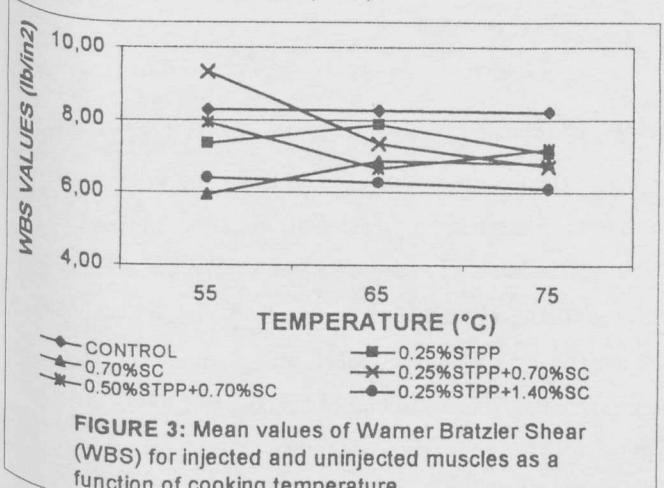

FIGURE 3: Mean values of Warner Bratzler Shear (WBS) for injected and uninjected muscles as a function of cooking temperature.

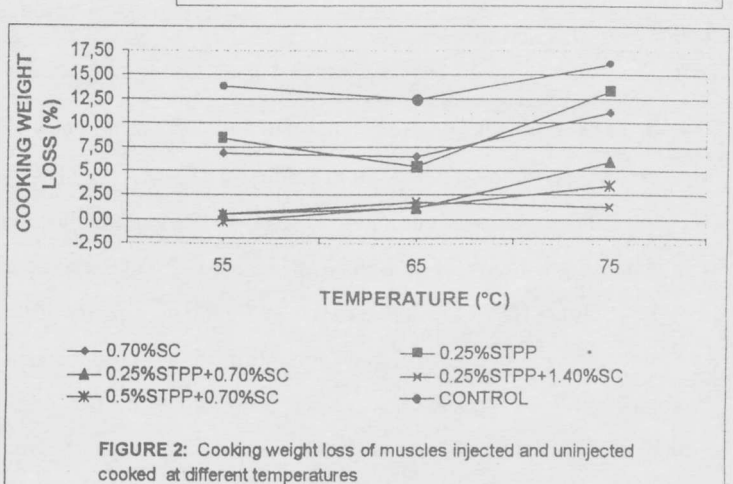

FIGURE 2: Cooking weight loss of muscles injected and uninjected cooked at different temperatures