THE EFFECT OF BRINE INJECTION LEVEL ON MOISTURE RETENTION AND SENSORY PROPERTIES OF CHICKEN BREAST MEAT

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Abstract – This study was conducted to determine the effect of 15% and 30% brine injection levels on chicken breast quality. Breasts injected to 15% showed lower thawing and cooking losses, compared to control and 30 % injected breasts. Control breasts had significantly (p<0.001) higher cooking losses compared to brine injected breasts, which could be ascribed to the absence of the brine ingredients, which held the moisture during cooking. Sensory properties of chicken meat, injected to 15% and 30% brine, were compared to uninjected controls by a 75 member consumer panel. The brine injected breasts were significantly preferred to the control samples, while the 15% injection level breast cuts were significantly preferred to the 30% level breast cuts. Tenderness of cooked meat was instrumentally predicted by Warner-Bratzler shear (WBS). The shear force values were significantly lower in brine injected breasts than controls. Sensory panellists rated breasts, injected to 15%, significantly more tender than 30% brine injected breasts.

I. INTRODUCTION

During commercial processing of poultry, brine is often introduced into poultry meat through injection. This has been justified on various technological grounds, such as improving the moisture retention and sensory properties (tenderness, juiciness, and flavour) [1, 2]. When brine injection was introduced, it was injected into poultry meat with an aqueous monosodium glutamate solution, to an extension level of 3% – 8% of the weight of the dressed chicken [3]. But lately, chicken processors tend to inject brine at varying levels. Sodium chloride and phosphate are being used as basic ingredients, together with various other ingredients, such as antioxidants, flavours, starch, non-meat proteins and hydrocolloids. In South Africa, injection levels are ranging from 30% – 60% [4]. This is the result of no current legal regulations, governing brine injection levels into poultry meat, in South Africa [5].This lack of regulations results in poultry processors injecting brine into meat at varying percentages. It is important to emphasize that injection percentage is one of the most important factors that influences the quality of brine injected poultry meat. High injection levels may degrade some of the quality characteristics, such as texture and flavour, and may lead to excessive muscle contraction during cooking [2]. Information is still lacking on realistic injection levels to obtain optimum positive effects on meat quality.

Therefore, the aim of this study was to determine the effect of 15% and 30% injection levels on moisture retention and sensory properties of chicken breast.

II. MATERIALS AND METHODS

Sample preparation

A total number of 288 “skin on” chicken breasts of known origin, not subjected to any processing steps that could add water to the portions, were injected with brine. Brine was prepared from cold tap water containing ice. Brine composition was calculated as follows,

$$\%\text{ in brine} = \frac{[100 + \%\text{ pump}]}{[\%\text{ in final product X }\%\text{ pump}]}$$

Brine composition was altered to allow for a constant ingredient level in the product. Brine ingredient in product was 1% salt, 0.5% dextrose, 0.2% carrageenan, 0.1 % xanthan and 0.5% sodium tri- polyphosphate. The chicken breasts with skin were injected manually. The treatments were control (no injection), 15% injection over raw weight, and 30% injection over raw weight. Breasts were weighed before, during and after injection, to determine the brine pick-up. After injection, breasts were vacuum packaged and stored at -18°C. Twelve portions were used for each treatment group, for all analysis.

Analytical procedures
Total moisture loss:
All the chicken portions were weighed pre- and post-thawing, as well as after cooking, for the determination of differences in the losses (%) during the thawing and cooking processes, respectively. Total moisture loss was calculated as:

$$\text{Moisture loss \%} = \frac{[\text{raw mass} - \text{cooked mass}]}{[\text{raw mass}]} \times 100$$

Thawing losses:
Chicken breast pieces were thawed at 4°C for 24 hours. Thawing loss was calculated as:

$$\text{Thawing loss \%} = \frac{[\text{raw mass} - \text{raw mass after thawing}]}{[\text{raw mass}]} \times 100$$

Cooking losses:
Samples were subsequently dry cooked at 160°C to an internal end point temperature of 85°C, for approximately one hour in the oven (Mielé, model H217). Internal temperature was recorded according to the American Meat Science Association (AMSA) [6]. Calculations were performed according to the guidelines of the AMSA [7] and using Microsoft Excel 2007. Cooking loss was calculated as:

$$\text{Cooking loss \%} = \frac{[\text{raw mass after thawing} - \text{cooked mass}]}{[\text{raw mass after thawing}]} \times 100$$

Shear force measurement:
Cooked breast samples were cooled at 4°C overnight. Samples were cored, after being cooled further to room temperature (centrally controlled at 22°C). Cylindrical cores, with a diameter of 12.7 mm (20 – 22 mm long), were obtained from the mid-portions of the cooked muscle. Samples were sheared perpendicular to the fibre direction, with a Warner-Bratzler shear (WBS) device mounted on a Universal Instron Machine (Model 4301; Instron Corporation, 1990). The shear force was determined using 200 mm/min test speed with a 1 kN load cell [8, 9, 10]. A total of 36 cores per treatment were obtained.

Sensory analysis:
Sample preparation was done according to the research guidelines of the AMSA [6]. During cooking, salt was lightly added to the control portions to compensate for the brine injected controls. The meat was evaluated in two sessions for the preference and attribute rating scale tests, respectively. Both tests were judged on a nine point hedonic scale, ranging from 1= dislike extremely to 9 = like extremely. The attributes tested were taste, tenderness, juiciness and aftertaste. For tenderness, the scale was changed to 'extremely tough=1 to extremely tender=9'; for juiciness, to 'extremely dry=1 to extremely juicy=9' and for aftertaste from 'non-present=1' to 'present=9'. A 75-member consumer panel, consisting of regular eaters of chicken meat, was used to evaluate the samples.

Statistical analysis:
Differences between treatments were determined, using a one-way analysis of variance (ANOVA) procedure. When applicable, the Tukey-Kramer multiple comparison test (α =0.05) was used to determine differences between treatment means [11].

III. RESULTS AND DISCUSSION

The control treatment had significantly ($p<0.001$) higher thawing losses than the breasts injected to 15%. However, the thawing losses for the control treatment were significantly ($p<0.001$) lower than the breasts injected to 30% (Table 1). It was apparent that at higher injection levels the muscle fibres could not hold the excess water injected into meat. After cooking, the control treatment lost 28% water, compared to 24% and 25% of breasts injected to 15% and 30%, respectively. This confirmed that brine ingredients were able to keep water in the meat during cooking. Salt, carrageenan, xanthan and phosphate have previously been reported to retain water in meat [12]. Hydrocolloids possess a great gelling capacity, thereby contributing to an increased WHC (water holding capacity) during cooking [2]. Total moisture loss of the controls was significantly higher than that of

Table 1: The effect of injection level on thawing loss, cooking loss and shear force resistance on chicken breast meat.

	Control	15% Injection	30% Injection	Significance level
Thawing loss (%)	4.04^{b}	2.36 ^{a}	5.29^{c}	p<0.001
Cooking loss (%)	28.41^{b}	24.05 ^{a}	25.30 ^{a}	p<0.001
Total moisture loss (%)	31.61^{c}	25.85^{a}	29.30^{b}	p<0.001
Shear force (kg)	2.39^{c}	1.25^{b}	1.06^{a}	p<0.001

^{a,b,} Means with different superscripts in the same row differ significantly.

the two injection levels.

Even though not statistically significant when comparing the two injection levels, the cooking losses for the breasts injected to 15% were lower than the breasts injected to 30%. Volpato et al. [13] used 12% and 15% brine in the processing of deboned chicken breasts. They found that the use of 12% brine, in relation to the weight of the raw material, resulted in a lower water loss during cooking, than the use of 15% brine. More water loss by non-injected controls could be expected.

The WBS values were significantly (p<0.001) lower in brine injected breasts, than the control breasts that were not injected (Table 1). The shear values were the lowest with a 30% injection level, compared to the 15% injection level. This could be attributed to the gelling properties of carrageenan and xanthan gum. Dransfield [14] showed that injected substances were probably only effective up to limited injection (± 10%) and further improvement of tenderness, with higher levels of injection, only occurred due to the dilution effect of the water-hydrocolloid gel, which caused other obvious negative quality defects. Lower shear force values found in brine injected controls were in agreement with Baumert & Mandigo, Xargayó [1, 2]. They found that brine injected meat resulted in lower shear values when compared to controls. It is also important to realize that shearforce values as low as the ± 2.4 kg as observed in the control breasts can also be considered as very tender.

The control samples had significantly (p<0.001) lower sensory scores, than injected samples for both preference and attribute tests (Table 2). Breasts injected to 15% were preferred to 30% brine injected breasts. This could be expected, because brine ingredients had been shown to increase the sensory properties of meat [2]. The non-injected control breasts had lost water during thawing and cooking, thus contributing to less tender and less juicy meat. Although not statistically significant, breasts injected to 15% were preferred and rated even higher than breasts injected to 30%, for all the attributes,. These current findings are also consistent with that of Xargayó *et al.* [2], who found that products injected to 15% scored higher in overall acceptability, than at higher injection levels of 25%. The explanation, for the aftertaste being rated higher in brine injected samples, might be because of the added brine ingredients, meaning that the consumers could detect the added brine ingredients. Recommended injection percentages range between 5% and 20%, for increasing the meat's sensory quality, depending on the type of animal and muscle [2].

Table 2: The effect of injection level on sensory score of chicken breast meat.

	Control	15% Injection	30% Injection	Significance level
Preference	5.23^{a}	6.80 ^{c}	6.13^{b}	p<0.001
Taste	4.38^{a}	6.70^{b}	6.63^{b}	p<0.001
Tenderness	4.04^{a}	7.33^{b}	7.03^{b}	p<0.001
Juiciness	3.29^{a}	6.63^{b}	6.53^{b}	p<0.001
Aftertaste	4.62^{a}	6.32^{b}	6.30 ^{b}	p<0.001

^{a,b,} Means with different superscripts in the same row differ significantly.

IV. CONCLUSIONS

The effect of carrageenan and xanthan was apparent in keeping the moisture in the meat, during thawing and cooking of brine injected chicken portions. Brine injected meat was mostly preferred by the consumers. Sensory properties, which included taste, tenderness and juiciness, were enhanced in brine injected meat. The 15% injection level was preferred by consumers to the 30% injection level. These results showed that low brine injection levels induce positive effects on meat quality, which were acceptable to the consumers. Results from this research clearly indicate that there is no real advantage in using injection levels higher than 15 % in fresh chicken.

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REFERENCES

1. Baumert, J. L. & Mandigo, R. W. (2005). The effects of phosphate type and potassium lactate on quality characteristics of enhanced beef steaks. Nebraska Beef Report (pp 95-99), University of Nebraska.
2. Xargayó, M., Lagares, J., Fernández, E., Borrell, D., & Juncà, G. (2010). Spray marinating: A definitive solution for improving meat texture. www.metalquimia.com/pdfs/doctec26.pdf. Retrieved on 05/02/2011.
3. Buchanan, B. F. (1955). US Patent 2, 709, 658. Process for treating poultry, Serial No. 221, 537. 17 April 1955. New York: International Minerals & Chemical Corporation.
4. Department of Agriculture, Forestry and Fisheries. (2011). Brine injection project and Supreme Poultry visit. www.daff.gov.za/doaDev/articles/BrineInjectionProject.html. Retrieved on 03/03/2011.
5. National Consumer Forum. (2010). Bloated chicken prices. Consumer Fair, Edition 4, 2010.
6. AMSA. (1995). Research Guidelines for Cookery, Sensory Evaluation of Meat and Instrumental Tenderness Measurements of Fresh Meat. Chicago. Illinois. National Livestock and Meat Board.
7. AMSA. (1978). Guidelines for Cookery and Sensory Evaluation of Meat. Chicago. Illinois. National Livestock and Meat Board.
8. Jaturasitha, S., Leangwunta, V., Leotaragul, A. & Phonghaew, T. (2002). A comparative study of Thai native chicken and broiler on productive performance, carcass and meat quality. Paper at Deutscher Tropentag, Witzenhausen. The Conference on International Agricultural Research for Development. October 9-11, 2002.
9. Castellini, C., Dal Bosco, A., Mugnai, C. & Pedrazzoli, M. (2005). Comparison of two chicken genotypes organically reared: oxidative stability and other qualitative traits of the meat. Italian Journal of Animal Science 5: 335-363.
10. Musa, H. H., Chen, G. H., Cheng, E. S., Shuiep, E.S. & Bao, W.B. (2006). Breed and sex on meat quality of chicken. International Journal of Poultry Science 5: 566-568.
11. NCSS. (2007). Statistical System for Windows. Number Cruncher Statistical Systems. Kaysville, Utah, USA.
12. Feiner, G. (2006). Meat Products Handbook: Practical Science and Technology. London: Woodhead Publishing.
13. Volpato, G., Michielin, E. M. Z., Ferreira, S.R.S. & Petrus, J. C. C. (2007). Optimisation of the chicken breast cooking process. Journal of Food Engineering 84: 576-581.
14. Dransfield, E. (1994). Optimisation of tenderisation, ageing and tenderness. Meat Science 36: 105-121.