THE EFFECT OF DIFFERENT PRE-WASHING TREATMENTS ON THE IMPROVEMENT OF THE QUALITY AND SHELF LIFE OF MECHANICALLY DEBONED CHICKEN MEAT

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INTRODUCTION

Mechanically deboned chicken meat (MDCM) or mechanically deboned poultry meat (MDPM) is produced from the edible tissue on chicken bones by deboning or separation techniques (Ockerman and Hansen, 2000). Oxidation is a natural process in meat and its derivatives (Bigolin *et al*., 2013). High amount of polyunsaturated fatty acid, high processing temperature, fine grinding and mixing of bone marrow, incorporation of air, free heme groups and content of deboned tissue together with the iron parts of the deboner provide ideal conditions for fat oxidation which results in flavor and colour deterioration (dull brownish-red) in mechanically separated meat (Ockerman and Hansen, 2000). Overall microbial quality of the MDCM is affected by several factors such as hygiene and sanitationof processing plants, types of contaminants present in the raw material and storage history.

Due to its batter-like texture and high protein content, MDCM is expected to have similar microbial risks as in minced meat. The risk increases during processing due to microbial growth associated with the release of nutrients and the spread of contaminants caused by the breakdown of muscles into small particles. Therefore, it is vital to control and minimize these challenges to improve both safety and quality of MDCM (Kanatt *et al.*, 2010).

An alternative way of delaying lipid oxidation in mechanically separated meat is the addition of antioxidants and preservatives (Bigolin *et al*., 2013). In nature, there is a wide variety of naturally occurring antioxidants which are different in their composition, physical and chemical properties, mechanism and site of action. Phenolic compounds in plants retard oxidative degradation of lipid and thereby improve the quality and nutritional value of food (Kahkonen *et al*., 1999).

Therefore, the present study was carried out with the objective of determining the effectiveness of extracts of ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), lactic acid and phosphate wash in order to reduce lipid oxidation, improve meat quality and the shelf-life of MDCM.

METHODOLOGY

Back and neck parts of chicken carcasses were obtained from the CIC Poultry Processing Plant, Badalgama. The preliminary studies, physicochemical and keeping quality analysis, were carried out at the Meat Science Laboratory, Department of Animal Science, Faculty of Agriculture, University of Peradeniya. Microbiological analyses were conducted at the Microbiology Laboratory, CIC Processing Plant, Badalgama and Microbiology Laboratory, Department of Animal Science, Faculty of Agriculture, University of Peradeniya during the year 2019.

In this study, only the back and neck parts of chicken were used to produce MDCM samples. The solutions containing 2% (v/v) lactic acid (LA), 8% (w/v) phosphate (PW), 25% (v/v) ginger extract (GE) and 25%(v/v) turmeric extract (TE) and water (as control treatment) were used to prewash the chicken parts.

Fresh turmeric and ginger rhizome were washed and cut into small pieces. Thousand grams of turmeric and ginger were ground separately and the sap was extracted. Each sap was filtered

through a cheesecloth and the filtrates were stored at 4 °C until use.

Measured back and neck parts were dipped in LA, PW, GE, TE solutions for 10 minutes and the samples were left drained off for 5 minutes. Finally, the MDCM samples were prepared with the help of the deboner. The samples were stored under -2˚C for one month.

The pH, colour, water holding capacity (WHC) and Thiobarbituric acid reactive substance (TBARS) of each sample were measured. Total viable plate count (TVPC) and *Salmonella* were carried out as microbiological tests. Three replicates from each treatment were analysed. The evaluation was carried out in a completely randomized design. Data were analyzed in one-way ANOVA using SAS programme (SAS Institute Inc., 2002) version 9.1 with a 95% confidence interval. Mean separation was done by Tukey's method.

RESULTS AND DISCUSSION

pH of MDCM

Table 3.1 below shows the pH of MDCM after 3 days of storage. The pH of the control was significantly higher ($P<0.05$) compared to the other treatments. The MDCM produced with lactic acid and turmeric wash had lower pH values. The pH values of MDCM increased with the phosphate wash. This result was in line with the findings made by Nguyen (2011). Food grade phosphates are one of the food additives. They are essential for several reasons such as increasing pH, increasing water holding capacity, sensory properties and extending shelf life of MDCM.

Table 3.1: Mean values of pH of MDCM

Pre-washing treatment	pH mean±SD
Control	6.36 ± 0.07^{a}
Lactic acid (LA)	6.07 ± 0.06^{c}
Sodium phosphate (PW)	$6.14\pm0.06^{b,c}$
Turmeric extraction (TE)	6.05 ± 0.02^{c}
Ginger extraction (GE)	6.29 ± 0.11^{b}

Mean±Standard deviation (SD). Mean values with different superscripts within the column are significantly different ($P<0.05$).

Colour of MDCM

Colour is an important factor for consumer acceptance of meat and its products. The effect of pre-wash treatments on the colour of MDCM is presented in table 3.2. As shown, all values of L*, a* and b* ($P<0.05$) were affected by the pre-wash treatments after 3 days of storage. Colour of meat can be altered by certain free radicals produced during the act of lipid oxidation directly on the pigment, resulting in its oxidation or damaging the pigment's reduction systems (Liu *et al*., 1995)

Table 3.2: Mean values of Lightness (L*), Redness (a*) and Yellowness (b*) of MDCM

Pre-washing treatment	Colour		
	Lightness(L*) mean±SE	Redness(a*) mean±SE	Yellowness(b*) mean±SE
Control	47.45±2.34^{a}	11.66±2.97^{b}	7.51±2.21^{c}
Lactic acid (LA)	46.10±0.20^{a,b}	11.23±0.32^{b}	9.33±0.20^{b}
Sodium phosphate (PW)	45.10±0.15^{b}	10.80±0.43^{b}	7.56±0.32^{c}
Turmeric extraction (TE)	44.43±0.30^{c}	12.23±0.20^{a}	11.23±0.40^{a}
Ginger extraction (GE)	43.90±0.26^{c}	10.10±0.43^{b}	6.50±0.40^{d}

Mean±Standard Error (SE). Mean values with different superscripts within the same column are significantly different (P<0.05).

The colour characteristic of MDCM is generally reddish in colour due to the inclusion of hemoglobin separated from the bone marrow during the manufacturing process (Ockerman & Hansen, 2000). In general, as the storage days of MDCM increase, the L* number increased; a* and b* values decreased; the amount of discoloration increased; and the discoloration was darker. The effectiveness of an antioxidant, in terms of colour stability, is determined by its ability to keep iron in the reduced state which results in a desirable colour.

2-thiobarbituric acid reactive substances (TBARS) of MDCM

As shown in Figure 3.1, the TBARS values of five treatment groups increased throughout the storage period of 5 weeks. Samples produced by LA pre-wash showed comparatively lower (P<0.05) lipid oxidation compared to the other treatment groups. Oxidation of lipids in MDCM depends on several factors other than fatty acid composition such as the level of the antioxidant and minerals coming from the fragmented bones. The grinding process increases the product's contact surface with light and oxygen, and the presence of oxidation accelerating agents (Bigolin *et al*., 2013).

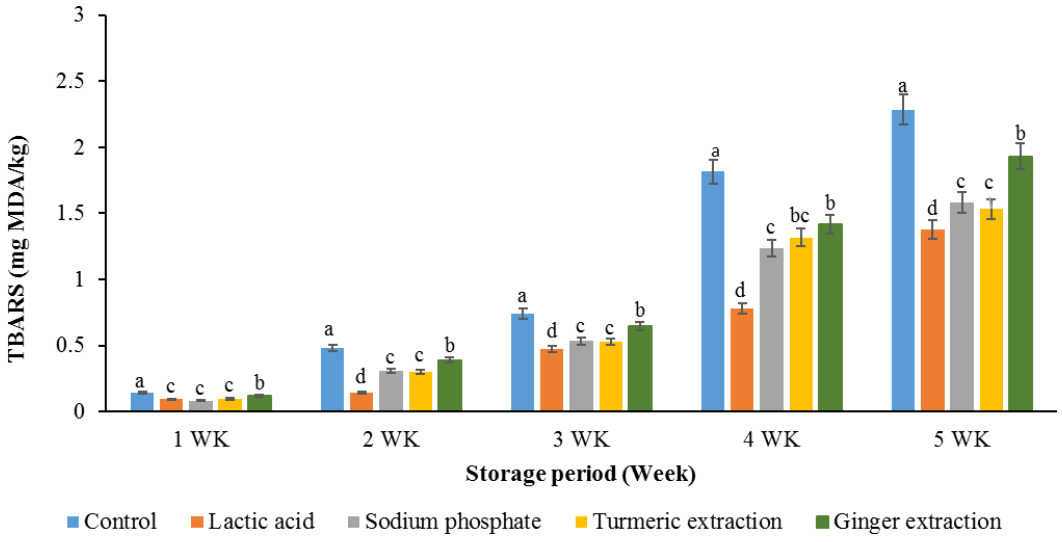

Figure 3.1: TBARS values of MDCM during storage
Values present mean±SD, n=3, Bars with different letters are significantly different (P<0.05).

Aqueous extracts of turmeric showed antioxidant and antimicrobial activity due to the presence of curcumin. It is known that the phenolic character of curcumin is responsible for its antioxidant properties (Sendamangalam, 2011). Due to this, rancidity was lower in TE treated MDCM sample during the storage period and it caused an increased shelf life of MDCD. Trout and Dale (1990) reported on the effectiveness of sodium tripolyphosphate in reducing rancidity.
The main active phytochemicals present in ginger are gingerols, shogaols, and paradols (Halvorsen *et al*., 2002). They have strong antioxidant properties. Thereby, they might be the reason to reduce rancidity during storage period of PE treated MDCM.

Water holding capacity (WHC) of MDCM

This property is related to the weight loss and final quality of the product in which the MDCM is used. As shown in Figure 3.2, the WHC percentages of the five treatment groups decreased throughout the storage period of 5 weeks. Samples produced by sodium phosphate showed comparatively higher ($P<0.05$) water holding capacity. Phosphate increases the WHC while calcium, magnesium, iron and copper decrease the WHC (Majid *et al*., 2017). The lowest ($P<0.05$) WHC was obtained from LA treatment in the 5th week.

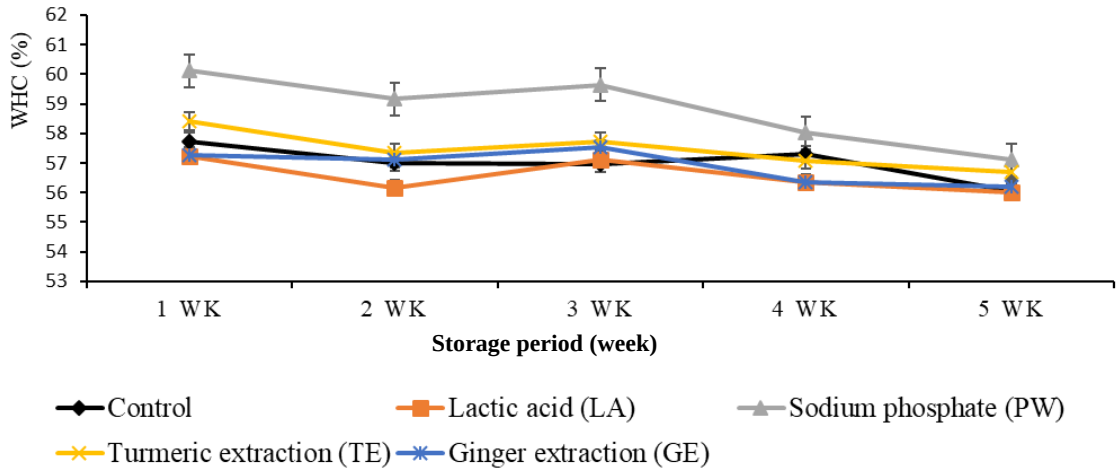

Figure 3.2: WHC of MDCM during storage
Values present mean±SD, n=3, Bars with different letters are significantly different ($P<0.05$).

Trisodium phosphate has the function of optimizing the water binding capacity of the muscle proteins by influencing pH. Hence, the contribution of phosphate is to enhance the WHC of MDCM. Also, phosphates have been used effectively in preventing lipid oxidation and to improve the quality characteristics in MDCM (Nguyen,2011).

Total Viable Plate Count (TVPC) and *Salmonella* analysis of MDCM

Turkish Food Codex has recommended the specifications of mechanically deboned meats. Accordingly, TVPC content in MDCM should be lower than 5×10^6 CFU/g of sample and *E. coli* should be lower than 5×10^3 CFU/g of sample.
Compared to the control sample, the TVPC belonging to pre-wash treatments of LA, PW, TE, GE reduced by 8%, 6%, 4.5% and 2% respectively on day 0 ($P<0.05$) indicating the antimicrobial effects of pre-wash treatments. On the other hand, despite the pre-wash treatments applied, the TVPC increased in all samples during the storage. In the 5th week, the control sample showed the highest ($P<0.05$) TVPC and the lactic acid treated sample showed the lowest TVPC ($P<0.05$). These findings are in agreement with the findings of Tosun and Tamer (2000) who reported that lactic acid application reduced microbiological count of carcasses.
There were no *Salmonella* counts recorded in all the treatment groups and the control throughout

the storage period. According to SLS standards, the MDCM must also be tested for *Salmonella* and it must be absent in MDCM. According to the findings of Doores (2005), lactic acid has shown antimicrobial activities against many pathogenic organisms such as *Salmonella* and *Clostridium* because it interferes with the proton transfer across cell membranes.

CONCLUSIONS/RECOMMENDATIONS

This study revealed that 2% (v/v) lactic acid (LA) could be successfully used to improve the quality and shelf life of MDCM with low lipid oxidation. Furthermore, MDCM made from all the pre-washed were effective in reducing the TVPC. Finally, it is recommended measure the quality parameters of MDCM for an extended storage time period.

REFERENCES

Aminzare, M & Hashemi, M & Ansarian, E & Bimkar, M & Hassanzadazar, H & Mehrasbi, M & Daneshamooz, S & Raeisi, M & Jannat, B & Afshari, A. (2019). Using Natural Antioxidants in Meat and Meat Products as Preservatives: A Review. *Advances in Animal and Veterinary Sciences*. 7. 10.17582

Antolovich, M., Prenzler, P. D., Patsalides, E., McDonald, S., & Robards, K. (2002). Methods for testing antioxidant activity. *The Analyst*, 127, 183–198.

Bigolin, J., Weber, C. & Alfaro, A. (2013). Lipid Oxidation in Mechanically Deboned Chicken Meat: Effect of the Addition of Different Agents. *Food and Nutrition Sciences*. 04. 219-223.

Doores S. Organic acids. In: Davidson P. M., Sofos J. N., Branen A. L., editors. *Antimicrobials in foods.* CRC Press; FL: (2005). pp. 91–142.

Halvorsen, B. L., Holte, K., Myhrstad, M. C. W., Barikmo, I., Hvattum, E., Remberg, S. F., Wold, A. B., Haffner, K., Baugerød, H., Andersen, L. F., Moskaug, O., Jacobs, D. R., & Blomhoff, R. (2002). A systematic screening of total antioxidants in dietary plants. *Journal of Nutrition*, 132(3), 461-471.

Kähkönen, M.P., Hopia, A.I., Vuorela, H.J. *et al.* (1999). Antioxidant activity of plant extracts containing phenolic compounds. *Journal of Agricultural & Food Chemistry*, 47, 3954–3962.

Kanatt, S. R., Chander, R., & Sharma, A. (2010). Antioxidant and antimicrobial activity of pomegranate peel extract improves the shelf life of chicken products. *International Journal of Food Science & Technology, 45(2), 216–222.*

Liu. Q., Lanari. C. & Schaefer. D. M. A Review of Dietary Vitamin E Supplementation for Improvement of Beef Quality. *Journal of Animal Science*, Vol. 73, No. 10, 1995, pp. 3131-3140.

Nguyen H.B.S.L. (2011). Use of phosphates in meat products. *African Journal of Biotechnology*, 10(86).

Ockerman H. W., Hansen C. L. *Edible tissue from bone: Animal by-produt utilization.* 1st ed. CRC Press; Boca Raton: (2000). pp. 217–246.

Sendamangalam, V., Choi, O. K., Seo, Y., & Kim, D.-S. (2011). Antimicrobial and Antioxidant Activities of Polyphenols against Streptococcus mutans. *Free Radicals and Antioxidants, 1(3), 48–55.*

Tosun H, Tamer AÜ (2000). A study on the effects of chilling on the microbial quality of poultry carcasses and surface decontamination with lactic acid. *Turkish Journal of Veterinary And Animal Sciences*., 24: 517-521.

Trout, G. R.; Dale, S. Prevention of warmed-over flavor in cooked beef: Effect of phosphate type, phosphate con-centration, a lemon juice/phosphate blend, and beefextract. *Journal of Agricultural and Food Chemistry* 1990 38 665–669

ACKNOWLEDGMENTS

The authors gratefully acknowledge the management of CIC Poultry Processing Plant, Badalgama Sri Lanka for providing opportunity to carry out this research.