EFFECTS OF AMMONIUM HYDROXIDE AND SALT ON MYOGLOBIN REDOX STABILITY AND LIPID OXIDATION IN GROUND BUFFALO MEAT

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***Abstract*-The objectives of this study was to evaluate the effects of ammonium hydroxide (AH) and sodium chloride on the quality of raw ground buffalo meat patties under aerobic packaging condition. Ground buffalo meat was treated with distilled water (control), 0.5% v/w AH, 1.0% v/w AH, 2.0% v/w AH and 1.0% w/w sodium chloride was added for all the samples. Patties (100 g) were prepared and packed under aerobic conditions and analyzed for different quality characteristics during storage at 4 ºC. Treatment with AH increased (*P*<0.05) the pH, water holding capacity (WHC), Hunterlab *a** (redness) and *chroma* values of raw ground buffalo meat patties during storage relative to their controls. Ammonium hydroxide inhibited (*P*<0.05) metmyoglobin formation compared to control in raw buffalo meat samples. There was a significant (*P*<0.05) reduction in thiobarbituric acid reactive substances (TBARS) values in AH treated samples compared to control throughout storage. These results indicate the potential antioxidant and color stabilizing effects of AH in raw ground buffalo meat patties.**

***Index Terms:* Ammonium hydroxide, buffalo meat, color, lipid oxidation**

I. INTRODUCTION

Ammonium hydroxide (NH_4 OH) is a strong alkali and is being used in food industry in baked goods, gelatins/puddings, cheeses etc. Ammonium hydroxide (AH) is listed as generally regarded as safe (GRAS) by Food and Drug Administration (FDA) (21 CFR 184.1139) and is included in the Codex Alimentarius and as such may be used in variety of meat and meat products including comminuted meats under the conditions of good manufacturing practices (GMP) as outlined in the Preamble of the Codex GSFA. Beneficial effect of AH in beef steaks in improving shear force value, tenderness, and sensory traits are recently reported by few researchers (Hamling & Calkins, 2008; Hamling, Jenschke, & Calkins, 2008). Enhancement of meat pH with a solution containing AH, carbon monoxide and salt has been shown to improve consumer palatability ratings (Nath, Hand, Everts, Everts, Wulf, & Maddock, 2006; Everts, Everts, Hand, Nath, Wulf, & Maddock, 2006). In addition, significant antimicrobial effects of AH was also reported in ground goat meat (Gupta, Garg, & Tiwari, 1988) and beef strip loins (Cerruto-Noya, Van Overbeke, & Mireles DeWitt, 2009).

However, it is unknown how AH might affect ground buffalo meat quality when used along with sodium chloride. Hence, the objective of this study was to evaluate the effects of ammonium hydroxide and sodium chloride on the quality of ground buffalo meat patties under aerobic packaging during refrigerated storage.

II. MATERIALS AND METHODS

Freshly ground buffalo meat was divided into four batches of 2 kg each and treated with 5.0% v/w distilled water (control), 0.5% v/w ammonium hydroxide (0.5% AH), 1.0% v/w ammonium hydroxide (1.0% AH) and 2.0% v/w ammonium hydroxide (2.0% AH). The ammonium hydroxide was diluted with distilled water to make a final volume of 5.0% v/w of meat. Sodium chloride (1.0% w/w) was added to all the four batches and mixed by hand for 5 minutes. From each treatment, eight patties (100 g, 10 cm diameter, and 1.5 cm thickness) were hand formed and two patties each were packaged in oxygen-permeable low-density polyethylene pouches. The aerobically packaged samples were analysed on 0, 3, 6 and 9 days of storage at 4 ºC. During storage raw ground buffalo meat samples were analyzed for pH, instrumental color, water holding capacity (WHC) (Wardlaw, Maccaskill, & Acton, 1973), metmyoglpbin formation (Warris, 1979), and thiobarbituric acid reactive substances (TBARS) (Witte, Krauze, & Bailey, 1970). The 0' day samples were analyzed prior to packaging immediately after patty formation. The overall experiment was replicated on three separate occasions. Statistical analysis was performed with the analysis of variance (ANOVA) using SPSS (SPSS version 13.0 for windows; SPSS, Chicago, IL, USA) and differences among mean values were obtained by Duncan's multiple range tests.

III. RESULTS AND DISCUSSION

Treatment with ammonium hydroxide (AH) increased (P<0.05) the pH of ground buffalo meat patties. Increase in pH and ionic strength resulted in significant (P < 0.05) increase in water holding capacity (WHC) in all AH treated ground buffalo meat samples compared to control samples. Treatment of ground buffalo meat with AH at all levels significantly (P<0.05) increased the Hunterlab a^* values (redness) (15.67) compared to controls (10.58) on 3rd, 6th and 9th day of storage under aerobic condition. Reduction in *hue* and increase in *chroma* were observed in all the AH treated ground buffalo meat patties in comparison to non-treated controls during storage. These instrumental color readings clearly suggest the beneficial effect of AH in improving the redness of ground buffalo meat during refrigerated storage under aerobic conditions.

Metmyoglobin (Met Mb) formation (Fig. 1) was significantly (P<0.05) reduced in AH treated ground buffalo meat patties during storage on 6th and 9th days compared to controls. However, no difference was observed in Met Mb formation between control and AH treatment on 0 and 3rd days of storage. This is because in ground buffalo meat patties stored under aerobic condition one would expect both control and treated samples under these conditions to have a more desirable, bright red oxymyoglobin (Oxy Mb) color

during initial storage. However, in control samples myoglobin oxidation quickly turns Oxy Mb to Met Mb, producing an undesirable brown color as the storage progresses.

Lipid oxidation as measured by thiobarbituric acid reactive substances (TBARS) was significantly (P<0.05) reduced (1.794 to 0.523 mg malonaldehyde/kg sample) in all AH treated samples compared to controls throughout the storage (Fig. 2). Many authors have suggested that lipid and pigment oxidation are closely related in different species and oxidation of one will exacerbate the other. Significantly higher malonaldehyde produced in control samples can alter Mb redox stability resulting in increased metmyoglobin formation (Lynch & Faustman, 2000).

IV. CONCLUSION

Ammonium hydroxide has significantly increased (P<0.05) the water holding capacity, a^* values (redness) and reduced the metmyoglobin formation, thiobarbituric acid reactive substances without any adverse effect on microbial quality (data not shown) in ground buffalo meat patties under aerobic conditions during storage at 4 ºC.

REFERENCES

Cerruto-Noya, C. A., VanOverbeke, D.L., & Mireles Dewitt, C.A. (2009). Evaluation of 0.1% ammonium hydroxide to replace sodium tripolyphosphate in fresh meat injection brines. *Journal of Food Science, 74,* C519-C525.

Everts, A. J., Everts, A. K. R., Hand, C. D., Nath, T. M., Wulf, D. M., & Maddock, R. J. (2006). Effects of pH-enhancement on consumer ratings of various meat products. http://www.meatscience.org/Pubs/rmcarchv/2006/presentations/RMC06_Abstracts.

Gupta, L. K., Garg, V., & Tiwari, R. P. (1988). Elaluation of ammonium hydroxide as preservative for ground meat. *MIRCEN Journal, 4,* 431-437.

Hamling, A. E., & Calkins, C. R. (2008). Enhancement of beef chuck and loin muscles with ammonium hydroxide and salt. *Journal of Animal Science, 86,* 967-971.

Hamling, A. E., Jenschke, B. E., & Calkins, C. R. (2008). Effects of aging on beef chuck and loin muscles enhanced with ammonium hydroxide and salt. *Journal of Animal Science, 86,* 1200-1204.

Lynch, M. P., & Faustman, C. (2000). Effect of aldehyde lipid oxidation products on myoglobin. *Journal of Agricultural and Food Chemistry, 48,* 600–604.

Nath, T. M., Hand, C. D., Everts, A. J., Everts, A. K. R., Wulf, D. M., & Maddock, R. J. (2006). Trained and consumer evaluations of five different beef muscles with or without pH enhancement using ammonium hydroxide. http://www.meatscience.org/Pubs/rmcarchv/2006/presentations/RMC06_Abstracts.

Wardlaw, F. B., Maccaskill, L. H., & Acton, J. C. (1973). Effect of postmortem muscle changes in poultry meat loaf properties. *Journal of Food Science, 38,* 421–424.

Warris, P. D. (1979). The extraction of haem pigments from fresh meat. *Journal of Food Technology, 14,* 75–80.

Witte, V. C., Krauze, G. F., & Bailey, M. E. (1970). A new extraction method for determining 2-thiobarbituric acid values of pork and beef during storage. *Journal of Food Science, 35,* 582–585.

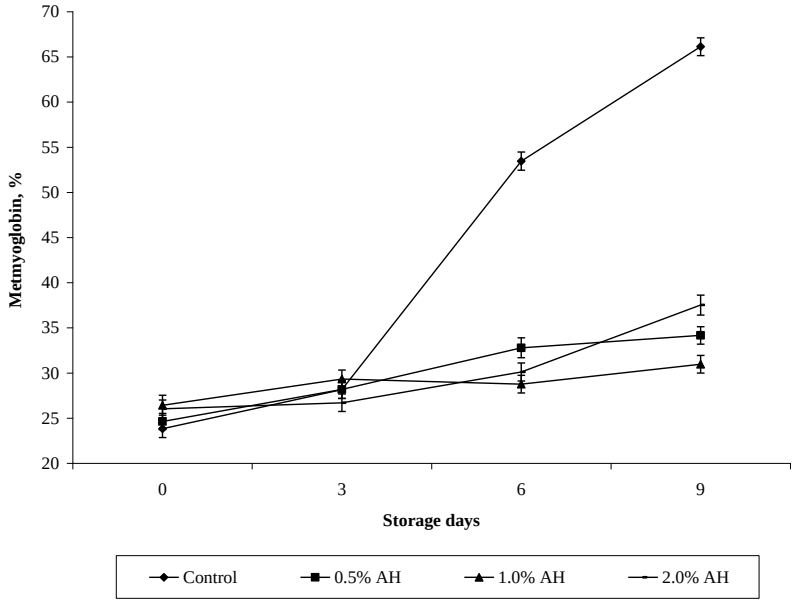

Fig. 1 Effects of ammonium hydroxide (AH) on the metmyoglobin (Met Mb) formation of raw ground buffalo meat patties stored at 4 °C. Standard error bars are indicated.

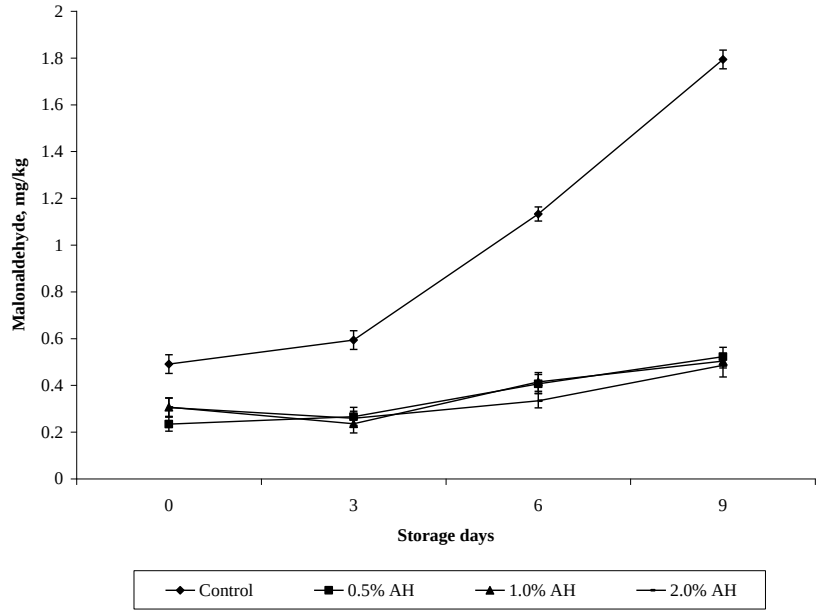

Fig. 2 Effects of ammonium hydroxide (AH) on the thiobarbituric acid recative substances (TBARS) values of raw ground buffalo meat patties stored at 4 °C. Standard error bars are indicated.