Effects of frozen storage duration on lipid and colour stability of mince from fallow deer meat during display storage

C. Chakanya[1*], E. Anaurd, V. Muchenje[2] and L.C. Hoffman[2]

[1]Department of Livestock and Pasture Science, University of Fort Hare, Private Bag X 1314, Alice 5700, South Africa;

[2]Department of Animal Sciences, Stellenbosch University, Private Bag X1 Matieland, Stellenbosch 7602, South Africa

[3]CIRAD, UMR QualiSud, F-34398, Montpellier, France

[4]CIRAD, UMR QualiSud, Matieland, Stellenbosch 7602, South Africa

*Corresponding author email: chido.thpp@gmail.com

Abstract – Colour and oxidative stability of minced meat produced from the trimmings of 2 and 4 months frozen/thawed fallow deer was investigated. For each of the harvested animals, trimmings were vacuum packed and frozen at -20°C and upon thawing, minced and aerobically displayed for five days. Colour attributes, myoglobin redox forms and lipid oxidation of the mince were measured daily. Proximate composition was determined in mince on day 0. Average lipid content did not differ between treatments (P≥0.05). Lipid and metmyoglobin oxidation increased (P≤0.05) with frozen duration. Shelf life of frozen/thawed minced meat, irrespective of duration, was limited to two days as evidenced by extended signs of oxidation and discolouration (a* values < 12 and high TBAR values).

Key Words – Venison, ground meat, oxidation

I. INTRODUCTION

Frozen/thawed products are regarded to be of an inferior quality as compared to fresh meat products [1]. This is mainly due to the disruptive actions of ice crystals that form during freezing on the meat structural lipids and proteins [4] which leads to poor colour and oxidative stability upon thawing [2]. Important to note is that the effects of freezing are dependent on the meat characteristics itself [3]. Research has focused on the display shelf life of frozen/thawed muscle cuts from traditional red meat species which differ considerably from game meat. Fallow deer meat contains higher amounts of myoglobin and poly-unsaturated fatty acids [4], making the meat more susceptible to oxidative processes and influencing its sensitivity to freezing and thawing. The aim of this study was therefore to determine the effects of frozen duration on the meat quality attributes of fallow deer mince during retail display following thawing.

II. MATERIALS AND METHODS

Twenty four mature fallow deer were harvested from Brakkekuil farm (34° 18’ 24.0” S and 20° 49’ 3.9” E; 93 m above sea level) in the Western Cape Province, South Africa. Harvesting procedures were approved by the Stellenbosch University Animal Care and Use Committee (ethical clearance number SU-ACUM 14-00044). After removing major muscles (*semitendinosus, biceps femoris, infra* and *supra spinatus, semimembranosus, longissimus thoracis et lamborum*) and discarding all external fat, trimmings were vacuum packed per animal and stored at -20±4°C for 2 and 4 months. After the freezing periods, meat was thawed (24 h; 4±1°C), minced (5 mm diameter plate; 8°C) and sub-divided into portions that were randomly allocated a sampling date; each portion was packaged in polystyrene trays and covered in low density polyethylene. Portions were then refrigerated at 4±1°C and sampled for analysis on day 0 (immediately after mincing), 1, 2, 3, 4 and 5. Moisture, protein, lipid and ash content were analyzed according to the AOAC [5]. Colour readings were done onto the overwrap packaging material. Total myoglobin forms were measured according to Tang *et al*. [6]. Thiobarbituric acid reactive substances (TBARS) were measured spectrophotometrically. The GLM model of STATISTICA (version 8) statistical software was used to compare LS Means. Fisher’s LSD was used for post hoc testing.

III. RESULTS AND DISCUSSION

No differences (P≥0.05) between mince produced from 2 months and 4 months frozen/thawed fallow deer meat were observed and the mince had an average of 74±0.14% moisture, 22.5±0.15% protein, 2.7±0.11% fat and 1.2±0.01) ash. The 2 months frozen/thawed meat mince had higher initial redness (a*) values on day 0 only (Figure 1). By the second day of display, the redness had gone below the acceptable value of 12 [8]. These findings are comparable to findings from Chakanya *et al*. [9]. Metmyoglobin increased throughout display and mince from 2 months frozen/thawed meat

had lower metmyoglobin percentages on day 0 only. A rapid increase in TBARS was noted throughout display with mince produced from meat frozen for 4 months showing higher values from day 4 onwards (Figure 1).

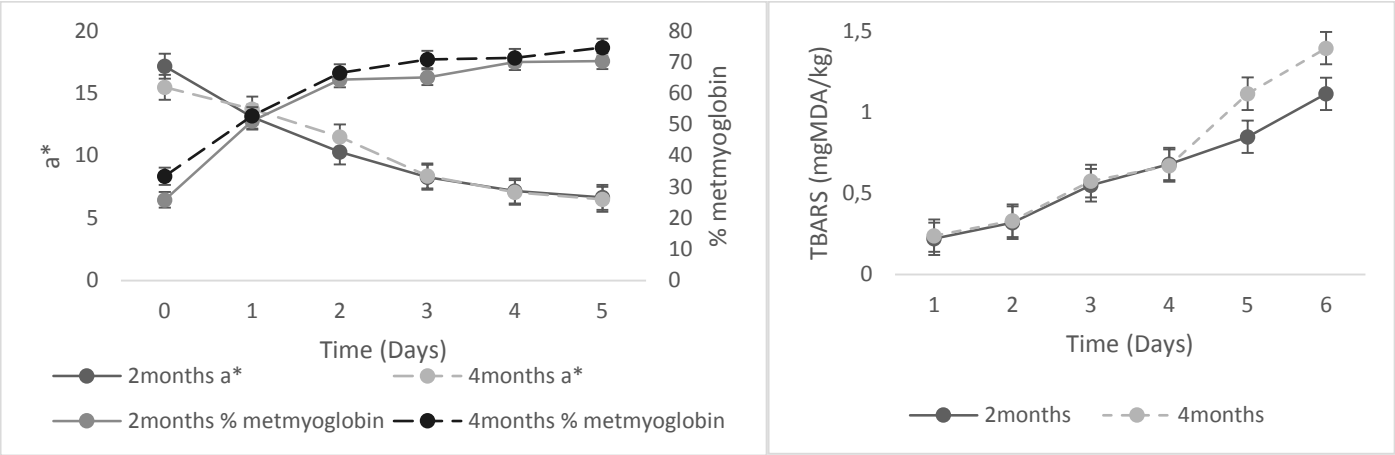

Figure 1 Colour (redness *a**) % metmyoglobin and TBAR values of mince from (●) 2 months frozen/thawed meat and (■) 4 months frozen/thawed meat over display storage. Least square means with different superscripts are significantly different ($P \leq 0.05$). Error bars represent standard error (n=12).

IV. CONCLUSION

Freezing fallow deer meat for four months resulted in reduced colour stability and limited retail display to two days. It would be recommended that freezing fallow deer meat for up to four months be done if meat will not be retail displayed for longer than two days.

ACKNOWLEDGEMENTS

This research was funded by the South African Department of Science and Technology and administered by the National Research Foundation of South Africa under the SARChI chair in Meat Sciences. The authors also acknowledge the Innovation Masters and doctoral scholarship for non-south African students (NRF Free standing).

REFERENCES

1. Kim, Y. H. B., Frandsen, M. & Rosenvold, K. (2011). Effect of ageing prior to freezing on colour stability of ovine longissimus muscle. Meat Science 88: 332–337.
2. Hansen, E., Junchar, D., Henckel, P., Karlsson, A., Bertelson, G. & Skibsted, L. H. (2004). Oxidative stability of chilled pork chops following long term freeze storage. Meat Science 68: 479–484.
3. Vieira, C., Diaz, M. T., Martínez, B. & García-Cachán M. D. (2009). Effect of frozen storage conditions (temperature and length of storage) on microbiological and sensory quality of rustic crossbred beef at different states of ageing. Meat Science 83: 398–404.
4. Daszkiewicz, T., Hnatyk, N., Dąbrowski, D., Janiszewski, P., Gugolek, A., Kubiac, D., ´Smieci`nska, K., Winarski, R. & Koba-Kowalczyk, M. (2015). A comparison of the quality of the Longisissimus luborum muscle from Wild and farm raised fallow deer (*Dama dama L*). Small Ruminant Research 129: 77–83.
5. AOAC International (1994). Official methods of analysis. (14th ed.). Washington, DC, USA: Association of Official Analytical Chemists Inc.
6. Tang, J., Faustman, C. & Hoagland, T. A. (2004). Krywicki revisited: Equations for spectrophotometric determination of myoglobin redox forms in aqueous meat extracts. Journal of Food Science 69: C717–C720.
7. Wiklund, E., Stevenson-Barry, J. M., Duncan, S. J. & Littlejohn, R. P. (2001). Electrical stimulation of red deer (*Cervus elaphus*) carcasses - effects on rate of pH-decline, meat tenderness, colour stability and water-holding capacity. Meat Science 59: 211–220.
8. Chakanya, C., Arnaud, E., Muchenje, V. & Hoffman, L. C. (2017). Colour and oxidative stability of mince produced from fresh and frozen/thawed fallow deer (*Dama dama*) meat. Meat Science 126: 63–72.
9. Leygonie, C., Britz, T. J. & Hoffman L. C. (2012). Meat quality comparison between fresh and frozen/thawed ostrich (*M. Iliofibularis*). Meat Science 91: 364–368.