IMPROVEMENT OF PHYSICOCHEMICAL QUALITY OF FRESH PORK LOIN DURING STORAGE BY NATURAL POLYPHENOL DIET SUPPLEMENTATION

M.P. Fortier[1,2], F. Guay[1], and L. Saucier[1,2]

[1]Department of Animal Science and [2]Institute of Nutraceutical and Functional Foods,

Université Laval, Quebec City (QC), G1V 0A6 Canada

Abstract – Oregano oil and ground cranberry pulp supplements were added to the diets of finishing pigs to determine their physicochemical effects on fresh loin during storage. Two concentrations of oil (250 and 500 mg/kg) and three of cranberry (5, 10 and 20 g/kg) were tested according to a factorial experimental design. The control group did not receive any supplements. The meat was vacuum packed and analyzed after 0, 23, 45 and 60 days of storage at < 4°C. Samples were re-packaged under aerobic conditions after 0 or 23 days and then analyzed after 4, 8 and 12 days. The pH was determined on the *Longissimus dorsi* muscle between the 3rd and 4th last ribs, 45 min and 24 h after slaughter. Color was also analyzed for each sample and drip loss evaluated only on day 0. The results showed that no treatment had any effect on the pH of the meat, whether at 45 min or 24 h after slaughter (P>0.05). The evaluation of the color showed, during the 60 days of storage, a significant difference between the control and the different treatments for L*, a*, b* (P<0.05) for samples stored under anaerobic conditions. The lowest drip loss was obtained with 10 g/kg of cranberry pulp (P <0.05).

Key Words – oregano oil, cranberry, meat quality

I. INTRODUCTION

From a physic-chemical standpoint, oxidation is the primary cause of fresh meat deterioration during storage [1]. Certain factors can influenced the oxidation of meat, such as reduced pH, a high content of polyunsaturated fatty acids, a high rate of myoglobin and temperatures above 4°C [2].

New technologies have been successfully implemented to slow down oxidation. These include the use of modified atmosphere packaging, control of storage conditions (temperature, light, humidity, etc.) and the addition of synthetic products to reduce physicochemical defects (e.g., lactate, nitrite and nitrate). However, consumers are increasingly concerned with the quality of their food and request more natural alternatives.

This has led to the increased interest in the antioxidant properties of natural substances, especially vitamin E. Vitamin E is now used systematically in the diet of pigs. Many reports also conclude that vitamin E feed supplementation to growing and finishing pigs improves color stability and lipid oxidation and more effectively than with exogenous addition[3, 4]. Thus far, the exogenous addition of essential oils to food has been investigated mainly to extend meat/food shelf life [5]. Essential oils are best known for their antimicrobial effects but may also positively influence the oxidation of meat during storage. A study on lambs also demonstrates that adding oregano oil supplement in the diet exerts powerful antioxidant effects, allowing a slow lipid oxidation in meat [6]. Also, a study on turkeys reported that the addition of dietary oregano oil reduced the oxidation of more than 50% after 9 days of storage [5].

The majority of berries such as raspberries or cranberries contain large amounts of polyphenolic compounds, especially flavonols and anthocyanins, known for their antioxidant capacity and their [7, 8] ability to reduce oxidation. In meat, the exogenous addition of extracts from cranberry juice or pulp showed a decrease of lipid oxidation of fresh turkey meat [9] and processed pork meat [10]. The addition of cranberries in the diet of pigs led to an increase in blood levels of anthocyanins and antioxidant capacity in plasma [11]. It was also demonstrated that anthocyanins contained in cranberry accumulate in tissues when added to pig feed and also remain longer in tissues than in plasma.

So far, the efficacy of these natural antioxidant compounds has been tested mainly by exogenous addition to fresh or processed meats. We investigated the potential of oregano oil and cranberry pulp in feed to improve the physicochemical quality of fresh pork loin during aerobic and anaerobic storage. The development of new strategies for preserving meat by focusing on dietary intake of natural active compounds should provide more immediate antioxidant action upon carcass breaking.

II. MATERIALS AND METHODS

A. Animals and feeding protocol

A total of 77 pigs were placed individually into pens and fed according to a commercial feed program based on corn and soybean meal diets served *ad libitum* until an average weight of 120 kg was reached. Six weeks before slaughter, each animal received the same diet supplemented with oregano oil (Regano® C500, Ralco Nutrition, Inc., Marshall, MN) and crushed cranberry pulp (Fruit d'Or, Notre-Dame-de-Lourdes, Quebec, Canada) using one of six predetermined combination treatments according to the following distribution factor: two concentrations of oregano oil (250 and 500 mg/kg of total feed) and three of cranberry pulp (5, 10 and 20 g/kg of total feed). Treatment without supplement was also included as a control.

B. Muscle sampling and pork quality measurements

Pigs were slaughtered in a federally inspected facility [12]. The pH was measured using a pH meter (ROSS, Orion 4 Star Thermo Scientific, Beverly, CA, USA) fitted with an Orion Kniphe pH electrode (ThermoFisher, Nepean, ON, Canada) and an automatic temperature compensation probe, 45 min (pH45) and 24 h (pHu) after slaughter. After a chilling period of 24 h, all *Longissimus dorsi* (LD) muscles were deboned and sliced to form 10 samples (12 cm long) per animal. Each sample was vacuum packed (Sealed Air Co, Mississauga, Canada), chilled in a salted water tank and then refrigerated in a commercial cooler set at 2 ± 1°C for up to 60 days. On days 0 and 23, six samples from different animals for each treatment were randomly selected and repackaged aerobically in a Styrofoam tray with an absorbent pad, and sealed with an oxygen permeable polyethylene film obtained from a local food equipment distributor (Emballage L. Boucher, Quebec City, Canada). Samples were kept refrigerated in a commercial cooler set at 2 ± 1°C under aerobic conditions for a period of 4, 8 and 12 days. Sample allocation was identical for all treatments and storage conditions.

The color was evaluated on the center of the eye of the loin using a Minolta Chromameter CR 300 (Minolta Ltd., Osaka, Japan) with a D65 light source and 0º viewing angle geometry according to the reflectance coordinates (CIE L*, a*, b*) after exposing the muscle surface to 20 min blooming time [13]. Drip loss was evaluated according to the EZ-Driploss method [14]. Briefly, a sample of LD (about 2.5 cm thick X 2.5 cm in diameter) was taken at the center of the muscle using a stainless steel punch and stored at 4°C for 48 h prior to measuring water loss by weight difference.

C. *Statistical analysis*

To determine whether treatment, time, and their interactions had an effect on the previously described measurements, data were analysed by an analysis of variance (ANOVA) using the MIXED procedure of SAS. Predetermined contrasts were used to determine the effect of supplementation (control vs. all other treatments), effect of oregano oil (250 vs. 500) and effect of cranberry pulp (linear and quadratic effect). Time of storage under aerobic conditions (4, 8, and 12 days) and anaerobic conditions (0, 23, 45 and 60 days) was taken into consideration for all analyses [15].

III. RESULTS AND DISCUSSION

For all analyses, whether under aerobic or anaerobic storage, there was a significant effect of time ($P < 0.05$). This means that, in spite of storage conditions (cold, under-vacuum packaging, etc...), the meat undergoes a physicochemical change, more or less important, during storage under refrigeration.

The pH value of meat from pigs receiving cranberry pulp and oregano oil supplement was similar to the control pigs ($P > 0.05$). The mean value of the pH 45 minutes after slaughter was 5.75 ± 0.08 and the mean value of the pHu for all the carcasses was 5.69 ± 0.05.

The drip loss evaluation showed a significant quadratic effect of the addition of cranberry pulp for the samples at day 0; the lowest drip loss was obtained with 10g/kg of pulp cranberry ($P<0.05$; Fig.1). Although the modes of action of cranberry compounds on muscle meat are not well known yet, this observation suggests that it is possible to reduce drip loss from the meat with cranberry pulp in the diet.

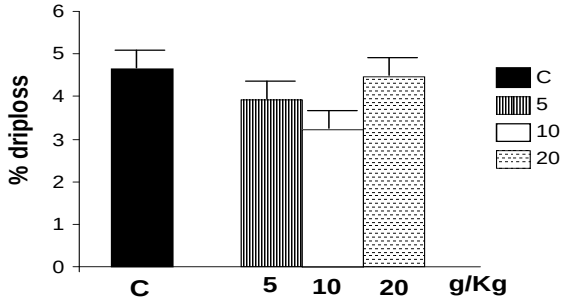
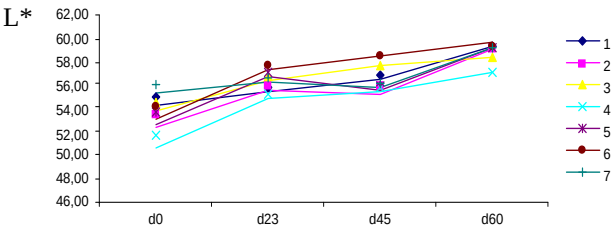
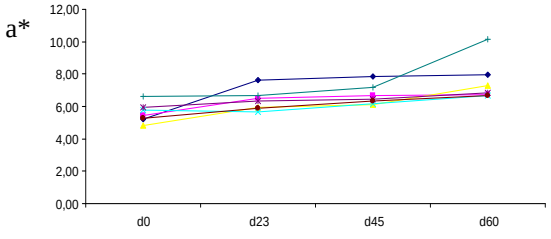


Fig.1. Dietary cranberry pulp effects on drip loss at day 0. Evaluation of drip loss showing a quadratic effect of cranberry pulp ($P<0.05$). The maximum effect is obtained with a concentration at 10 mg/kg.

The evaluation of the color showed, during the 60 days of storage, a significant difference between the control and the different treatments for L*, a*, b* ($P<0.05$; Fig. 2) for samples stored under anaerobic conditions. At day 0, the evaluation of L* space showed that control group is more reflective than all other treatments. The evaluation of a* space, during all storage time, showed that groups with the different supplementations maintain their color more effectively than the control group ($P<0.05$). The same portrait is observed with the evaluation of color in the b* space.



Day of sampling



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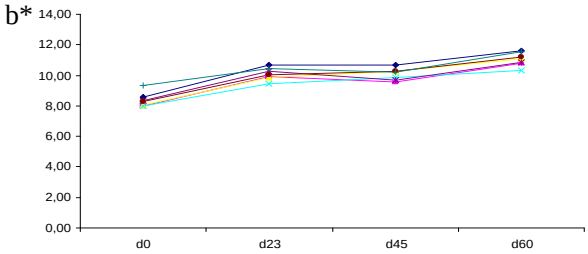

Day of sampling

Fig. 2. Evolution of color in the different space (L*, a*, b*) of fresh pork loins after 0 to 60 days of storage at 2 ± 1°C under anaerobic conditions

The analysis of color in the different space (L*, a*, b*) demonstrated that the addition of cranberry pulp and oregano oil improves meat color stability during the whole days of storage.

IV. CONCLUSION

The results suggest that supplementation of feed with oregano oil and cranberry pulp had a positive effect on meat physicochemical quality. Cranberry pulp reduces the meat exudation in the first days of storage. Moreover, treatments studied showed a better stability in color compared to the control group. The incorporation of antioxidant from natural sources is an attractive way to improve meat quality which deserves further attention. The positive effect was observed with only six weeks of supplementation before slaughter.

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REFERENCES

1. Min, B. and Ahn, D.U. (2005) Mechanism of Lipid Peroxidation in Meat and Meat Products - A Review. Food Science and Biotechnology. 14 (1): 152-163.
2. Zouari, N., Elgharbi, F., Fakhfakh, N., Bacha, A.B., Gargouri, Y. and Miled, N. (2010) Effect of dietary vitamin E supplementation on lipid and colour stability of chicken thigh meat. African Journal of Biotechnology. 9(15): 2276-2283.
3. Houben, J.H. and Gerris, C.V. (2002) In vivo or in vitro application of vitamin E and the colour stability of low-oxygen packaged, sliced, pasteurised, differently cured pork shoulder model products. European Food Research and Technology, 215 (5), 384-389.
4. Lahucky, R., Nuernberg, K., Kovac, L., Bucko, O., and Nuernberg, G. (2010) Assessment of the antioxidant potential of selected plant extracts – In vitro and in vivo experiments on pork. Meat Science, 85, 779-784.
5. Govaris, A., Botsoglou, N., Papageorgiou, G., Botsoglou, E., and Ambrosiadis, I. (2004) Dietary versus post-mortem use of oregano oil and/or a-tocopherol in turkeys to inhibit development of lipid oxidation in meat during refrigerated storage. International Journal of Food Sciences and Nutrition. 55 (2): 115-123.
6. Simitzis, P.E., Deligeorgis, S.G., Bizelis, J.A., Dardamani, A., Theodosiou, I., Fegeros, K., Riëtte, L., and Van Laack, J.M. (2008). Determinants of Ultimate pH of Meat and Poultry. Meat Science. 79: 217–223.
7. Kahkonen, M.P., Hopia, A. and Heinonen, M. (2001). Antioxydative potential and antioxidant activity determination of plant extracts. Journal of agriculture and food chemistry, 49, 4076-4082.
8. He, X. and Liu, R.H. (2006) Cranberry phytochemicals: isolation, structure elucidation, and their antiproliferative and antioxidant activities. Journal of Agriculture and Food Chemistry. 54, 7069–7074.
9. Raghavan, S. and Richards, M.P. (2006) Partitioning and Inhibition of Lipid Oxidation in Mechanically Separated Turkey by Components of Cranberry Press Cake. Journal of Agriculture and Food Chemistry, 54 (17), 6403–6408.
10. Lee, C., Reed, J.D. and Richards, M.P. (2006) Ability of various polyphenolic classes from cranberry to inhibit lipid oxidation in mechanically separated turkey and cooked ground pork. Journal of muscle food, 17 (3), 248-266.
11. Kalt, W., Blumberg, J.B., McDonald, J.E., Vinqvist-Tymchuk, M.R., Fillmore, S.A., Graf, B.A., O'Leary, J.M., and Milbury, P.E. (2008) Identification of anthocyanins in the liver, eye, and brain of blueberry-fed pigs. Journal of Agriculture and Food Chemistry. 56: 705–712.
12. CFIA (2011) Canadian Food Inspection Agency. Sampling and testing procedures. Chapter 5 in: Meat Hygiene Manual. Meat and Processed Animal Products Division, Government of Canada. http://www.inspection.gc.ca/francais/fssa/meavia/man/ch5/table5f.shtml. Page visited 2012-03-12
13. Faucitano, L., Ielo, M.C., Ster, C., Lo Fiego, D.P., Methot, S. and Saucier, L. (2010). Shelf life of pork from five different quality classes. Meat Science, 84(3), 466-469.
14. Rasmussen, A.J. and Andersson, M. (1996) New method for determination of drip loss in pork muscles. In: Hildrum and Risvik (Eds.) Proc. 42nd International Congress of Meat Science and Technology, Lillehammer, Norway, 286–287.
15. SAS (2002). Statistical Analysis System, Release 9.1. SAS Institute Inc., Cary NC.