VOLATILE COMPOUNDS OF MEAT FROM BROILERS FED WITH DIFFERENT DIETARY OILS AND ANTIOXIDANTS

J. A. García Regueiro, I. Díaz and M. Hortós
IRTA. Food Chemistry Unit. Centre de Tecnologia de la Carn. Granja Camps i Armet. 17121 Monells (Spain)

Background

The safety, nutritional value and sensorial quality of meat is related to lipid oxidation. Polyunsaturated and monounsaturated fatty acids are oxidized to render different products, mainly volatile compounds like alkanes, aldehydes, ketones and alcohols. The concentration of aldehydes, in particular malondialdehyde and hexanal, can be used as an indicator of the degree of oxidation and can be related to the deterioration of meat (Jensen et al. 1998). Also, sensorial characteristics are influenced by the composition of volatile compounds (O'Neill et al. 1995). The use of antioxidants can reduce the degree of oxidation by increasing the stability of meat (Brandon et al. 1992, Wen et al. 1996, Jensen et al. 1997). Vitamin E is one of the most appropiate antioxidant to prevent lipid oxidation (O'Neill et al. 1995, Lauridsen et al. 1997, Ruiz et al. 1997). Vitamin E is accumulated in muscle tissue of broilers fed with supplemented Vitamin E. However, other antioxidants can be used to reduce lipid oxidation. ß-carotene is an alternative to the use of Vitamin E (King et al. 1995), however little information is available about the effects of this antioxidant on meat quality.

Objectives

Evaluation of the effect of antioxidants on volatile profile of meat from broilers fed with vitamin E, ß-carotene and different dietary fats (lard, sunflower oil and olive oil)

Methods

Animals, dietary treatments and experiments: For each experiment, two hundred and eighty eight day-old female broiler chicks of the Ross strain were used. The chicks were fed a single diet during six weeks throughout each experiment. The antioxidant supplemented and dietary fat are presented in table 1, the basal diet was, in percentages: maize 50.56, soybean meal 39.58, fat 6.00, calcium carbonate 1.00, dicalcium phosphate 2.00, salt 0.40, dl-methionine 0.16 and vitamins/minerals 0.40. In table 1 are showed the experiments and dietary treatments.

Table 1. Experiments

Dietary Treatment	Experiment 1	Experiment 2	Experiment 3
Fat	Lard	Sunflower	Olive oil
Vitamin E (*)	200	200	200
ß-carotene (*)	50	15	15

(*) mg/Kg of diet

Analytical procedure: 2 g of muscle were placed in a vessel that was closed and heated at 100 °C for 30 minutes. After the heating the vessel was cooled at room temperature and was coupled to a nitrogen stream flowing through the sample, the volatile were collected with a trap of graphited charcoal during 15 minutes. The volatile compounds were desorbed in a Retorik desorption unit (Switzerland) by applying microwave energy. Gas chromatography-mass spectrometry: volatiles compounds were separated in a capillary column 40 m x 180 µm and a film thickness of 0.4 µm coated with a stationary phase of 5% phenyl methylsilicone (J&W, USA), the temperature program applied was: 50°C- 2 minutes- 5°C/min-270°C-2 minutes, the head pressure was 140 kPa and the carrier gas helium; the temperature of GC-MS interface was 280°C, scans were acquired in the range 40-400 Da/e. Mass spectra were compared with the spectra of NBS library and Kovats index were used in the procedure for peak identification. Statistical analysis was carried out with the Statistical Analysis System (SAS), the model included the effects of treatment, experiment and the interaction treatment - experiment.

Results and Discussion

The most remarkable results obtained were: aldehydes and hydrocarbons were the main compounds in the volatile profiles. Hexanal and nonanal were the aldehydes showing the highest concentrations. There was not evidence of any effect of dietary treatment (vitamin E or ß-carotene), excepted for hexanal. However it was observed a lower content of aldehydes in the groups treated with vitamin E. The contribution of alcohols and ketones to the volatile profile was not very important, only 1-octen-3-ol showed appreciable concentrations. It was observed a relationship between the TBA values (Ruiz et al. 1997) and hexanal concentrations. Vitamin E produced a low hexanal concentrations in the diets containing lard and olive oil, in the case of sunflower oil the reduction was slighter. Similar results for tallow and olive oil were reported (Lauridsen et al. 1997). Olive oil experiment showed a higher content of hydrocarbons and benzaldehyde than sunflower oil and lard experiments. Hexanal, octanal and nonanal concentrations were higher in sunflower oil and lard experiments, showing a more intense lipid oxidation. The influence of

dietary fat is showed in table 2, there were significant differences for hexanal, hexane, styrene and hydrocarbons. Hexanal showed a higher concentration in sunflower oil experiment, this fact could be related with the higher percentages of polyunsaturated fatty acids of the muscle tissue of broilers fed sunflower oil (Díaz and Hortós, personal communication). Table 3 shows the influence of antioxidants in volatile concentrations. Vitamin E showed a reduction on hexanal content respect to ß-carotene, however not significant differences were found between ß-carotene and control group. Octanal and nonanal showed the same tendency, with the highest values for ß-carotene treatment. These results seemed to indicate that ß-carotene could act as prooxidant or did not have any protective effect over lipid oxidation.

Conclusion

The stability of meat produced from broilers fed vitamin E was improved. ß-carotene did not show any antioxidant effect. Sunflower oil increased the concentrations of aldehydes showing a higher susceptibility to lipid oxidation than olive oil.

Table 2. Influence of diet on selected compounds from volatile profile

Diet	hexane	hexanal	styrene	octanal	nonanal	dodecene	dodecane	tridecane	tetradecane
Lard	1.58^{a}	0.36^{b}	0.03^{b}	0.19	0.25	0.08^{b}	0.10^{b}	0.07^{b}	0.15^{b}
Sunflower oil	0.72^{b}	0.71^{a}	0.03^{b}	0.04	0.07	0.04^{b}	0.05^{b}	0.05^{b}	0.15^{b}
Olive oil	0.67^{b}	0.22^{b}	0.20^{a}	0.02	0.05	0.23^{a}	0.37^{a}	0.16^{a}	0.43^{a}

values in columns with different superscripts are significantly different (P>0.05)

Table 3. Influence of antioxidants on selected compounds from volatile profile

Diet	hexane	hexanal	styrene	octanal	nonanal	dodecene	dodecane	tridecane	tetradecane
Control	0.90	0.45^{ab}	0.09	0.05	0.08	0.12	0.18	0.09	0.30
Vitamin E	1.00	0.28^{b}	0.08	0.05	0.07	0.07	0.12	0.07	0.17
ß-Carotene	1.07	0.56^{a}	0.09	0.16	0.23	0.15	0.22	0.13	0.26

values in columns with different superscripts are significantly different (P>0.05)

Acknowledgments

This work was supported by the AIR2-CTp4 1577 contract (Diet-Ox)

References

Brandon, S., Morrissey, P. A. and Buckley, D. J. (1992). The effect of dietary a-tocopherol and sunflower oil on the oxidative stability of chicken tissues. *Proc. of the 38th ICoMST*, Clermont-Ferrand, pp 463-465

Jensen, C., Laudrisen, C. and Bertelsen, G. (1998). Dietary vitamin E: quality and storage stability of pork and poultry. *Trend in Food Science and Technology*, 9:62-72

Jensen, C., Enberg, E., Jakobsen, K., Skibsted, L. H. and Bertelsen, G. (1997). Influence of the oxidative quality of dietary oil on broiler meat storage stability. *Meat Sci.*, 47: 211-222

King, A. J., Vijthenbogaart, T. G. and Vries, A. W. de (1995). a-Tocopherol, ß-carotene and ascorbic acid as antioxidants in stored poultry muscle. *J. Food Sci.*, 60: 1009-1012

Lauridsen, C., Buckley, D. J. and Morrissey, P. A. (1997). Influence of dietary fat and vitamin E supplementation on a-tocopherol levels and fatty acid profiles in chicken muscle membranal fractions and on suceptibility to lipid peroxidation. *Meat Sci.*, 46: 9-22

O'Neill, L., Morrissey, P. A. and Buckley, D. J. (1995). Effect of dietary fat and vitamin E supplementation on the oxidative stability and sensory quality of chicken muscle. *Irish Journal of Agricultural and Food Research*, 34: 205-206

Ruiz, J. A., Pérez-Vendrell, A. M. and Esteve-García, E. (1997). ß-carotene or a-tocopherol in fed improve the oxidative stability of poultry meat. Abstract from *11th European Symposium on Poultry Nutrition*

Wen, J., Morrissey, P. A., Buckley, D. J. and Seehy, P. J. A. (1996). Oxidative stability and a-tocopherol retention in turkey burgers during refrigerated and frozen storage as influenced by dietary a-tocopheryl acetate. *Brit. Poult. Sci.*, 37: 787-795