LIPID OXIDATION AND SENSORY ANALYSIS OF RAW BREAST MUSCLES FROM BROILERS FED α-TOCOPHEROL AND β-CAROTENE SUPPLEMENTED DIETS

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Background

Current lifestyle involves the increase of precooked food consumption. Poultry meat consumption has increased mainly during last years due to its accessible prize and a higher safety of this kind of meat when compare to other meat species. However, poultry meat is prone to oxidation and deterioration because of its higher unsaturated fatty acid content (Rhee et al. 1996).
Lipid oxidation leads to the development of undesirable flavours (off-flavours or taints), especially in reheated cooked meat, which result in poor acceptability or even rejection by consumers (Kilcast, 1993; Gray et al. 1996). Moreover, compounds derived of oxidative processes are thought to be involved in the ethiology of cancer or cardiovascular diseases (Halliwell et al. 1989; Kubow, 1993). Many studies have demonstrated the efficiency of the dietary supplementation of some natural antioxidants to prevent oxidative damage. In this sense, α-tocopherol (vitamin E) as a dietary lipophilic antioxidant, has been widely reported as useful for protecting muscle against these processes (Maraschiello et al. 1998; Renerre et al. 1999; Mercier et al. 2001). Results obtained with β-carotene are not as conclusive, since it could act as prooxidant depending on the dose (Ruiz et al. 1999).

Objectives

The aim of this study was to investigate the effect of dietary supplementation of α-tocopheryl acetate and β-carotene, on the oxidative stability of breast muscles from broilers. The lipid oxidation degree of samples was determinate trough the iron-induced thiobarbituric acid test. Sensory levels of two flavour attributes were evaluated: warmed-over flavour (WOF) and rancidity. This allowed study the relationship between chemical and sensory parameters related to lipid oxidation.

Methods

A day-old broiler chickens were fed as follow: control chickens were fed only the basal diet which included 20 mg/Kg of vitamin E and lard as saturated fat, a second group was fed the basal diet supplemented with 100 mg/Kg of α-tocopheryl acetate, and a third group was fed the basal diet supplemented with 100 mg/Kg of α-tocopheryl acetate and 1.5 mg/Kg of β-carotene.
At the end of each experiment, chickens were slaughtered and breasts were removed, vacuum-packed and stored at –20ºC until analyses.
Iron-induced thiobarbituric acid test was carried out by the method of Kornsbrust and Mavis (1980).
For sensory analysis, vacuum-packed breasts were cooked at 80ºC for 30 min in a water bath. Then were cut into pieces and stored 6 days at 4ºC. Afterwards, samples were reheated 25 min at 65ºC and evaluated immediately by six previously trained panellists (Guerrero et al. 2000). A complete block design was used. The order of presentation of samples and the first order carryover effects were blocked, as well as the piece of the breast served to each assessor in each of the six tasting sessions carried out. Two flavour descriptors were evaluated: warmed-over flavour (WOF) and rancidity. These attributes were quantified on a rating scale from 0 to 10.
Vitamin E levels in breast muscles were determined by normal phase HPLC. Samples were sonicated in n-hexane/2-propanol (3:2, v/v) to achieve the extraction, then were centrifugated and evaporated to dryness in a stream of nitrogen. The residue was redissolved in 1 ml of n-hexane/ethyl acetate (80:20, v/v). The column used was a Supelco NH_2-NP (5µm) (250 x 4.6 mm I.D.). The mobile phase was n-hexane/ethyl acetate (80:20, v/v) and the flow rate was 1.20 ml/min. The detection was carried out by the measurement of the fluorescence (290nm-330nm).

Results and discussion

Results showed that vitamin E levels of breast muscles from broilers fed α-tocopherol supplemented diets increased significantly ($p<0.05$) compared to control samples. When both antioxidants (α-tocopherol and β-carotene) were supplemented, vitamin E content was not significantly different from control (Table.1). It could be suggested that the β-carotene tended to limit the muscle accumulation of α-tocopherol. Similar results were found by Ruiz et al. (1999), although β-carotene doses were not the same and the analyses were performed in thigh broiler muscles.
TBA values suggested that α-tocopherol supplementation reduced significatively lipid oxidation compared to control ($p<0.05$), but this result was not obtained when both antioxidants were supplemented (Table.1). A negative correlation between vitamin E levels and TBA values was obtained ($r=-0.70$).
Sensory indicators of lipid oxidation showed significant differences ($p<0.05$) between treatments in rancidity but not in WOF (Table.2). α-tocopherol supplemented samples showed lower rancidity than control. However, significant differences between the control and samples supplemented with the combination of the two antioxidants were not found. Rancidity seemed to be the responsible of masking the warmed-over flavour, since treatments showing higher rancidity levels, corresponded to lower WOF values.
The correlation analyses performed showed a negative relationship between vitamin E levels and rancidity ($r=-0.60$), while TBA values were positively correlated to rancidity ($r=0.57$).

Conclusions

The correlation results obtained confirm that sensory analyses in combination with chemical measurements are excellent tools to determine the lipid oxidation status of samples. High TBA values and sensory rancidity corresponds to samples with high lipid oxidation.
The results suggested that dietary vitamin E supplementation is effective in protecting meat from lipid oxidation. β-carotene in combination with α-tocopherol is not efficient as antioxidant at the tested doses since: it didn't reduce TBA values respect to the control, it difficulted the vitamin E accumulation and samples had a high rancid flavour.

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Table 1. Vitamin E levels and TBA values of raw breast meat.

	μg α-vitamin E/g tissue		nmols MDA/mg tissue	
Dietary group (n=10)	Mean	S.D.	Mean	S.D.
T1	2.398 ^{bc}	1.790	0.153 ^{ab}	0.027
T2	4.689 ^{a}	1.780	0.103 ^{c}	0.017
T3	3.556 ^{ab}	1.500	0.128 ^{bc}	0.034

Different superscript letters in the same column denote significant differences ($p<0.05$)

Experimental treatments: T1 basal diet (control), T2 basal diet supplemented with 100 mg/Kg of α-tocopheryl acetate, T3 basal diet supplemented with 100 mg/Kg of α-tocopheryl acetate and 1.5 mg/Kg of β-carotene.

Table2. Results of sensory parameters of lipid oxidation in raw breast meat.

	warmed-over flavour		rancidity	
Dietary group (n=6)	Mean	S.D.	Mean	S.D.
T1	1.8	1.6	5.6 ^{a}	2.7
T2	2.4	2.8	1.6 ^{c}	2.4
T3	2.3	2.2	2.5 ^{ab}	2.7

Different superscript letters in the same column denote significant differences ($p<0.05$)

Experimental treatments: T1 basal diet (control), T2 basal diet supplemented with 100 mg/Kg of α-tocopheryl acetate, T3 basal diet supplemented with 100 mg/Kg of α-tocopheryl acetate and 1.5 mg/Kg of β-carotene.