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INFLUENCE OF pH, TEMPERATURE, METABOLIC RATE AND TIME POST-MORTEM ON THE RATE OF AUTOXIDATION OF TURKEY MYOGLOBIN

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INTRODUCTION

Discoloration of meat is associated with a change of haeminic iron, which oxidizes during storage. Factors influencing colour stability of meat during storage has been reviewed, particularly on beef meats (Renerre, 1990). Metmyoglobin formation is enhanced by acidic pH and high temperature (Charpentier, 1969). Metmyoglobin formation was studied in turkey meat especially for its effect on lipid oxidation in meat (Kanner and Harel, 1985). Incidence of salt in oxidation of turkey metmyoglobin was also investigated (Trout, 1990). However, information is lacking on the relationship between metabolic type, post-mortem time and environmental conditions on metmyoglobin formation in turkey meat.

MATERIAL AND METHODS

Animals

Biopsies of m.pectoralis superficialis (PP) from 50 turkeys were taken four days before slaughter for determining myoglobin concentration. Six turkeys were then selected. Three of these were chosen for their high myoglobin content (Group 1) and the other three for their low myoglobin content (Group 2).

These six turkeys were killed at 12 weeks and the meat was chilled for 24 hours at 2.4°C. In the first trial, muscle PP was frozen in nitrogen liquid at different post-mortem times: 0, 1, 2 and 7 days of storage. Except for 0 time, meat was kept on a fibre board tray and wrapped in oxygen permeable film before being frozen. In a second trial, PP and *m.biceps femoris* (BF) from turkey, *m.longissimus dorsi* and *m.psoas major* from beef, and *m.longissimus dorsi* from pork were frozen on day 2. In both trials meat was stored at -30°C before analysis.

Muscle preparation

Ten grams of ground PP were added to 25ml of 100mM acetate buffer, pH5.5, homogenized, filtered and the pH adjusted to 5.5, 5.8, 6.1 and 6.3. Homogenates were placed in water at 25°C, 30°C, 35°C and 40°C.

Assessment of myoglobin oxidation

Agitation of homogenate occurred just before the first measurement to determine the spectra 100% MbO2. Spectra of myoglobin were obtained from a spectrophotometer Aminco DW2A using the method of dual wavelength scan mode (525/500-650mm). Measurements were performed every 10 minutes during one hour before the addition of potassium ferricyanure to provide a spectra of 100% metmyoglobin.

Myoglobin content

Myoglobin content was determined according to Hornsey (1956).

RESULTS AND DISCUSSION

Myoglobin contents are presented in Table 1. Myoglobin content did not differ significantly ($P>0.05$) in m.pectoralis superficialis. The concentration of myoglobin is in the same range reported by Ubrin (1988). Myoglobin content differed significantly in m.biceps femoris ($P<0.05$).

First Trail

The amount of oxidized myoglobin/hour decreased between 0 and 1 day post-mortem and remains stable whatever post-mortem time (Figure 1). The effect of post-mortem time on the rate of myoglobin oxidation is unclear. On the contrary, Foucat *et al.* (1993) found that the rate of myoglobin autoxidation was 1.6 higher at 8 days post-mortem than at day 0. This difference could be partly explained by the fact that:

(1) these authors used purified myoglobin from bovine muscle so the molecule was devoid of free radicals coming from lipid oxidation, which are known to enhance metmyoglobin formation (Kranner, 1992); and

(2) the rate of pH decline in *m.pectoralis superficialis* is particularly high which would increase metmyoglobin formation.

Second Trail

We compared the autoxidation rate in breast and thigh muscles at different pH and temperatures (Table 2). The amount of metmyoglobin was higher after one hour in meat from Group 1 than from Group 2 at pH5.5 and temperature 30°C ($P<0.05$) and 40°C (but not significantly different). It was higher in both groups at 40°C than at 30°C. These results agree with those of Cornish and Froning (1974). These authors reported that an increase from 5°C to 30°C enhanced the autoxidation rate by a factor of 15. Faustman and Cassens (1990) suggested that temperature could accelerate myoglobin oxidation by increasing the rate of pro-oxidant reactions.

The autoxidation rate is particularly high when compared with other species (Figure 2). Whatever the group, turkey metmyoglobin was higher in amount than in beef or pork. These results agree with those of Snyder and Ayres (1962) using crystallized myoglobin from turkey.

In the presence of 1.5% salt, the amount of metmyoglobin was similar in beef and turkey (Trout, 1990). Myoglobin from pork was particularly stable under the same conditions.

The autoxidation rate (at pH5.5 and for all temperatures) in *m.pectoralis superficialis* and *m.biceps femoris* were similar. The results showed, at pH6.3 and a temperature of 30°C, no oxidation of myoglobin from *m.pectoralis superficialis*. This result shows that myoglobin from *m.pectoralis superficialis* under the above pH and temperature conditions is stable. In previous studies we reported that after death, pH decline was extremely fast in *m.pectoralis superficialis* (Santé *et* al., 1991) and this would enhance myoglobin oxidation. Janky and Froning (1973) showed that turkey myoglobin was unstable in the pH range of 5.5 to 6.0. Also, Gotoh and Shikama (1974) reported that the half-life of bovine myoglobin was five days at pH5.0 and one year at pH9.0 at 0°C.

CONCLUSION

The autoxidation rate of turkey myoglobin was not significantly different regarding post-mortem time with a tendency to decrease between times 0 and day 1. By contrast, an inverse relationship exists in bovine myoglobin.

For a pH value of 6.3 at 30°C, myoglobin from *m.pectoralis superficialis* was stable. no oxidized myoglobin was found

while oxidized myoglobin was detected in *m.biceps femoris*.

The rate of metmyoglobin formation in turkey is higher than those obtained in beef and pork.

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Table 1. Myoglobin content (mean±standard deviation) in *m.pectoralis superficialis* and *m.biceps femoris* in the two groups.

	m. pectoralis superficialis mg myoglobin /g	m.biceps femoris mg myoglobin /g
Group 1	0.42±0.01	5.3±0.6
Group 2	0.51±0.07	7.1±0.2

Table 2. Autoxidation rate (% metmyoglobin/hour) in *m.pectoralis superficialis* and *m.biceps femoris* at different temperatures and pH values.

		m.pectoralis superficialis		m.biceps femoris	
	Temp.	Group 1	Group 2	Group 1	Group 2
pH=5.5	30°C	$39\pm6^{a,i}$	$27\pm3^{b,i}$	$36\pm3^{a,i}$	$38\pm7^{a,i}$
	35°C	$45\pm7^{a,i}$	$47\pm9^{a,j}$	$41\pm4^{a,i}$	$43\pm4^{a,i}$
	40°C	$70\pm8^{a,j}$	$60\pm7^{a,j}$	$56\pm9^{a,j}$	$67\pm4^{a,j}$
pH=6.3	30°C	0^{i}	0^{i}	$16\pm4^{a,i}$	6 ± 2^{b}
	35°C	$37\pm5^{a,i}$	$39\pm7^{a,j}$	25 ± 2^{j}	nd

^{a,b} = Means in a same row with different a,b superscripts differ significantly ($P<0.05$).
^{i,j} = Means in a same column with different i,j superscripts differ significantly ($P<0.05$).
nd = not determined