Free Amino Acids in Porcine Muscle Aged One or Eight Days

Concentrations of histidine, threonine, serine, glutamic acid, proline, glycine, alanine, valine, methionine, isoleucine, and taurine were higher in longissimus dorsi muscles of Hampshire barrows aged 8 days than those aged 1 day. Values for other amino acids, pH, lactic acid, glucose, moisture, and ether extract were similar for muscles aged for both periods of time.

Various chemical changes take place while meat ages. Even after death of an animal, enzymes of its muscle are active. Post-mortem glycolytic changes in muscle resulting in the formation of lactic acid and a decrease in pH and proteolytic changes take place. McCain *et al.* (1968) found that in cured hams, serine, glutamic acid, threonine, leucine, isoleucine, valine, phenylalanine, proline, tyrosine, alanine, glycine, and histidine increased during aging periods of 0 to 24 weeks. In sterile cod muscle stored at 0° C. for 25 days, glutamic acid, β-alanine, and 1-methylhistidine increased; lysine and leucine decreased; and other amino acids remained fairly constant (Hodgkiss and Jones, 1955).

Certain amino acids may be important flavor precursors in meat (Macy *et al.*, 1964), and therefore influence flavor of meat if concentrations of free amino acids change as meat ages. This study compared concentrations of free amino acids and other chemical constituents in porcine muscle aged 1 or 8 days.

PROCEDURE

Sections from the left loin between the eighth thoracic and second lumbar vertebrae from Hampshire barrows weighing approximately 220 pounds were used. After slaughter, carcasses were held 24 hours at 2° C. and then loin sections were removed and those aged 8 days placed in Cyrovac bags and held at 2° C. There were six replications of each aging period. After aging, the sections were frozen and held at −20° C. 3 to 6 months before being analyzed.

The longissimus dorsi muscle was excised, stripped of visible fat, ground, and used for all measurements. A Fisher expanded scale pH meter was used to measure pH of ground muscle samples. To estimate total free amines, a filtrate from a meat slurry that had been deproteinized with zinc hydroxide and barium sulfate was prepared. The method of Yemm and Cocking (1955) was used to determine total free amines, and micromoles of ninhydrin-reactive substances were calculated from a standard curve prepared from glycine. Glucose was determined by Nelson's (1944) method; percentage of ether-extractable material, with a Goldfisch extraction apparatus; and lactic acid, by the method of Barker and Summerson (1941). Ten-gram samples of ground muscle were dried at 121° C. for 2 hours in a Brabender Semi-Automatic moisture tester to measure percentages of moisture. Free amino acid analysis (by Wisconsin Alumni Research Foundation, Madison, Wis.) of the muscle was by the method of Spackman *et al.* (1958). Data were subjected to analysis of variance to determine if differences between aging periods existed.

RESULTS AND DISCUSSION

Results of certain chemical determinations for porcine muscle aged 1 or 8 days are presented in Table I. Percentages of ether-extractable material and moisture were similar for muscles aged for the two periods. Concentrations of ether-extractable material or moisture would not be expected to change appreciably during aging times studied.

There was no significant difference in concentration of lactic acid in muscles aged 1 and 8 days. Since pH values depend, in part, on lactic acid formation, it seems reasonable that pH values of muscles were similar for the two periods. Glucose concentration tended to be slightly, but not significantly, higher in muscle aged 8 days than in muscle aged 1 day. Generally, it is agreed that major glycolytic changes in the muscle usually take place within 24 hours post-mortem. The rate of post-mortem glycolysis varies considerably for porcine muscle from different animals. However, when glycolysis proceeded at a slow rate, lactic acid levels changed little after 10 to 12 hours post-mortem (Wismer-Pedersen and Briskey, 1961). Gunther and Schweiger (1966) reported that for beef muscle aged 0 to 169 hours, lactic acid levels remained fairly constant after 30 hours of aging.

Increase in total free amines as estimated by ninhydrin was significant ($P < 0.05$) when muscle was aged 8 days, compared with muscle aged 1 day. Specific amino acids that increased

Table I. Average Values of Six Replications for Indicated Measurements of Porcine Muscle Aged 1 or 8 Days

Measurement	Aging Period, Days 1	Aging Period, Days 8	F-Value Sig.[a]
pH	5.47	5.48	ns
Lactic acid, mg./g.	12.29	12.12	ns
Glucose, mg./100 g.	801.83	1162.30	ns
Moisture, %	73.77	73.32	ns
Ether extract, %	2.79	2.76	ns
Free amines, μmoles glycine/g.	1521.51	2030.63	a
Amino acids, mg./100 g.			
Lysine	10.89	8.71	ns
Histidine	1.88	7.18	a
Arginine	4.79	10.74	ns
Aspartic acid	0.67	3.95	ns
Threonine	9.29	20.32	a
Serine	22.40	37.45	a
Glutamic acid	27.98	44.42	a
Proline	6.39	13.82	a
Glycine	9.99	16.16	a
Alanine	28.37	42.27	a
Cystine	2.71	1.99	ns
Valine	13.74	20.80	a
Methionine	9.92	13.93	a
Isoleucine	10.17	16.03	a
Leucine	24.02	34.32	ns
Tyrosine	10.87	15.02	ns
Phenylalanine	11.46	15.73	ns
Tryptophan	25.70	33.15	ns
Ornithine	1.68	3.34	ns
Phosphoethanolamine	19.05	25.20	ns
Taurine	31.62	41.53	a
Asparagine	11.03	21.40	ns
β-Alanine	4.44	5.20	ns

[a] ns, nonsignificant, a, $P < 0.05$.

($P < 0.05$) with increased aging were: histidine, threonine, serine, glutamic acid, proline, glycine, alanine, valine, methionine, isoleucine, and taurine. Similar increases in amino acid concentration were noted by McCain *et al.* (1968) in cured ham aged 0 to 24 weeks for all those amino acids except methionine. Additionally, they found increases in tyrosine and phenylalanine. The increase in free amino acids in the muscle suggests some enzymatic degradation of protein from either microbial or naturally occurring muscle enzymes. Zender *et al.* (1958) noted aseptic and anaerobic degradation of rabbit and lamb muscle with a rise in the level of amino acids during storage for 150 days at 25° C. and 15 days at 38° C.

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