EFFECT OF CERTAIN PROCESSING METHODS ON PHOSPHOLIPID COMPONENTS IN RABBIT MEAT

PROF. DR. M. KAMAL E. YOUSSEF, PROF. DR. S.H. ABOU-EL-HAWA, PROF. DR. M.N. EL-RIFY and A.H. KHALIFA
Food Science & Technology Department, Faculty of Agriculture, Assiut University, ASSIUT, A.R. EGYPT

SUMMARY: Fore limb, loin and hind limb cuts of California and New Zealand White rabbits (both sexes) of a marketable age (2 and 3 months) were used to assess the effect of certain processing methods namely: pressure cooking, roasting and smoking on phospholipid components in rabbit meat. Phospholipids were fractionated applying thin-layer chromatographic technique to eight fractions namely: phosphatidylserine (PS), lysophosphatidylcholine (LPC), phosphatidyl inositol (PI), sphengomylein (SL), phosphatidylcholine (PC), phosphatidyl ethanolamine (PE), phosphatidic acid (PA) and phosphatidyl glycerol (PG). Rather slight differences between sexes, ages and three studied cuts in their quantitative phospholipid components were observed. Phospholipid fractions recorded qualitatively the same pattern as that of fresh meat in the three studied processing methods of rabbit meat. However, all studied processing methods resulted in a decrement in all phospholipids fraction contents, except that lysophosphatidyl choline and (phosphatidic acid + phosphatidyl glycerol) slightly increased.

INTRODUCTION: In many areas in developing countries, rabbit production could be an effective means and make an important contribution to meat production (Cheeke, 1986). Different projects focused their investments on rabbit production in Egypt (El-Seesy, 1989). Both fat content and composition are important factors for meat rancidity (Wilson et al., 1976; Igene et al., 1980; Pikul et al., 1983). Phospholipid fraction is more responsible for the generation of malonaldehyde in meat than other lipid fractions, therefore many studies were done on phospholipids of chicken meat (Igene and Pearson, 1979; Igene et al., 1980; Melton, 1983; Pikul et al., 1984) and on beef, pork, lamb and seafood phospholipids (Love and Pearson, 1971; Aman and Shehata, 1978b; Abou-El-Hawa and Omar; 1980; Igene et al., 1980; Khayat and Schwall, 1983; Melton, 1983). Romans et al., 1974 reported that in rabbit lipid approximately 45% is phospholipids. Foad and Hassan (1977) reported that five phospholipid fractions, namely: lecithins, ethanolaminphospholipids, serinophospholipids, sphangomyelin and lysolecithins were present in rabbit lipid. However, rather limited information are available on phospholipids of rabbit meat and generally on rabbit meat composition (El-Gamal et al., 1984; Holmes et al., 1984 and Lukefahr et al., 1989).

This study was conducted to identify and quantitate the phospholipid components of rabbit meat as well as the effect of pressure cooking, roasting and smoking on phospholipid composition of rabbit meat.

MATERIALS and METHODS:

Sampling: Sixty four California and New Zealand white rabbits (equal number of both sexes) of a marketable age (2 and 3 months) were procured from Al Barari Investment Company farm at Ismaila Governorate; Egypt were used in the present study. The rabbits were slaughtered and the carcasses were skinned, eviscerated, washed and spilt along the backbone into two halves. One half of each carcass was packaged in polyethylene bag and kept frozen at -20°C until withdrawn for treatment.

Treatments: The investigated rabbit carcasses were divided into four specified groups treated as follows: a) The first group was analyzed fresh and served as control. b) The second frozen at -20°C group was thawed at 4°C for 8-10 hours, then cooked in pressure cooker pan applying the sterilization $\frac{10\text{-}15\text{-}10}{110°C}$ as recommended by Ball and Olson (1957) and Helwan Engineering Industries Catalogue (Anon, 1988) for pressure cooked rabbit meat. The pressure used in the pressure cooker pan was about 1,991 mm mercury. c) The third frozen at -20°C group was

thawed, wrapped with aluminum foil and roasted in an electric oven at 167 (±2)°C to an internal temperature of 95°C according to the method of Greenhouse et al., (1984). d) The fourth frozen at -20°C group was thawed, hot cured at 50°C in a brine solution consisting of 15% salt, 3% sucrose and 1.5 ppm sodium nitrite for 20 hours, then cold smoked for 3 hours within the temperature range of 30-35°C in the smoke chamber according to the method of Owen et al. (1979).

Preparation of samples: Fore limb, loin and hind limb cuts were withdrawn from fresh and treated carcasses according to Deltro and Lopez (1985). Each cut was deboned and finely minced rapidly through a mechanical meat chopper, then all determinations began promptly without any delay.

Extraction of lipids: The lipid was extracted from tissue samples according to the method described by Folch et al., (1957).

Fraction and identification of phospholipids: Phospholipids were segregated by thin layer chromatography technique (TLC) using a specific solvent namely: chloroform:methanol:water (65:25:4, v/v/v). For visualization of phodpholipids prior to qualitative analysis, phosphomolybdic acid (10% in ethanol) was applied. The identification of phospholipid fractions was carried out according to El-Sebaiy et al., (1980). Iodine vapours were used for visualization prior to quantification according to Stahl (1965).

RESULTS and DISCUSSION: Phospholipids were fractionated applying thin-layer chromatographic technique to eight fractions namely: phosphatidylserine (PS), lysophosphatidycholine (LPC), phosphatidyl inositol (PI), sphengomyelin (SL), phosphatidylcholine (PC), phosphatidyl ethanolamine (PE), phosphatidic acid (PA) and phosphatidyl glycerol (PG), (table 1). However, Foad and Hassan (1977) previously reported that there were only five identified phospholipid fractions in Baladi rabbit tissues.

The data given in table (1) indicated that rather slight differences between sexes, ages and three studied cuts in their quantitative phospholipid components were observed. The data given in table (1) indicated that phosphatidylcholine constituted that the highest percentage of total phospholipids (34.76 and 35.57%) for the two studied rabbit strains, while phosphatidic acid recorded the lowest content (4.41 and 4.31%) of total phospholipids; respectively. The other phospholipid fractions constituted (5.39 and 4.78%), (7.76 and 7.83%), (6.76 and 6.79), (13.82 and 13.69%), (22.45 and 22.97%) and (4.66 and 4.36%) for PS, LPC, PI, SL, PE and PG California and New Zealand white rabbit; respectively.

On the other hand, Foad and Hassan (1977) reported that among phospholipid fractions lecithins proved to be the highest phospholipids fraction persent, while lysolecithins recorded the lowest values in Baladi rabbit meat.

The data in table (2) revealed the effect of three processing methods namely: pressure cooking, roasting and smoking on phospholipid composition of California and New Zealand white rabbit meat. However, it was rather difficult to detect the phosphatidic and fraction (PA) from phosphatidyl glycerol (PG), therefore both were treated as one fraction in all processing methods (Aman and Shehata, 1978b).

The data in outlined table (2) indicated that the three studied processing methods resulted in a decrement in all class of phospholipids content, except that lysophosphatidyl choline and (phosphatidic acid + phosphatidyl glycerol) levels were increased. However, rather marked decrease in phosphatidyl choline content was existent. Similar data were previously observed by Aman and Shehata (1978b) for fish phospholipids, while Abou-El-Hawa and Omar (1980) reported that the content of all phospholipids fraction decreased in smoked fish. In general, the increase of lysophosphatidyl choline by the three studied processing methods might be due to the hydrolysis in phosphatidyl choline fraction, which was decreased.

Table (1): Effect of sexes, ages and cuts on phospholipid composition of rabbit meat (as % of total phospholipids).

Sex	Age	Cut	PS		LPC		PI		SL		PC		PE		PA		PG	
			I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Male	2 Months	A	4.95	4.80	8.91	7.50	6.93	6.35	14.85	13.11	34.65	35.01	21.78	22.19	3.96	5.70	3.96	5.34
		B	4.62	4.15	7.52	7.81	6.90	6.71	13.87	13.83	34.68	35.15	23.12	23.51	4.62	4.34	4.65	4.50
		C	5.80	4.65	7.89	7.95	7.01	7.09	14.04	14.10	34.46	34.81	21.93	22.07	4.39	4.52	4.48	4.81
		mean	5.12	4.53	8.11	7.75	6.95	6.72	14.25	13.68	34.60	34.99	22.28	22.59	4.32	4.85	4.36	4.88
	3 Months	A	5.03	4.90	7.63	7.79	6.82	6.77	14.50	14.33	35.25	35.70	21.38	22.82	4.82	4.01	4.57	3.68
		B	4.88	4.72	7.90	8.01	6.75	6.85	13.95	13.82	35.02	35.51	22.11	21.90	3.98	4.53	5.41	4.66
		C	5.39	4.81	8.83	7.85	7.12	6.66	12.87	13.05	34.52	35.52	21.90	23.57	4.37	4.14	5.00	4.40
		mean	5.10	4.81	8.12	7.88	6.90	6.76	13.77	13.73	34.93	35.58	21.80	22.76	4.39	4.23	4.99	4.25
	Mean		5.11	4.67	8.12	7.82	6.93	6.74	14.01	13.71	34.77	35.29	22.04	22.68	4.36	4.54	4.68	4.57
Female	2 Months	A	5.80	4.88	7.35	7.31	6.50	6.71	13.95	13.77	35.11	34.91	22.72	27.75	4.20	4.67	4.37	5.00
		B	5.59	4.70	7.82	7.59	6.47	7.11	12.29	13.50	35.11	35.20	23.14	33.09	4.88	4.31	4.70	4.50
		C	6.31	4.95	6.46	8.11	5.43	6.95	13.96	14.06	34.91	35.89	22.25	22.79	4.90	3.25	5.78	4.00
		mean	5.90	4.84	7.21	7.67	6.13	6.92	13.40	13.78	35.04	35.33	22.70	22.88	4.66	4.08	4.95	4.50
	3 Months	A	5.93	5.00	7.59	8.15	6.82	6.76	14.65	12.97	33.98	35.71	23.15	23.71	4.08	3.63	3.80	4.07
		B	5.50	4.87	7.82	7.89	7.23	6.39	12.99	14.05	35.27	35.10	22.71	23.69	4.22	4.10	4.26	3.91
		C	4.85	4.95	7.38	7.97	7.10	7.15	13.90	13.62	34.12	34.75	23.19	23.57	4.46	4.50	5.00	3.49
		mean	5.43	4.94	7.60	8.00	7.05	6.77	13.85	13.55	34.46	35.19	23.02	23.66	4.25	4.08	4.35	3.82
	Mean		5.67	4.89	7.41	7.84	6.59	6.85	13.63	13.67	34.75	35.26	22.86	23.27	4.46	4.08	4.65	4.16
Over all mean			5.39	4.78	7.76	7.83	6.76	6.79	13.82	13.69	34.76	35.57	22.45	22.97	4,41	4.31	4.66	4.36

A = Fore limb B = Loin C = Hind limb I = California II= New Zealand White

Table (2): Effect of processing methods on phospholipid composition of rabbit meat (as % of total phospholipids)

Strain	Process	PS	LPC	PI	SL	PC	PE	(PA+PG)
California	raw	5.39	7.76	6.76	13.82	34.76	22.45	9.07
	pressure cooking	2.76	10.90	6.52	13.23	33.02	20.94	12.63
	roasting	2.86	10.58	6.53	13.35	33.29	21.44	11.96
	smoking	3.98	10.10	6.20	13.06	32.84	20.70	13.12
New Zealand white	raw	4.78	7.83	6.79	13.69	35.57	22.97	8.67
	pressure cooking	2.56	9.69	6.17	13.17	33.23	20.53	14.65
	roasting	2.41	9.39	6.21	13.18	34.14	21.67	13.08
	smoking	3.48	9.61	6.23	13.21	33.36	20.53	13.59

REFERENCES:

ABOU-EL-HAWA, S.H. and OMAR, M.B.E. (1980): Effect of smoking and storage on phospholipid fractions in certain Nile fish species, Assiut J. Agric. Sci. 11: 53.

AMAN, M.E.B. and SHEHATA, A.A.Y. (1987b): Effect of prolonged frozen storage and after-heat treatment on lipid changes in the muscles of sheat-fish. Alex. J. Agric. Res. 26: 145.

ANON (1988): Pressure cooker pan. Helwan Engineering Industries Catalogue, Helwan, Cairo.

BALL, C.O. and OLSON, F.C.W. (1957): Sterilization in Food Technology. First Edition, McGraw-Hill Book Company, Inc. New York. Toronto. London.

CHEEKE, P.R. (1986): Potentials of rabbit production in tropical and subtropical agriculture systems. J. Anim. Sci. 63: 1581.

DELTORO, J. and LOPEZ, A.M. (1985): Allometric changes during growth in rabbits. J. Agric. Sci. 105: 339.

EL-GAMAL, A.M., MAKLED, M.N. and ABD EL-NABY, M.A. (1984): Chemical composition of rabbit meat as affected by age, sex and carcass cuts. Indian. J. Anim. Sci. 54: 227.

EL-SEBAIY, L.A., EL-MAHDY, A.R., MOUSTAFA, E.K. and MOHAMED, M.S. (1980): Phospholipids of Egyptian vegetable oils.1- Cotton-seed, soybean and their products. Alex. J. Agric. Res. 28: 137.

EL-SEESY, T.A. (1989): Studies on the improvement of meat quality during storage. Ph.D. Thesis. Food Sci. Depart. Fac. of Agric., Ain Shams Univ., Cairo, Egypt.

FOAD, A.A. and HASSAN, K.A. (1977): Fractionation and identification of phospholipids by thin layer chromatography in certain tissues of rabbits. First Arab Biologists Congress, 26-30 October, Alexandria, Egypt.

FOLCH, J., LEES, M. and SLOANESTANLEG, G.H. (1957): A simple method for the isolation and purification of total lipids from animal tissues, J. Biological. Chem. 226: 497.

GREENHOUSE, P., KIRMANI, Z. and STIGGER, F. (1984): Sensory panel rates domestic rabbit meat. Arkansas Farm 33

HOLMES, Z.A., WEI, S.F., HARRIS, D.J., CHEEKE, P.R. and PATTON, N.M. (1984): Proximate composition and sensory characteristics of meat from rabbits fed three levels of alfalfa meal. J. Anim. Sci., 58: 62.

IGENE, J.O. and PEARSON, A.M. (1979): Role of phospholipids and triglycerides in warmed-over flavor development in meat model systems. J. Food Sci. 44: 1285.

IGENE, J.O., PEARSON, A.M., DUGAN, L.R.JR. and PRICE, J.F. (1980): Role of triglycerides and phospholipids on development of rancidity in model meat systems during frozen storage. Food Chem. 5: 263.

KHAYAT, A. and SCHWALL, D. (1983): Lipid oxidation in seafood. Food Technol. 37: 130.

LOVE, J.D. and PEARSON, A.M. (1971): Lipid oxidation in meat and meat products-a review. J. Amer. Oil Chem. Soc. 48: 547.

LUKEFAHR, S.D., NWOSU, C.V. and RAO, D.R. (1989): Cholesterol level of rabbit meat and trait relationshops among growth, carcass and lean yield performances. J. Anim. Sci. 67: 2009.

MELTON, S.L. (1983): Methodology for following lipid oxidation in muscle foods. Food Technol. 37: 105.

OWEN, J.E., ISON, R.W., NICOLAIDES, L., REILLY, A. and SILVERSIDE, D. (1979): Curing and smoking of rabbit meat. Tropical Sci. 21: 11.

PIKUL, J., LESZYZYNSKI, D.E., and KUMMEROW, F.A. (1983): The elimination of sample autoxidation by butylated hydroxytoluene additions before thiobarbituric acid assay for malonaldehyde in fat from chicken meat. J. Agric. Food Chem. 31: 1338.

PIKUL, J., LESZCZYNSKI, D.E., and KUMMEROW, F.A. (1984): Relative role of phospholipids, triacylglycerols, and cholesterol esters on malonaldehyde formation in fat extracted from chicken meat. J. Food Sci. 49: 704.

ROMANS J.R., PALMER, I.S., WENGER, D.R., COSTELLO, W.J., TUMA, H.J. and WAHLSTROM, R.C. (1974): Preslaughter treatment affecting intramuscular and plasma lipid. 1. Effect of ACTH in rabbits. J. Anim. Sci. 38: 32.

STAHL, E. (1965): Thin layer chromatography, A laboratory hand book, New York, N.Y.

WILSON, B.R., PEARSON, A.M., and SHORLAND, F.B. (1976): Effect of total lipids and phospholipids on warmed-over flavor in red and white muscles from several species as measured by thiobarbituric acid analysis. J. Agric. Food Chem. 24: 7.