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EFFECT OF CERTAIN PROCESSING METHODS ON PHOSPHOLIPID COMPONENTS IN RABBIT MEAT

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Abstract

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 study the effect of certain processing methods (pressure cooking, roasting and smoking) on phospholipid components in rabbit meat.

Phospholipids were fractionated applying thin-layer chromatographic (TLC) technique to eight fractions (phosphatidylserine (PS), lysophosphatidylcholine (LPC), phosphatidyl inositol (PI), sphingomyelin (SL), phosphatidylcholine (PC), phosphatidyl ethanolamine (PE), phosphatidic acid (PA) and phosphatidyl glycerol (PG)). Rather slight differences were observed between sexes, ages and three studied cuts in the quantities of phospholipid components. Phospholipid fractions showed 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 decrease in all phospholipid fraction contents, except that of lysophosphatidyl choline and (phosphatidic acid + phosphatidyl glycerol) which slightly increased.

Keywords: meat, rabbit meat, phospholipids, changes during processing.

Introduction

In many areas in developing countries, rabbit production could be an effective means of and make an important contribution to meat production (CHEEKE, 1986). Different projects focussed their investments on rabbit production in Egypt (EL-SEESY, 1989). Both the fat content and composition are important factors for meat rancidity (WILSON et al., 1976; IGENE et al., 1980; PIKUL et al. 1983). The 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 rabbit total lipid contains approximately 45% of phospholipids. FOAD and HASSAN (1977) reported that five phospholipid fractions, namely: lecithins, ethanolaminephospholipids, serine phospholipids, sphingomyelin and lysolecithins were present in rabbit lipid. However, rather limited information is 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 the phospholipid composition of rabbit meat.

Materials and Methods

Sixtyfour California and New Zealand white rabbits (equal number of both sexes) of a marketable age (2 and 3 months) 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 split 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 group frozen at $-20°C$ was thawed at $4°C$ for 8–10 hours, then cooked in pressure cooker pan applying the sterilization $\frac{10-15-10}{110°C}$ 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 group frozen at $-20°C$ was thawed, wrapped with aluminium foil and roasted in an electric oven at $167(\pm 2)°C$, internal temperature $95°C$, according to the method of GREENHOUSE et al., (1984).
d) The fourth group frozen at $-20°C$ 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).

Table 1

Effect of sexes, ages and cuts on the phospholipid composition of rabbit meat (as % of total phospholipids)

Sex	Age	Cut	PS		LPC		PI		SL		PC		PE		PA		PG	
	(months)		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Male	2	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	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	5.19	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	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	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
Overall 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

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).

Fractionation and identification of phospholipids: Phospholipids were separated by thin layer chromatography (TLC) using chloroform: methanol: water (65 : 24 : 4, v/v/v) solvent. For visualization of phospholipids prior to qualitative analysis, phosphomolybdenic 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).

Result and Discussion

Eight fractions, namely: phosphatidylserine (PS), lysophosphatidylcholine (LPC), phosphatidyl inositol (PI), sphingomyelin (SL), phosphatidylcholine (PC), phosphatidyl ethanolamine (PE), phosphatidic acid (PA) and phosphatidyl glycerol (PG) were detected and quantitatively evaluated.The results are summarized in *Table 1.*

The data given in *Table 1* indicate that rather slight differences were observed between sexes, ages and three studied cuts in the quantities of phospholipid components. It was also shown that phosphatidylcholine constituted the highest percentage of total phospholipids (34.76 and 35.57%) for the two studied rabbit strains, while phosphatidic acid was the smallest fraction (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 rabbits, respectively.

In an earlier work FOAD and HASSAN (1977) reported similar results. They found that among phospholipid fractions lecithins had the highest proportion, while lysolecithins 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 the phospholipid composition of California and New Zealand white rabbit meat. However, it was rather difficult to separate the phosphatidic acid fraction (PA) from

Table 2
Effect of processing methods on the 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

phosphatidyl glycerol (PG), therefore both were treated as one fraction in all processing methods (AMAN and SHEHATA, 1978b).

The data in *Table 2* indicate that the three studied processing methods resulted in a decrease in all phospholipid fractions except the lysophosphatidyl choline and (phosphatidic acid + phosphatidyl glycerol) levels which increased. However, a significant decrease in phosphatidyl choline content was observed. 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 phospholipid fractions 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.

References

ABOU-EL-HAWA, S. H. – OMAR, M. B. E. (1980): Effect of Smoking and Storage on Phospholipid Fractions in Certain Nile Fish Species. *Assiut J. Agric. Sci.* Vol. 11, p. 53.

AMAN, M. E. B. – 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.* Vol. 26. p. 145.

ANON (1988): Pressure Cooker Pan. Helwan Engineering Industries Catalogue, Helwan, Cairo.

BALL, C. O. – 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.* Vol. 63, p. 1581.

DELTORO, J. – LOPEZ, A. M. (1985): Allometric Changes During Growth in Rabbits. *J. Agric. Sci.* Vol. 105, p. 339.

EL-GAMAL, A. M. – MAKLED, M. N. – ABD EL-NABY, M. A. (1984): Chemical Composition of Rabbit Meat as Affected by Age, Sex and Carcass Cuts. *Indian. J. Anim. Sci.* Vol. 54, p. 227.

EL-SEBAIY, L. A. – EL-MAHDY, A. R. – MOUSTAFA, E. K. – MOHAMED, M. S. (1980): Phospholipids of Egyptian Vegetable Oils. 1-Cotton-Seed, Soybean and their Producsts. *Alex. J. Agric. Res.* Vol. 28, pp. 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. – 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. – LESS, M. – SLOANESTANLEG, G. H. (1957): A Simple Method for the Isolation and Purification of Total Lipids from Animal Tissues, *J. Biological. Chem.* Vol. 226, p. 497.

GREENHOUSE, P. – KIRMANI, Z. – STIGGER, F. (1984): Sensory Panel Rates Domestic Rabbit Meat. *Arkansas Farm.* Vol. 33, p. 6.

HOLMES, Z. A. – WEI, S. F. – HARRIS, D. J. – CHEEKE, P. R. – PATTON, N. M. (1984): Proximate Composition and Sensory Characteristics of Meat from Rabbits Fed Three Levels of Alfalfa Meal. *J. Anim. Sci.* Vol. 58, p. 62.

IGENE, J. O. – PEARSON, A. M. (1979): Role of Phospholipids and Triglycerides in Warmed-Over Flavor Development in Meat Model Systems. *J. Food Sci.* Vol. 44, p. 1285.

IGENE, J. O. – PEARSON, A. M. – DUGAN, L.R.JR. – PRICE, J. F. (1980): Role of Triglycerides and Phospholipids on Development of Rancidity in Model Meat Systems during Frozen Storage. *Food Chem.* Vol. 5, p. 263.

KHAYAT, A. – SCHWALL, D. (1983): Lipid Oxidation in Seafood. *Food Technol.* Vol. 37, p. 130.

LOVE, J. D. – PEARSON, A. M. (1971): Lipid Oxidation in Meat and Meat Products – a Review. *J. Amer. Oil Chem. Soc.* Vol. 48, p. 547.

LUKEFAHR, S. D. – NWOSU, C. V. – RAO, D. R. (1989): Cholesterol Level of Rabbit Meat and Trait Relationships among Growth, Carcass and Lean Yield Performances. *J. Anim. Sci.* Vol. 67, p. 2009.

MELTON, S. L. (1983): Methodology for Following Lipid Oxidation in Muscle Foods. *Food Technol.* Vol. 37, p. 105.

OWEN, J. E. – ISON, R. W. – NICOLAIDES, L. – REILLY, A. – SILVERSIDE, D. (1979): Curing and Smoking of Rabbit Meat. *Tropical Sci.* Vol. 21, p. 11.

PIKUL, J. – LESZCZYNSKI, D. E. – 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.* Vol. 31, p. 1338.

PIKUL, J. – LESZCZYNSKI, D. E. – KUMMEROW, F. A. (1984): Relative Role of Phospholipids, Triacylglycerols, and Cholesterol Esters on Malonaldehyde Formation in Fat Extracted from Chicken Meat. *J. Food Sci.* Vol. 49, p. 704.

ROMANS, J. R. – PALMER, I. S. – WENGER, D. R. – COSTELLO, W. J. – TUMA, H. J. – WAHLSTROM, R. C. (1974): Preslaughter Treatment Affecting Intramuscular and Plasma Lipid. 1. Effect of ACTH in Rabbits. *J. Anim. Sci.* Vol. 38, p. 32.

STAHL, E. (1965): Thin Layer Chromatography, A laboratory Handbook, New York, N. Y.

WILSON, B. R. – PEARSON, A. M. – 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.* Vol. 24, p. 7.

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