Dieldrin Levels in Relation to Total, Neutral, and Phospholipid Composition in Selected Pork Muscles[1]

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INTRODUCTION

Animal tissue varies both in the amount of total lipid and in the relative proportion of phospholipid to neutral lipid (1,2). These variations in the percentage of neutral to phospholipid have been linked with the total lipid content of the muscle tissue (3) as with muscle color (4). The relationships of chlorinated hydrocarbon pesticides to lipid component of meats have not been elucidated. Hugunin and Bradley (5) suggested a relationship between organochlorine pesticides and lipoproteins in milk fat; however, the data of Ang (6) did not substantiate such a relationship.

In the current study, dieldrin levels, total lipid composition and the relative proportion of neutral lipids to phospholipids were determined in selected raw and cooked pork muscles. Muscles of fresh pork ham were selected to represent those reportedly varying in total lipid content and in the proportion of neutral lipids to phospholipid. Cooking has been reported to alter neutral lipid and phospholipid content in muscle tissues (7) and decrease their pesticide residue levels (8,9,10).

EXPERIMENTAL PROCEDURES

Sample Isolation and Cooking. Uncured ham samples were obtained from three crossbred Yorkshire-Hampshire hogs. These animals were fed standard rations ad libitum. Thirteen days prior to slaughter, two animals (designated 1 and 2) were also fed capsules containing 1.56 g of dieldrin on nine randomly selected days to give a total dose of 14.04 g. Animal 3, which was used as a control, was not fed the dieldrin capsules. The adductor, quadriceps femoris, semimembranosus, biceps femoris, and semitendinosus muscles were dissected from the fresh hams, all external fat was removed. Each of the muscles from the left hams was roasted to an internal temperture of 77°C ± 1° in a Hotpoint deck oven, model HJ225, at an oven temperature of 177°C ± 1°. Cooking drip was collected and total, volatile, and drip losses during roasting were calculated according to the methods of Funk et al., (11). Raw muscles from the right hams and the cooked muscles were individually finely ground to obtain homogeneous samples for analyses.

1/ Michigan Agricultural Experiment Station Journal No. 5741.
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Bulletin of Environmental Contamination & Toxicology,
Vol. 8, No. 5, 1972 © by Springer-Verlag New York Inc.

Chemical Analyses. Duplicate determinations were made for each analysis, except for the dieldrin analyses of cooking drip, in which the entire drip sample was used for a single determination.

Percentage moisture in the muscle tissue was determined by drying for 6 hr. at 90°C under vacuum. The total lipid was analyzed using chloroform-methanol extraction described by Bligh and Dyer (12). Modifications of the procedure described by Zabik and Dugan (13), were used to separate total lipids into neutral lipid and phospholipid fractions.

Dieldrin Extraction. Hexane-acetone extractions, acetonitrile partitioning and Florisil-Celite column clean-up of dieldrin residues was carried out as outlined by Yadrick et al (8).

Gas chromatographic analyses were carried out using a Varian Aerograph Series 1200 instrument equipped with a tritium foil electron capture detector. It was fitted with a 6 ft (1.83m) x 1/12 inch (2.0mm) I.D. stainless steel column packed with 11% (1:3) QF-1 and OV-17 on 80/100 mesh Gas Chrom Q and was operated at column, injector, and detector temperatures of 200, 240, and 210°C, respectively. Nitrogen flow rate was 100 ml/min for the discharge side of the detector. Quantitations were based on peak heights of standards prepared with analytical grade dieldrin[3] in nanograde hexane. Dieldrin levels were calculated as parts per million based on fat content.

RESULTS AND DISCUSSION

Parts per million of dieldrin based on fat content in the raw and cooked muscles as well as in the cooking drip are reported in Table 1. Although analyses of variance failed to reveal any significant differences among dieldrin levels in the fat of the muscles, the dark adductor muscle tended to have the highest dieldrin levels where as the light biceps femoris muscle had the lowest.

A consistent reduction in residue levels based on fat, though not significant, occurred with roasting. Most of the loss of residues apparently accompanied volatile losses in the meat during cooking since drip losses were minimal. Ritchey (10) indicated fat rendering during cooking to be the primary mode of chlorinated hydrocarbon removal with roasting, but the extremely low fat levels in the trimmed muscles minimized this route of removal in the current study.

3/ Recrystallized, 99 + %, Shell Chemical Company, New York.

TABLE 1

Dieldrin levels in pork muscles and drip.

Muscle	Animal	Dieldrin residues (ppm in fat) Raw	Cooked	Drip
Adductor	1	38.35	35.87	58.82
	2	59.16	34.53	[a]
	3(Control)	5.72	3.33	59.39
Quadriceps femoris	1	42.19	37.71	34.94
	2	50.30	30.13	11.28
	3(Control)	2.56	2.17	12.76
Semimembranosus	1	30.11	29.05	18.39
	2	33.70	27.16	33.86
	3(Control)	3.01	3.01	5.39
Biceps femoris	1	26.09	18.73	22.23
	2	28.49	24.34	11.61
	3(Control)	2.41	0.82	2.91
Semitendinosus	1	30.65	27.21	16.88
	2	31.76	14.35	20.39
	3(Control)	2.05	0.96	1.36

[a]Sample lost.

Cooking loss data and lipid characteristics for the five muscles are shown in Table 2. Cooking losses were similar among muscles but cooked muscles were higher in fat presumably due to moisture loss during roasting.

Duncan's multiple range test (14) was used to sort out significant differences revealed by analyses of variance in percentage of total, neutral, and phospholipid among the five muscles. Both raw and cooked muscles exhibited similar trends. The light semitendinosus muscles contained a significantly higher ($P \leq 0.01$) level of total lipid than all other muscles, and the light biceps femoris and quadriceps femoris (dark) had significantly higher ($P \leq 0.01$) values for percentage total lipid than the adductor (dark). The adductor had a significantly higher ($P \leq 0.001$) level of phospholipid and lower ($P \leq 0.001$) level of neutral lipid than all other muscles. Percentage phospholipid values for the quadriceps femoris and semimembranosus (light) muscles were significantly higher ($P \leq 0.01$) than those for the biceps femoris and semitendinosus.

The percentages of each lipid fraction found in the muscles of the animals studied seemed to be even more closely related to percentage of total lipid in the muscle or animal than to

muscle color itself. Muscles with lower total lipid possessed the greatest proportion of phospholipid while muscles with higher total lipid had lower proportions of phospholipid.

TABLE 2

Cooking Losses and Lipid Composition of Selected Pork Muscles

Muscle	Cooking Losses			Lipid Composition[a]		
	Total %	Volatile %	Drip %	Total[b] %	Neutral[c] %	Phospholipid[c] %
Raw:						
Adductor				2.12^{A}	69.23	30.78
Quadriceps femoris				3.19^{B}	79.05^{C}	20.53^{E}
Semimembranosus				2.96^{AB}	80.01^{C}	19.87^{E}
Biceps femoris				4.44^{B}	89.51^{D}	10.50^{F}
Semitendinosus				5.86	88.01^{D}	11.99^{F}
Cooked:						
Adductor	34.52	31.57	2.95	3.01^{A}	68.70	31.63
Quadriceps femoris	34.81	33.90	1.91	6.47^{B}	82.36^{C}	17.63^{E}
Semimembranosus	30.01	28.31	1.70	4.26^{AB}	77.58^{C}	20.76^{E}
Biceps femoris	33.39	30.69	2.70	6.53^{B}	84.95^{D}	15.05^{F}
Semitendinosus	29.67	27.86	1.81	10.63	80.50^{D}	10.50^{F}

[a]Values with same superscript are not significantly different ($P<0.01$), (14)
[b]Based on wet weight of muscle.
[c]Based on percentage total lipid.

Correlation coefficients were calculated between the parts per million dieldrin in muscle fat and the proportion of neutral and phospholipids in total muscle lipid and are reported in Table 3.

TABLE 3

Correlation coefficients of ppm (based on lipid) of dieldrin with percentage of neutral or phospholipid.

Animal	Percentage Neutral Lipid	Percentage Phospholipid
1	-0.76**	0.74**
2	-0.44	0.44
3	-0.79***	0.78***

**Significant at the 0.01 level of probability.
***Significant at the 0.001 level of probability.

Correlation coefficients indicate an association between percentage phospholipid content and dieldrin residue levels in muscle tissues. The significant correlations between the percentage phospholipid of animals 1 and 3 may indicate some preferential deposition of the dieldrin into the phospholipid component of the fat. Although the correlation coefficient for animal 2 is not significant, it supports the trend demonstrated in the other two animals.

Ingestion of dieldrin in quantities higher than those naturally occurring in pork tissues did not appear to affect the correlation of phospholipid with dieldrin, since coefficients were similar for animal 1, fed 14.02 g dieldrin prior to slaughter, and animal 3, the control animal fed no dieldrin.

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