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EFFECTS OF DIFFERENT DIETARY PROTEIN AND LIPID SOURCES ON LIVE PERFORMANCE, CARCASS COMPOSITION AND TISSUES DISTRIBUTION OF BROILER CHICKENS

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ABSTRACT

The effects of dietary protein sources (fish meal, soybean meal, poultry by-product meal and poultry offal meal), dietary lipid sources (cottonseed oil and poultry fat) and sex on live performance and carcass composition and distribution of tissues over the carcass were studied.

Dietary protein and lipid sources significantly affected live body weight at 6 weeks of age. At this age chicks fed poultry by-product meal had significantly heavier live body weight than those fed either soybean meal or fish meal. Feed intake and feed conversion were not significantly affected by dietary lipid sources, but differed significantly between dietary protein sources. Feed: gain ratio was markedly less efficient in birds fed soybean meal than those fed the other dietary protein sources. Carcass composition differed significantly between birds fed different dietary protein. Carcasses of chicks fed diet supplemented with poultry fat had more muscle and less fat than carcasses of chicks fed diet supplemented with cottonseed oil. The proportion of bone in carcass was not significantly affected by dietary lipid sources. Compared with female, male had similar proportions of muscle and bone with less proportion of fat. Dietary protein sources and sex did not influence the distribution of muscle throughout the carcass parts. Dietary protein and lipids sources had no significant effect on fat weight distribution. Sex differences in fat weight distribution were not significant. The proportion of total carcass bone in breast, thigh and wing were significantly affected by protein source diets. Dietary fat sources had no significant effect on bone weight distribution. . Significant differences in protein x lipid and sex x lipid interactions were found for the proportions of total muscle in breast, thigh and drumstick.

Keywords: Dietary protein and lipid sources, sex, live performance, carcass traits

INTRODUCTION

A superior carcass is characterized by a desirable composition and right muscle weight distribution. Live performance and carcass composition in broilers can be manipulated through genetic and nutritional routes. Increasing protein: energy ratio resulted in increasing live performance, carcass leanness and decreasing body fatness with the opposite effect was elicited by a low protein: energy ratio (Bartov and Plavnik, 1998). Also, carcass leanness can be achieved by feeding birds low energy, low-cost high fibrous diets and by restricted feeding (Khantaprab *et al,* 1997; Shahin and Abd El Azeem, 2005).

Traditional feedstuffs such as soybean and fish meal are often not available and expensive. Alternative feed that cost less than these feedstuffs include poultry offal meal and poultry by-product meal might have a beneficial effect on poultry production cost. These non conventional feedstuffs may be used in poultry feeding as part or complete replacements of conventional feedstuffs (Escalona and Pesti, 1987; Reddy, 1988 and Ghazalah *et al.*, 1998). The animal nature of these by-products contributes to their protein, amino acids, energy density, fat, minerals and vitamins. Lipids either from vegetable or animal origin are used as source of energy in broiler diets and to improve live performance traits (Atteh *et al;* 1983; Abou El-Wafa *et al.*, 2000 and Azman *et al.*, 2004). Studies have shown that a high polyunsaturated fatty acid content in the diet reduces abdominal fat and total fat accretion in chickens (Pinchasov and Nir, 1992 and Sanz et al., 1999 and Sanz et al., 2000). The combined effects of dietary protein and lipid sources and sex as well as their interactions on live performance and carcass characteristics have received little attention. This study was designed to evaluate the effects of isoenergetic and isonitrogenous diets of different protein sources (fish meal, soybean meal, poultry by-product meal and poultry offal meal), dietary lipid sources (cottonseed oil and poultry fat) and sex on live performance and carcass composition and distribution of tissues over the carcass.

MATERIALS AND METHODS

Two hundred and forty 1-d-old unsexed Arbor Acres broiler chicks were used in this study. These birds were from the Poultry Nutrition Research Station, Department of Poultry Production, Ain Shams University. Chicks were fed starter diet of fish meal (21.28% CP and 2926 Kcal ME/kg) for the first three days of age. Then chicks were divided equally into four groups, and randomly assigned to one of eight treatment groups each contained 30 chicks in two replicates. The diets were formulated to be isoenergetic and isonitrogenous and to contain four different protein sources: fish meal (FM), soybean meal (SBM), and poultry offal meal (POM) and poultry by-products meal (PBPM) supplemented with two lipid sources (cottonseed oil and poultry fat).The ingredients and chemical composition of the diets are given in Table 1.

All the diets were provided *ad. libitum* and conventional brooding and rearing practices were followed. Body weights, body weight gains, feed intake and feed: gain ratios were recorded weekly during 0-4 weeks starting-growing period and for the 4-6 weeks finishing period.

At the end of the experiment (6 weeks of age), a representative samples of 15 (8 male, 7 female) broilers fed each diet were taken at random for slaughter and dissection. The birds were fasted overnight prior to sacrifice, individually weighed and killed by severing the carotid artery and jugular veins. The head was removed at the atlanto-occipital articulation. After dressing the carcass was stored in closed bags at -20 °C. Carcass yield 'dressing percentage' is obtained by expressing the dressed carcass weight (without giblets) as a percentage of live body weight. Prior to dissection, carcasses were thawed for approximately 20 hr. at 5 °C while being in their bags. The right side was divided into the following commercial cuts: drumstick, thigh, breast, wing, and neck. The breast and thigh were considered as highly desired cuts. The skin, subcutaneous fat, muscle, bone and intermuscular fat in each cut were dissected and weighed. The sum of these parts over all cuts gives total side muscle, total side bone and total side fat. The sum of the dissected muscle, fat and bone was used as dissected side weight.

Table (1): composition of the starter and finisher experimental diets fed to broiler chicks.

Ingredients	Starter diets				Finisher diets			
	FM	SBM	POM	PBPM	FM	SBM	POM	PBPM
Yellow corn	56.30	56.00	56.00	56.30	62.30	62.00	62.00	62.50
Soy bean meal (44%)	32.00	37.59	32.00	32.00	22.50	28.00	22.70	22.50
Fish meal (72%)	3.00	-	-	-	3.00	-	-	-
Poultry offel meal (57.3%)	-	-	3.80	-	-	-	3.80	-
Poultry by product meal (62.18%)	-	-	-	3.80	-	-	-	3.80
Wheat bran	3.60	1.00	3.30	3.00	5.00	2.60	4.50	4.20
Cotton seed oil [1]	2.00	2.00	2.00	2.00	4.00	4.00	4.00	4.00
Limestone	0.50	0.40	0.40	0.40	0.50	0.30	0.40	0.40
Bone meal	2.00	2.40	1.90	1.90	2.10	2.50	2.00	2.00
Salts	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vits + Mins premix [2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL.Meth (99%)	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100	100	100	100
Calculated analysis [3]:								
Crude protein,%	21.28	21.18	21.22	21.36	17.75	17.70	17.75	17.85
ME (K Cal/Kg)	2926	2913	2918	2937	3106	3098	3107	3123
C/P ratio	137.5	137.5	137.5	137.5	175	175	175	175
Meth + Cyst ,%	0.83	0.82	0.83	0.82	0.74	0.71	0.72	0.73
Lysine, %	1.27	1.26	1.21	1.21	1.02	1.01	0.97	0.96
Calcium, %	0.94	0.94	0.91	0.92	0.90	0.90	0.90	0.91
Av. Phosphorus, %	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Linoleic acid $C_{18:2}$, %	2.43	2.46	2.48	2.57	3.66	3.63	3.74	3.75

1. Replaced by poultry fat at level 2.20% in starter diets and 4.40% in finisher diets, respectively and price per ton 2150 LE.
2. Each 2.5 kg of vitamins and minerals mixture contains: Vit. A: 12000,000 IU; vit. D_3: 2000,000 IU; vit. E: 10,000 mg; vit. K_3: 2000 mg; vit. B_1: 1000 mg; vit. B_2: 4000 mg; vit. B_6: 1500 mg; vit. B_{12}: 10mg; pantothenic acid: 10,000 mg, Nicotenic acid 20,000 mg; Folic acid: 1000 mg; Bioten 50mg; Choline: 500,000 mg; Cupper: 10,000; Iodin 1000 mg; Iron: 30,000 mg; Manganese: 55,000 mg; Cobalt: 0.25 mg; Zinc: 55,000 mg and Selenium 100 mg; carrier to 2.5 kg calcium carbonate.
3. According to feed composition tables for animal and poultry feedstuffs used in Egypt (CLFF, 2001).

Representative samples from different dietary protein were analyzed for moisture, protein, ether extract and ash using standard methods of A.O.A.C. (1990). The analysis of fatty acids was done using chromatography GC apparatus according to Pequot and Hautfenne (1985).

Statistical analyses:

To assess protein and fat sources and sex influences on live performance, carcass composition and tissue weight distribution, the data were analyzed by the General Linear Models procedures of SAS (SAS Institute, 1995) according to the following model

$$Y_{ijkl} = \mu + P_i + L_j + S_k + (PL)_{ij} + (PS)_{ik} + (LS)_{jk} + E_{ijkl}$$

Where,

Y_{ijkl} = weight (g) or percentage of the component Y of the $_{ijkl}$ bird;

μ = Overall mean;

P_i = fixed effect of the protein source (i= 1,2,3,4);

S_k = fixed effect of the sex (k= 1,2);

Lj = fixed effect of the diet (j=1,2);

$(PS)_{ij}$ = the interactions between protein and lipid sources;

$(PS)_{ik}$ = the interactions between protein source and sex;

$(LS)_{jk}$ = the interactions between sex and lipid source;

E_{ijkl} = the random error assumed N.I.D. (0, σ^2 e).

DUNCAN'S multiple range test was used to test for significant differences between pairs of means.

RESULTS AND DISCUSSION

Nutrient value of various proteins:

The typical nutrient composition of the various protein sources used in this study is shown in Table 2. As can be noted either POM neither FM nor PBPM are higher in protein, fat, calcium and phosphorus than SBM. The calcium in PBPM is ten-fold than that of soybean meal.

Table 2. Chemical composition† of different protein sources used in the experiment

Protein source	Dry matter %	Crude protein %	Ether extract %	Ash %	Calcium %	Phosphorus %
Soybean meal	91.83	44.23	1.70	0.69	0.31	0.68
Fish meal	92.23	72.58	9.14	0.98	3.08	1.62
Poultry offal meal	89.59	57.30	23.36	10.42	2.91	1.69
Poultry by-product meal	91.01	62.18	19.84	10.06	3.18	1.80

† Air dry sample.

Fatty acid composition of cottonseed oil and poultry fat:

The fatty acid profiles of the two lipid sources are given in Table 3.

Table 3. Fatty acids composition of cottonseed oil and poultry fat

Lipid source	Selected fatty acids (%)					
	Palmitic $C_{16:0}$	Palmitoleic $C_{16:1}$	Stearic C_{18}	Oleic $C_{18:1}$	Linoleic $C_{18:2}$	Linolenic $C_{18:3}$
Cottonseed oil	27.191	0.298	1.215	15.629	52.791	0.439
Poultry fat	32.875	4.896	8.189	29.411	31.290	0.000

This table illustrates the variance in fatty acid composition of various lipid sources. Cottonseed oil contained polyunsaturated fatty acids, predominantly linoleic acid and poultry fat (PF) contained saturated fatty acids, predominatly palmitic and stearic acids. Poultry fat is higher in palmtic acid (C_{16}), palmitoleic acid ($C_{16:1}$), stearic acid (C_{18}) and oleic acid ($C_{18:1}$) and lower in linoleic acid ($C_{18:2}$) than cottonseed oil, (CSO).

Live performance parameters:

Live body weight:

Dietary protein significantly affected live body weight at 2, 4 and 6 weeks of age. Body weight at 4 weeks of age in chicks fed PBPM did not differ significantly from that in birds fed soybean meal, while at 6 weeks of age body weight fed the former diets exceeded than in chicks fed the latter diet by about 10%. In this respect, Gazalah *et al.* (1998) found that chicks fed poultry offal meal did not differ significantly than those fed the control diet in their body weight at 7 weeks of age. Aggoor *et al.* (2003) found that body weight at 4 weeks of age in birds fed PBPM was significantly higher than that in birds fed soybean meal. At marketing age chicks fed PBPM had significantly heavier live body weight than those fed either soybean meal or fish meal (Table 4). On the other hand chicks fed poultry offal meal diet did not differ significantly from those fed poultry by-product meal

Table 4. The effects of protein and lipid sources on body weight, feed intake and feed conversion at different ages in broilers

Item	Protein Source (P) ¶				Lipid source (L)		Significance of difference		
	FM	SBM	POM	PBPM	CSO	PF	P	L	PXL
Body weight (g) at :									
3-days	72.38	73.07	73.05	73.35	72.98	72.94	NS	NS	NS
2 weeks	577.83^{a}	533.77^{d}	566.00^{b}	558.72^{c}	560.42	557.74	**	NS	**
4 weeks	1360.38^{a}	1306.27^{b}	1373.98^{a}	1343.03^{ab}	1348.12	1343.72	*	NS	NS
6 weeks	2033.25^{b}	1942.70^{c}	2091.37^{ab}	2139.47^{a}	2081.44^{a}	2029.95	*	**	NS
Feed intake (g) at:									
(0 - 2 weeks)	715.67	726.80	695.50	720.83	700.75^{b}	728.50^{a}	NS	*	NS
(0 -4 weeks)	2176.00^{b}	2222.50^{ab}	2180.83^{b}	2281.33^{a}	2205.58	2224.75	*	NS	NS
(0 - 6 weeks)	3963.50^{b}	3947.17^{b}	3963.33^{b}	4217.17^{a}	4080.67	3964.92	**	NS	NS
Feed: gain ratio:									
(0 - 2 weeks)	1.42^{c}	1.58^{a}	1.41^{c}	1.40^{b}	1.48^{b}	1.50^{a}	*	**	NS
(0 – 4 weeks)	1.69^{b}	1.81^{a}	1.68^{b}	1.79^{a}	1.72	1.75	**	NS	NS
(0 – 6 weeks)	2.02^{b}	2.11^{a}	1.98^{b}	2.04^{ab}	2.04	2.03	*	NS	NS

a, b, c,... Means in raw bearing different superscripts differs significantly at $P < 0.05$.*, ** $P < 0.05$ and $P<0.01$, respectively. NS, not significant ($P > 0.05$). ¶ the abbreviations are defined in the text

Dietary lipid significantly affected live body weight at 6 weeks of age. Chicks fed diet supplemented with cottonseed oil had significantly heavier live body weight than those birds fed diet supplemented with poultry fat (Table 4). The relatively higher body weight at 6 weeks of chicks fed on diets supplemented with cottonseed oils could be related to lower digestibility. Abou El-Wafa *et al.* (2000) found that body weight at 7 weeks of age of chicks fed on sunflower oils (vegetable oils) was heavier than corresponding trait in chicks fed other lipids (camel fat, margarine and extruded full fat soybean).

Azman *et al.* (2004) found that body weight at 41 days was significantly affected by dietary fat sources (soybean oil, poultry grease, beef tallow and a mixture of soybean oil with poultry grease). They found that body weight at 41 days was higher in broilers fed with soybean oil than in those fed with other dietary fat sources.

Feed intake:

Dietary protein sources significantly affected feed intake during 4 weeks of age and whole experimental periods (Table 4). The feed consumption increased sharply with increasing live body weight. Feed intake of birds fed PBPM was significantly greater than birds fed other diets. These birds ate more feed to balance the extra live weight gain.

Chicks fed diets supplemented with poultry fat did not differ significantly from those birds fed diets supplemented with cottonseed oil in their feed intake up to 4 and 6 weeks (Table 4). However, at 2 weeks of age chicks fed diets supplemented with poultry fat consumed more food than those fed diets supplemented with cottonseed oil.

Feed conversion ratio (g Feed/ g gain):

Feed: gain ratios during starting growing and whole experimental periods were significantly affected by dietary protein sources (Table 4). Feed conversion during the growing period (0-4 weeks) was markedly more efficient in birds fed either fish meal or poultry offal meal than those birds fed soybean meal and poultry by-product meal which did not differ significantly from each other. During the whole experimental period (0 - 6 weeks) it was markedly less efficient in birds fed soybean meal than in birds fed other dietary protein sources (Table 4). Deaton et al. (1983) found that feed conversion (grams of feed per gram live weight) significantly increased as dietary energy level decreased. Differences in feed conversion efficiency could be ascribed to difference in energy digestibility, difference in the composition of the weight gain (proteins and lipids) and difference in growth rate. It is worth mentioning that feed accounts for as much as 60 to 70% of broiler production costs. Consequently, any efforts to minimize costs per unit of saleable broiler production through genetic and/ or nutrition will affect the profitability of broiler producers.

At 2 weeks of age, feed conversion exhibited that birds on diets supplemented with cottonseed oil was significantly superior to birds fed diets supplemented with poultry fat (Table 4). Feed: gain ratio during the growing and the whole experimental periods was not significantly affected by different dietary lipid sources. The non significant differences between the two sources of lipids for this trait would suggest that their action is similar. These results are in agreement with those of Manilla *et al.* (1999) who evaluated the effects of dietary fat origin on live performance of broiler chickens and found that feed conversion ratio was not affected by fat supplementation. Sanz *et al.* (1999) found that no significant differences in feed to gain ratios between birds fed on diets differing solely in degree of fat saturation. Also, Azman *et al.* (2004) found that there were no significant differences among treatment groups in feed conversion ratio.

Carcass performance parameters:

Carcass yield:

Dressing percentage (without giblets) was significantly higher in birds given poultry offal meal than corresponding values of those given the other diets (Table 5). There were no significant differences in this trait between birds fed FM and poultry by-product meal. Chicks fed on soybean meal had the lowest dressing percentage.

Chicks fed on diets supplemented with cottonseed oil had significantly higher dressing percentage than those fed on diets supplemented with poultry fat (Table 5). These results are in disagreement with those of Sanz *et al.* (1999) who found that dietary fat type (sunflower oil and animal fat blend) had no appreciable effect on dressing percentage.

There were no significant differences between males and females in dressing percentage (Table 5). These results are in agreement with those of Sanz et al. (1999) who found that sex had no significant effect on this trait. Hayse and Marion (1973) found that males had a significantly a higher carcass yield (72 vs. 70) than females.

Carcass composition:

There were significant differences between chicks fed different protein sources in their carcass composition (Table 5 and Figure 1). Birds fed poultry offal meal had significantly higher proportion of total carcass muscle and lower proportion of total carcass fat than those fed the other diets which were not significantly different among each other. The proportion of total carcass bone was significantly lower in birds given poultry offal meal than those given either fish meal or soybean meal.

Expressed as a percentage of carcass weight, carcasses from broilers fed on diets containing poultry fat diet had more muscle and less fat than carcasses from broilers fed on diets containing cottonseed oil (Table 5 and Figure 2). The proportion of total carcass bone did not significantly influenced by dietary lipid sources. Results of total carcass fat in the present study were at variance with those of Hulan *et al.* (1984) who found that total carcass lipids were not significantly affected by different dietary fat sources.

Compared with female carcasses, male carcasses had similar proportions of muscle and bone, boneless carcass and fat free carcass and less proportion of fat (Table 5). Males had higher muscle: bone ratios and higher muscle: fat ratios but they had lower meat: bone ratios than females. Shahin and Abd El Azeem (2005) found that expressed as a percentage of carcass weight, male carcasses had more muscle, more bone and more fat-free carcass but less fat, less boneless carcass than female carcasses .

Muscle weight distribution:

The effect of dietary protein and lipid sources and sex upon total muscle in the different parts of the carcass is shown in Table 5. The percentages of breast muscle, drumstick muscle, and wing muscle were not significantly different between dietary protein and lipid sources and between sexes. On the other hand, the percentage of thigh muscle was significantly higher in carcasses from chicks fed diet supplemented with cottonseed oil than that from chicks fed diet supplemented with poultry fat.

Bone weight distribution:

Dietary protein sources significantly affected proportion of total bone in breast, thigh and wing but not significantly affected proportion of total bone in drumstick (Table 5 and Figure 3). Birds fed fish meal had significantly higher proportion of total bone in breast and lower proportion of total bone in thigh and wing than those fed poultry by-product meal and poultry offal meal diets.

Table 5. The effect of source of protein and lipids and sex on live weight, carcass composition, muscle, bone, fat and meat weight distribution in broiler chicks

Item	Source of Protein (P) ¶				Source of lipids (L)		Sex (S)		Significance of difference					
	FM	SBM	POM	PBPM	CSO	PF	Male	Female	P	L	S	PL	PS	LS
Dressing percentage	63.11b	62.18b	66.99a	64.33ab	64.90	63.32a	64.37	63.98	**	*	NS	NS	NS	NS
% of carcass														
Muscle	61.23b	61.72b	63.68a	61.59b	61.17b	62.75a	62.51	61.53	*	*	NS	NS	NS	NS
Fat	16.86a	16.61a	15.59b	17.56a	17.59a	15.96b	16.12	17.31	*	*	*	NS	NS	NS
Bone	21.91a	21.67a	20.73b	20.85b	21.24	21.30	21.37	21.16	*	NS	NS	NS	NS	NS
Boneless	75.09b	78.33a	79.27a	79.15a	78.76	78.70	78.63	79.83	*	NS	NS	NS	NS	NS
Fatless	84.14a	83.39a	84.41a	82.44b	82.14b	84.04a	83.88	82.70	*	*	NS	*	NS	NS
Ratios														
Muscle: Bone	2.82	2.90	3.14	2.98	2.99	2.92	2.96	2.05	NS	NS	NS	NS	NS	NS
Muscle: Fat	3.76	3.89	4.31	3.64	3.52b	4.11a	4.06	3.70	NS	*	NS	NS	NS	*
% of total muscle														
Breast muscle	45.84	45.52	45.91	45.97	45.67	45.95	45.24	46.42	NS	NS	NS	*	NS	**
Thigh muscle	26.97	27.89	27.63	27.02	27.83a	26.93b	27.57	27.11	NS	*	NS	*	NS	**
Drumstick muscle	17.72	17.96	17.78	18.68	17.93	18.17	18.39	17.73	NS	NS	NS	*	NS	*
Wing muscle	9.48	8.63	8.69	8.32	8.57	8.94	8.80	8.75	NS	NS	NS	NS	NS	NS
% of total bone														
Breast bone	39.81a	34.47b	33.90b	32.84b	35.50	34.98	34.49	35.97	**	NS	NS	NS	NS	NS
Thigh bone	27.10b	29.98ab	29.87ab	31.45a	39.34	29.90	30.30	28.97	*	NS	NS	NS	NS	NS
Drumstick bone	18.70	20.10	20.57	20.63	19.98	20.03	20.45	19.55	NS	NS	NS	NS	NS	NS
Wing bone	14.39b	15.46b	15.66a	15.09ab	15.18	15.09	14.76b	15.50a	*	NS	*	*	NS	NS
% of total fat														
Breast fat	33.51	33.70	33.07	31.55	32.66	33.07	32.89	32.87	NS	NS	NS	NS	NS	NS
Thigh fat	37.73	39.02	36.34	37.81	38.56	36.58	37.32	37.66	NS	NS	NS	NS	NS	NS
Drumstick fat	11.55	10.50	12.02	13.35	11.64	12.21	11.63	12.78	NS	NS	NS	NS	NS	NS
Wing fat	17.21	17.78	18.56	17.30	17.14	19.14	18.16	17.19	NS	NS	NS	NS	NS	NS

a, b, c means in raw bearing different superscripts differs significantly at $P < 0.05$.*, ** $P < 0.05$ and $P < 0.01$, respectively.
NS, not significant ($P > 0.05$). ¶ the abbreviations are defined in the text

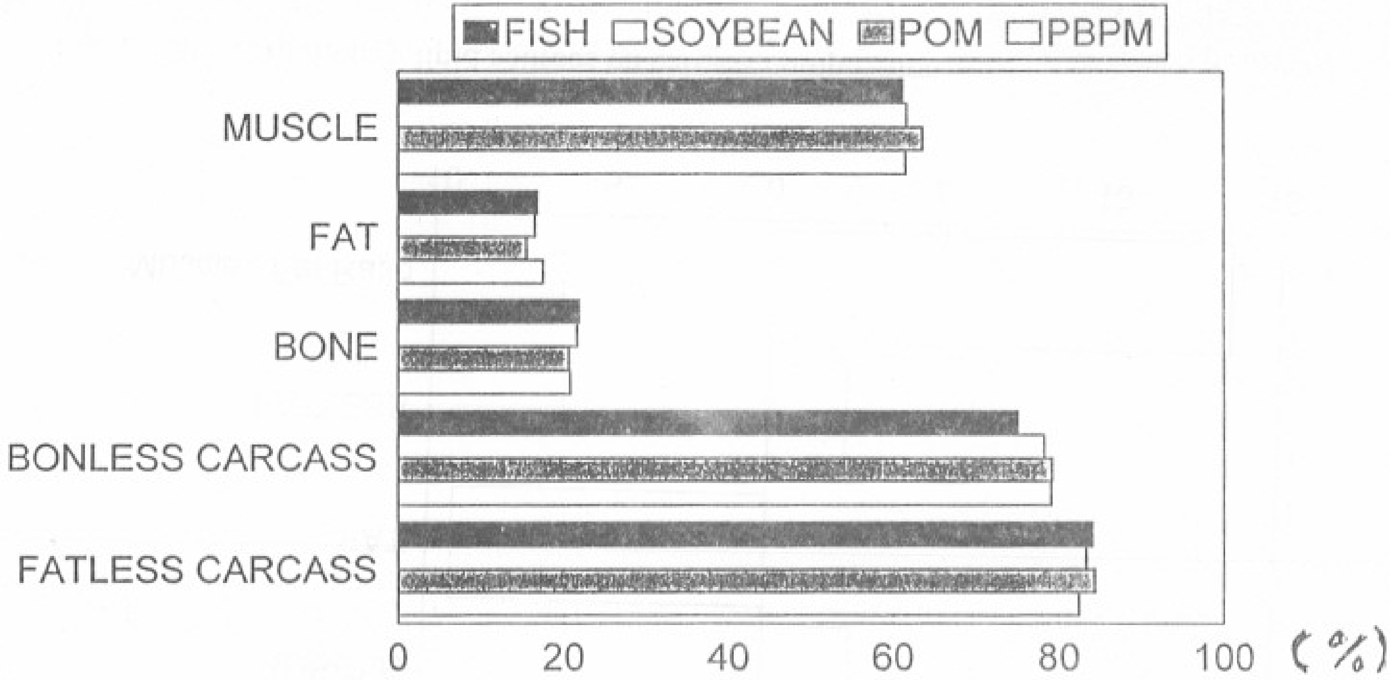

Figure 1. Effects of different dietary protein sources on carcass composition

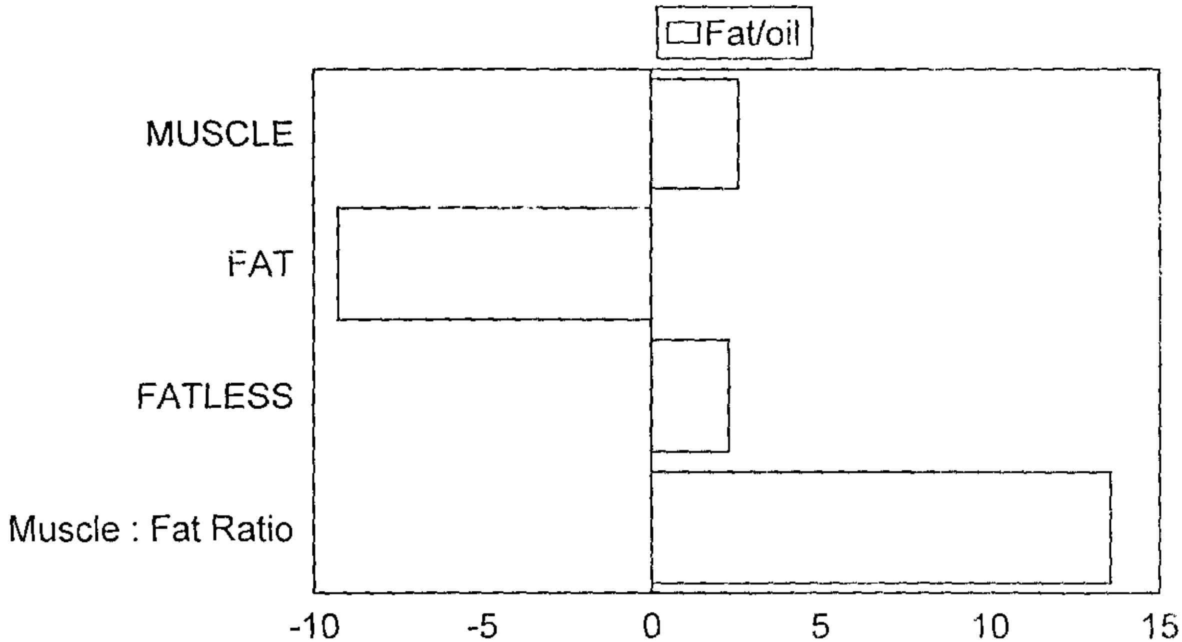

Fig. 2. Effects of dietary lipid sources on carcass composition

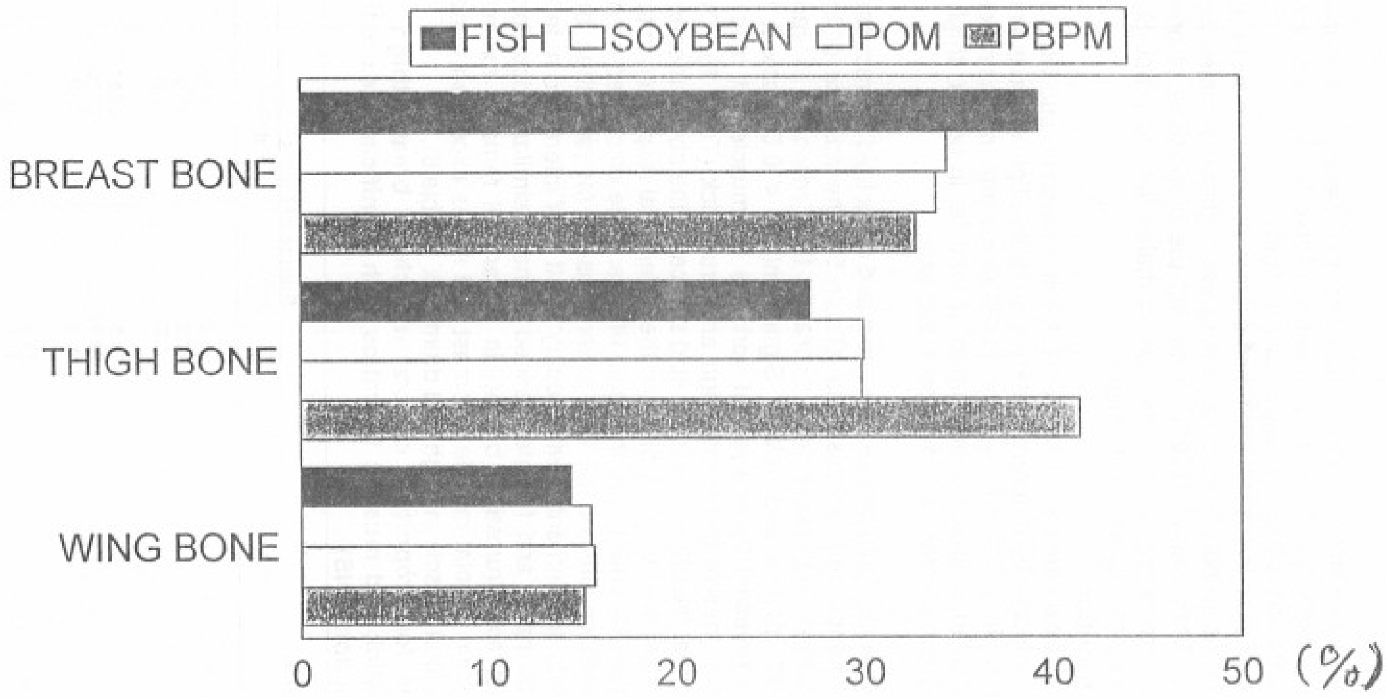

Figure 3. Effect of different protein sources on bone weight distribution

There were no significant differences between dietary lipid sources in proportion of total bone found in all cuts studied (Table 5). It is seemed that bone weight distribution is independent of dietary lipids.

The proportions of bone in breast, thigh and drumstick were similar in males and females, but the proportion of bone in wing was higher in females than in males (Table 5). Shahin *et al.* (1996) found that the proportions of bone in thigh and wing were higher in females than in males but the proportion of bone in drumstick was similar in both sexes.

Fat weight distribution:

The proportion of total carcass fat in breast, thigh, drumstick and wing were not significantly affected by different dietary protein and lipid sources and by sex (Table 5). Shahin and Abd El Azeem (2005) found that increasing crude fiber in diets resulted in lowering proportion of total fat in breast, thigh but increasing proportion of total fat in drumstick and wing.

Interactions

There were no significant sex x protein and sex x lipid interactions for most live performance and carcass traits (Table 5). The absence of these interactions indicated that, sexes were similar in their response to various sources of dietary protein and lipids. Significant ($P < 0.05$) sex x lipid interactions was revealed by analysis of variance for muscle: fat ratio and proportion of total muscle in breast, thigh and drumstick (Table 6). These results indicated that the effect of dietary lipid source on the above mentioned traits was dependent on the sex of bird and the differential responses in these traits may be more important than the main effects. Male chicks fed on diets supplemented with cottonseed oil had lower muscle: fat ratio than those chicks fed on diets supplemented with poultry fat. It is of interest to note that within dietary fat males and females tended to have similar proportion of muscle in breast and drumstick, but within dietary oil females exceeded males for proportion of total muscle in breast and males exceeded females for proportion of total muscle in thigh and drumstick (Table 6).

Table 6. Means for proportion of total muscle in breast, thigh and drumstick and muscle: fat ratios with significant sex x lipid interactions (NS)

Item	Source of Lipids	
	Oil (CSO)	Fat (PF)
Breast muscle%		
Male	44.08	46.26
Female	47.37	45.65
Male/Female	0.93	1.01
Thigh muscle%		
Male	28.67	26.61
Female	26.93	27.25
Male/Female	1.06	0.98
Drumstick muscle%		
Male	18.63	18.18
Female	17.18	18.17
Male/Female	1.08	1.00
Muscle: Fat ratio		
Male	3.51	4.54
Female	3.73	3.68
Male/Female	0.94	1.23

NS: Not significant.

Significant (P < 0.05) protein x lipid interactions was revealed by analysis of variance for proportion of total muscle in breast, thigh and drumstick (Table 5). These indicated that the effect of dietary lipid sources on the above-mentioned traits was dependent on the dietary protein sources. Feeding chicks either fish meal or poultry by-product meal supplemented with cottonseed oil resulted in increasing proportion of total muscle in breast and decreasing proportion of total muscle in drumstick than those chicks receiving the same protein sources supplemented with poultry fat (Table 7). Such information is limited in the literature.

Table 7. Means for proportion of total muscle in breast, thigh and drumstick with significant protein x lipid interactions (NS)

Item	Source of Protein			
	FM	SBM	POM	PBPM
Breast muscle%				
Oil	46.52	45.56	43.77	46.64
Fat	45.23	45.49	48.05	45.38
Oil/Fat	1.03	1.00	0.91	1.03
Thigh muscle%				
Oil	27.11	28.28	26.20	26.99
Fat	26.34	27.65	26.05	27.06
Oil/Fat	1.01	1.02	1.01	1.00
Drumstick muscle%				
Oil	17.47	18.15	17.94	18.19
Fat	17.94	17.84	17.62	19.11
Oil/Fat	0.97	1.02	1.02	0.95

NS: Not significant.

Economic efficiency:

The cost of feeding, total cost, the total revenue and the economical efficiency of broiler production for different experimental diets are shown in Table 8. Feed cost and marketing body weight are the most important factors affected efficiency of poultry production. The highest economic efficiency obtained from feeding chicks on poultry offal meal diet as the sole source of protein while the lowest economic efficiency obtained from feeding chicks on fish meal. Feeding broilers either poultry offal meal or poultry by-product meal resulted in lowering feeding costs and increasing net revenue (financial returns) and economical efficiency than feeding broilers fish meal and soybean meal. These findings are in agreement with Ghazalah *et al.* (1998) who found that feeding broilers on poultry offal meal diets decreased the feed costs and improved economic efficiency. From the economic point of view that the efficiency of diets supplemented with cottonseed oil was better than that of diets supplemented with poultry fat.

Table 8. Effects of different protein and lipid sources on economic efficiency

Item	Protein sources*				Lipid sources*	
	FM	SBM	POM	PBPM	CSO	FP
Cost of feeding; LE[1]	5.02	4.42	4.58	4.78	4.64	4.61
Total cost; LE[2]	8,12	7.52	7.68	7.88	7.74	7.71
Selling income; LE[3]	12.81	12.24	13.18	13.48	13.11	12.74
Net income; LE[4]	4.69	4.72	5.50	5.60	5.37	5.03
Economical efficiency :%[5]	57.76	62.77	71.61	71.07	69.38	65.24

* The abbreviations are defined in the text.
(1) Cost of feeding = Total feed consumption x price of kg feed (starter and finisher, LE)
(2) Total cost = 1 + fixed cost (price of chick, labor, medication, electricity, ..., etc)
(3) Selling income = body weight x price of one kg live body weight (LE)
(4) Net income = Selling income – total cost
(5) Economical efficiency = (Net income/ Total cost) x 100

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تأثير مصادر مختلفة من البروتين والدهون على الأداء الانتاجى وتركيب الذبيحة وتوزيع الأنسجة لبدارى التسمين

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فى هذه التجربة تم دراسة التأثير الغذائى لمصادر البروتين (مسحوق السمك وكسب فول الصويا ومسحوق مخلفات مجازر الدواجن ومسحوق الأحشاء) ومصادر الدهون (زيت بذرة القطن ودهن الدواجن). والنتائج توضح أن وزن الجسم عند ٦ أسابيع من العمر يتأثر معنويا بمصادر البروتين والدهون. وعند نفس العمر وجد أن الكتاكيت المغذاة على مسحوق مخلفات الدواجن أعطت أثقل وزن للجسم وبتأثير معنوى عن الكتاكيت المغذاة على كل من كسب فول الصويا ومسحوق السمك. الغذاء المأكول ومعامل التحويل الغذائى لا يتأثر معنويا بمصادر الدهون ولكن كان هناك تأثير معنوى لمصادر البروتين المختلفة. معامل التحويل الغذائى كان أقل بصورة واضحة فى الطيور المغذاه على عليقة تحتوى على كسب فول الصويا كمصدر للبروتين عن الطيور المغذاه على باقى العلائق المحتوية على مصادر البروتين المختلفة الأخرى. تركيب الذبيحة يختلف معنويا بين الطيور المغذاه على مصادر البروتين المختلفة. ذبائح الطيور المغذاه على علائق مضاف إليها دهن الدواجن كانت تحتوى على عضلات أكثر ودهن أقل عن الذبائح الأخرى المغذاه على علائق مضاف إليها زيت بذرة القطن. نسبة العظام فى الذبائح لم تتأثر معنويا بمصادر الدهون المستخدمة. الذكور لها نفس نسبة العضلات والعظام بالمقارنة بالاناث الا أنها تحتوى على نسبة أقل من الدهون.

مصادر البروتين المختلفة والجنس ليس لها تأثير معنوى على توزيع العضلات خلال اجزاء الذبيحة المختلفة. مصادر البروتين والدهون ليس لها تأثير معنوى على توزيع وزن الدهن . الاختلاف فى الجنس ليس له تأثير معنوى على توزيع وزن الدهن . نسبة عظام الذبيحة الكلية فى الصدر والفخذ والجناح تتأثر معنويا بمصادر البروتين المختلفة بينما مصادر الدهون ليس لها تأثير معنوى على توزيع وزن العظام . هناك تأثير معنوى للتداخل بين مصادر البروتين والدهون وكذلك الجنس والدهون فى نسبة العضلات الكلية فى الصدر والفخذ والدبوس للذبيحة .