Protein Efficiency Ratio and Amounts of Selected Nutrients in Mechanically Deboned Spent Layer Meat

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ABSTRACT

Three types of mechanically deboned spent layer meat (MDSL) were found to have adjusted protein efficiency ratios (PER) equivalent or superior to a standard (casein) diet. These same materials proved to be good sources of calcium, iron and zinc. Percentage protein ranged from 15.39 for MDSL from whole spent layers to 16.55 for MDSL from spent layer frames with wings. Fat levels were highest for whole birds (20.41%) and lowest for frames without skin (16.84%). High levels of unsaturated fatty acids were found to be associated with these products.

INTRODUCTION

MECHANICALLY DEBONED poultry meat (MDPM) from spent layers is currently being used in a variety of food products—specifically in sausage-type foods such as frankfurters and bologna. These products have met with consumer approval and expanded usage in other food items is underway.

Chemical and physical characteristics of MDPM were first identified by Grunden et al. (1972). Further studies by Cunningham and Mugler (1974), Dhillon and Maurer (1975) and Mast and MacNeil (1976) provided information on the functional properties of MDPM. Microbial qualities of MDPM were identified by Ostovar et al. (1971), Maxcy et al. (1973) and Mulder and Dorresteijn (1975).

Several studies on the nutritional characteristics of MDPM have been conducted. Essary and Ritchey (1968) determined the amino acid profile of mechanically deboned turkey meat. MacNeil et al. (1978) reported similar amino acid profiles for mechanically deboned broiler meat and ground beef. Biological evaluation of protein quality, as expressed by Protein Efficiency Ratio (PER), for raw mechanically deboned broiler meat was found to be comparable to a standard casein-lactalbumin diet (Brinkman and MacNeil, 1976) and a standard casein diet (MacNeil et al., 1978). Mechanically deboned turkey meat (MDTM) was also found to have a significantly higher PER value when compared to a casein diet (MacNeil et al., 1979).

Little comprehensive information concerning mechanically deboned spent layer meat (MDSL) is available in the literature. It is the intent of this paper to provide this information.

EXPERIMENTAL

THREE TYPES OF MDSL were obtained from a commercial poultry processing plant in New Jersey. Samples consisted of deboned meat from raw whole spent layers, spent layer frames with wings (MDSL with skin) and spent layer frames (MDSL without skin). Poultry frames include backs, breast cage and ribs, and pelvic girdle areas. Four 10 kg boxes of each type of meat were obtained. One box from each type was packed in insulated containers and immediately transported unfrozen to the university for initial analysis. The remaining boxes representing samples of each group were placed in the plant's freezer along with the regular production run of mechanically deboned poultry meat. This material was removed from the freezer and transported to the university after 1 wk. The study was replicated three times with all chemical analyses conducted in duplicate.

Official methods of the AOAC (1975) were used to determine fat (petroleum ether extractables), moisture, ash, fatty acids (preparation according to Metcalfe et al., 1966) and protein by Kjeldahl nitrogen determination (N x 6.25 for meat protein). Iron and zinc were measured by atomic absorption spectrophotometry (Perkin-Elmer Co., Norwalk, CT), calcium content by a Corning calcium analyzer (Corning Scientific Inst., Medford, MA), calorie content by a Parr Automatic Adiabatic Calorimeter, Parr Instrument Co., Moine, IL), amino acids with a Beckman Model 121 amino acid analyzer (Beckman Instruments, Palo Alto, CA), using procedures outlined in Beckman Instruction Manual A-IM3 fluoride content using a specific ion electrode (Dolan et al. 1977) and oxidative stability changes by the 2-thiobarbituric acid (TBA) test (Tarladgis et al., 1960).

Amino acid analysis and the PER study were conducted on pooled samples of each type of meat from the three replicates. Frozen blocks of meat were cut into small cubes using a meat band saw, and freeze-dried. The material was then ground in a Hobart meat grinder, placed in sealed containers and held at 21°C until incorporated into the experimental diets. Proximate analysis, amino acids and fatty acids were determined on freeze-dried material as well as fresh MDSL to detect possible changes during freeze-drying.

AOAC (1975) procedures for PER were followed except that fat contents of the diets were adjusted to complement the higher fat content of the test material. For example, inclusion of the test material at the recommended level to provide the required 9% protein resulted in an 18% dietary fat content. Thus a standard casein diet with an 18% fat level was included as well as a 9% fat level casein diet. This procedure is similar to that suggested by Hurt et al. (1974). It has been shown in two previous studies, MacNeil et al. (1978) and MacNeil et al. (1979), that there were no significant differences between the PER values obtained with the high and low fat casein diets. Subsequent testing used the conventional 9% fat level diets for adjusting the PER values. Each test diet was fed to 10 male weanling rats (Wistar strain, Charles River Breeding Labs, Wilmington, MA) which were individually housed in stainless steel cages with raised wire bottoms. Food and water were supplied *ad libitum*. PER values were computed for each rat as grams of weight per gram of protein consumed. PER values obtained were adjusted with the reference casein diet being given the value of 2.5.

Data were analyzed by analysis of variance to determine effects of treatment and replication on the characteristics of MDPM. When significant differences were found by the analysis of variance, Duncans New Multiple Range Test (1955) was applied.

RESULTS & DISCUSSION

MDSL produced from whole spent layers (Table 1) contained 15.39% protein, 20.41% fat, and 62.47% moisture. The proteinand moisture levels were significantly lower and fat content was significantly higher for this type of meat than those levels observed in previous studies (MacNeil et al., 1978, 1979). This reflects the composition of the sample prior to deboning: MDSL from whole spent layers has a high meat-to-bone ratio and includes the heavy carcass fat deposits and skin of the bird. Thus, the increased fat concentration reflects the presence of carcass fat as well as

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the fact that fat from skin is expressed with the meat. Reduced protein concentration is thought to be due to a dilution effect and also due to the fact that skin protein (collagen) is discarded with the bone during the deboning process. Work on the effect of skin on the resultant composition of the MDSL product was first done by Froning et al. (1973) and later confirmed by MacNeil et al. (1977). Whole MDSL and MDSL with skin had a significantly lower ash concentration as compared to MDSL without skin. This is thought to be due to the dilution effect of fat from skin on the samples.

Table 1—Proximate analysis[a] and selected nutrient content of mechanically deboned spent layer meat (wet wt)

Characteristic	Whole	W/Skin	W/O Skin
Protein (%)	15.39b	16.19a	16.55a
Fat (%)	20.41a	16.91b	16.84b
Moisture (%)	62.47b	66.35a	66.63a
Ash (%)	1.19b	1.28b	1.39a
Calcium (%)	0.19a	0.20a	0.23a
Iron (mg/100g)	1.20b	4.25a	4.05a
Zinc (mg/100g)	1.87a	2.48a	2.40a
Fluoride (ppm)	–	12.27b	14.58a
Kilocalories/100g	271.4a	234.4b	23.13b

[a] Means followed by the same letter are not significantly different ($p < 0.01$) from each other. Each mean represents six determinations.

Table 2—Amino acid analysis of freeze dried deboned spent layers meat (grams of amino acid residue per 100 g of total amino acid residues)

Amino acid	Whole	W/Skin	W/O Skin
	Essential Amino Acids		
Histidine	3.47b	5.00a	5.07a
Lysine	9.59a	11.19a	9.17a
Threonine	4.81a	4.84a	4.42a
½ Cystine	0.42a	0.41a	0.65a
Valine	4.01b	4.42ab	4.74a
Methionine	2.95a	2.52b	2.66b
Isoleucine	3.95b	5.61a	5.62a
Leucine	8.46a	7.87b	7.91b
Phenylalanine	4.02b	4.09ba	4.32a
Tryptophan	ND	ND	ND
Total	41.68	45.95	44.56
	Nonessential Amino Acids		
Arginine	6.60a	6.25a	4.34b
Aspartic	10.73a	8.74b	9.08b
Serine	4.39a	4.21b	4.29b
Glutamic	16.95a	15.91a	17.11a
Proline	4.26a	4.11a	5.01a
Glycine	5.12b	4.45a	5.51a
Alanine	6.28a	5.71ab	5.51b
Tyrosine	3.62a	3.62a	3.67a
Total	58.45	53.95	54.52

[a] Each value represents the mean of four determinations on the pooled sample.
[b] ND — not determined
[c] Means followed by the same letter are not significantly different ($p > 0.01$) from each other.

Table 1 (Selected nutrient content of the three types of MDSL) shows that MDSL is a good source of calcium, iron and zinc. Iron concentration is significantly lower in whole MDSL due to the presence of additional meat on the carcass prior to deboning. High fluoride concentrations, due to the age of the bird and the brittleness of the bones, in MDSL with skin and MSDL without skin could be reduced by making the appropriate adjustment to the deboner screen. Kilocalories, as expected, reflect the fat concentrations of the individual samples.

Amino acid profiles of the three MDSL types are shown in Table 2 and are grouped into essential and nonessential amino acids. This study did not include a determination of tryptophan since it is readily destroyed by the acid hydrolysis procedure used. Histidine is included as an essential amino acid because it is essential in the diets of infants and rats. Cystine is included since it may replace part of methionine. There was little variation in the amino acid profile of each MDSL type. Analysis of variance on the essential amino acid grouping showed that whole MDSL was significantly different from MDSL with skin and without skin for histidine, methionine, isoleucine, and leucine. Studies on commercial lean ground beef performed in this laboratory revealed a total of 40g essential amino acids per 100g of total amino acids as compared to 41.68g, 45.98g, and 44.56g essential amino acids per 100g of total amino acids for whole MDSL, MDSL with skin, and MDSL without skin.

The results of the PER test are shown in Table 3. In test 1 when whole fowl was evaluated the PER value for this material, while higher, was not significantly better than the high-fat standard casein diet but was higher than the low-fat diet. In test 2 when two types of MDSL was compared to the conventional 9% fat casein diet both were found to be significantly higher. It is evident then that the whole fowl or MDSL obtained from fowl frames, with or without skin, is a good source of high quality protein.

Fatty acid composition (Table 4) shows little difference between two types of MDSL tested. It should be noted that MDSL contains the expected high level of unsaturated fatty acids normally associated with poultry products.

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Table 3—Growth and protein efficiency ratios (PER) for rats fed mechanically deboned spent layer meat

Diet	Total wt gained (g)	Total feed consumed (g)	Total protein consumed (g)	Adjusted PER
Test I				
Casein (8% fat)	111.69b	401.88b	36.17b	2.36b
Casein (18% fat)	111.88b	381.91b	34.37b	2.50ab
Whole fowl	142.97a	461.97a	41.58a	2.65a
Test II				
Casein (9% fat)	106.69b	435.67b	39.21b	2.50b
Fowl w/skin	146.57a	505.50a	45.49a	2.94a
Fowl w/o skin	139.88a	503.91a	43.35a	2.73a

[a] Means within columns followed by the same letter are not significantly different ($p < 0.01$) from each other.

Table 4—Fatty acid composition in mechanically deboned spent layer meat

Treatment	Lauric	Myristic	Palmitic	Palmitoleic	Stearic	Oleic	Linoleic	Linolenic
	12:0	14:0	16:0	16:1	18:1	18:1	18:2	18:3
Whole		0.94	21.18	5.36	4.10	45.50	22.11	0.79
w/skin		1.13	26.26	7.06	4.43	41.82	19.30	trace

[a] Each value represents the mean of 4 determinations on the pooled sample