IAFMM

international association of fish meal manufacturers

Hoval House, Mutton Lane, Potters Bar, Herts. EN6 3AR U.K.
Tel: (Potters Bar) 0707 42343 Telex: 8811909 London

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ENERGY VALUES OF FISH MEALS FOR RUMINANTS

SUMMARY

In the absence of energy values determined on fish meals fed to ruminants, metabolisable energy (ME) determinations were carried out using mature sheep at the Rowett Research Institute in Aberdeen, Scotland. Three fish meals were tested: A South American meal, a white-fish offal meal and a North European herring-type meal. These were fed with grass silage, and also with either dried grass, hay or ammonia treated straw at maintenance level of energy intake.

The ME values found for the fish meals were as follows (as received):

South American	13.1 MJ/kg
White-fish offal	13.4 MJ/kg
North European herring-type	16.4 MJ/kg

These values are considerably higher than those currently in use in most feedingstuffs tables, none of which appears to have been derived directly from trials with ruminants, e.g. the value used by U.K. Ministry of Agriculture, Fisheries and Food is 10.0 MJ/kg. These low ME values used in computers undervalue fish meal for ruminants by about £10 per tonne.

It is recommended that the above ME figures should be used in the formulation of feeds for ruminants until such time as more determined values, and details of their derivation etc become available. Emphasis should be placed on updating values in feedingstuff analysis tables.

Introduction

It has been found that fish meals, because of their high content of good quality protein which escapes breakdown in the rumen (undegraded dietary protein), provide a very effective source of protein for ruminants (1, 2 and 3). This is especially true for fish meals which are selected for ruminants on the basis of very fresh raw material and a low content solubles added back in the processing (4). Extensive trial work with lactating cows (5) and beef cattle (6) have shown the benefits of incorporating fish meal in the diet - increased milk production, faster growth and savings in feed required to supplement forage.

This research has created much interest in fish meal, and there has been a rapid growth in its use in ruminant feeds in the last five years in the U.K. and Scandinavia.

As well as providing protein, fish meal is an important source of energy. For the feed formulator/animal feeder to take this into account, reliable data are required based on experiments with ruminants.

Previously published values for the energy determination of fish meal using ruminants were carried out many years ago - Kellner, 1877 (7), Honcamp et al, 1911, (8) and Linsey and Smith, 1914 (9), Isaachsen and Uvesli, 1926 (10) and Honcamp et al, 1933, (11). It is questionable whether the fish meals used at that time bore any relation to those currently produced. For example, Linsey and Smith use two kinds of fish meal, the first, Gloucester fish meal, was from the Russian Cement Company and was a bi-product from the manufacture of fish glue, whereas the second was a bi-product of the Menhaden Fisheries previously used as as fertiliser. There does not appear to have been any further published ME values determined with ruminants fed fish meal since 1933.

In the absence of reliable ME data on fish meal the Rowett Research Institute in Aberdeen, Scotland has determined the metabolisable energy value of three of the main types of fish meal used in Northern Europe (South American), white fish offal UK produced, and North European herring type meal. This was fed to mature wether sheep.

Methods

The metabolisable energy contents of diets were determined by holding 12 mature Suffolk Cross half bred wether sheep in crates and collecting faeces and urine for a 10-day period following a 15-day preliminary feeding period. In addition two 24 hour measurements of methane loss for each sheep were carried out in closed circuit resporation chambers. The sheep were restricted fed 875g of diet dry matter per day approximately, providing sufficient energy for maintenance only.

The fish meals tested were as follows:
(1) South American meal from Chile made from Spanish pilchard, and treated with the anti-oxidant Ethoxyquin (700 ppm of meal).

(2) White-fish offal meal, mainly from cod.

(3) Herring-type fish meal made in in Northern Europe from sprat. Each fish meal was fed with grass silage and also with a dried roughage, either hay, ammonia treated straw or dried grass at three rates of inclusion in the diet 80g, 160g and 240g per kg dry matter fed. Each of the 12 sheep received each fish meal (F1, F2 and F3) in combination with silage and also with one of type of dried forage at each rate of fish meal inclusion in the diet in separate periods. A mineral supplement was added to all diets.

Metabolisable energy values (gross energy less the sum of energy in faeces, urine and methane) were determined for each diet. Regression equations were determined relating fish meal intake to the ME of the diet for each forage.

Results and Discussion

The compositions of the fish meals are given in table 1. The protein content of the herring type meal appears rather high (75.8%). A typical value, as given in the IAFMM nutrient analysis tables for the UK, is 72.0%.

The regression equations relating ME of the diet to the content of fish meal were found to be linear for the South American and North European fish meals, ME increasing with increased content of fish meal. For the white-fish offal meal, ME did not increase with increasing fish meal inclusion. Furthermore, digestibility of organic matter was low (below 80%). It was felt that these values for white-fish offal meal were aberrant. In consequence, the energy determinations were repeated for white-fish offal meal, adding 10% or 20% to a diet based on dried grass. The ME of the dried grass diet increased with 10% addition of fish meal, but there was no further increase when the inclusion was increased to 20%. In view of this, the ME for the white-fish offal meal was determined based on the low level (10%) inclusion.

The ME values and digestibility data for the fish meals are given in table 2.

Since the Rowett Research Institute undertook this work, the UK Ministry of Agriculture's Feed Evaluation Unit at Drayton has determined the ME value of 6 UK produced fish meals fed to sheep(12). Methane production was calculated, average value being 10% of gross energy of the diet. The meals used were obtained locally, and included both white-fish offal meals and meals made from mixtures of white fish offal and whole fish. Unfortunately, there is little information available about their origin. Their analysis and ME value averaged for the 6 meals are given in table 3. The average ME value (15.1 MJ/kg) falls almost midway between the Rowett values for white-fish offal meal (13 MJ/kg) and herring-type meal (16.4 MJ/kg).

The higher ME value for herring-type fish meal determined by the Rowett reflects the higher protein and fat content than that in the other two meals, rather than differences in digestibility of the protein and oil.

The Feed Evaluation Unit of the Rowett Research Institute has determined ME values for a wide range of feeds using mature wether sheep fed at the maintenance level (see reports nos. 1 to 5 - ref. (14)). Although rate of passage of digest differs comparing mature sheep and lactating dairy cows, for example, retention time in the rumen is less likely to be affected for feeds presented with relatively small particle size, e.g. cereal and protein meals. Consequently the ranking of such meals based on ME values determined with mature sheep is believed to be applicable to other ruminant species such as lactating dairy cows.

As mentioned earlier the energy value of fish meals fed to ruminants does not appear to have been determined by direct measurement using ruminants in the past 40 years. Values which appear in feedstuffs tables are generally much lower than the values reported by the Rowett, and of uncertain origin, for example, the UK Ministry of Agriculture give an ME value for white fish offal meal of 10.0 MJ/kg. This was calculated using digestibility coefficients for fish fat and fish protein and substituting them into an equation determined by Kellner working in Rostock (11). In the feedstuffs tables produced by the company BP Nutrition, ME values of 11.3 MJ/kg and 12.2 MJ/kg are ascribed to white-fish offal meal and South American fish meal respectively, though these are currently under review. The U.K. based feed supplement company Colborn-Dawes uses values of 10.5, 12.1 and 12.5 MJ/kg respectively for white-fish meal, South American and North European meals; Feedstuffs Ingredient Analysis Tables (USA publication) gives values for Menhaden meal of 71 TDN which is equivalent to 10.7 MJ/kg and for herring-type and South American meals 73 TDN - equivalent to 11.0 MJ/kg. Clearly there is an urgent need for these values to be updated.

Based on a computer formulation of a high energy dairy cow feed with 18% protein, 81g/kg undegraded dietary protein and 12.2 MJ/kg ME, the value of a white-fish meal was found to be undervalued by around £10 per tonne as a result of using an old energy value of 10.0 MJ/kg rather than the new value of 13.4 MJ/kg for fish meal with 66% CP and 7.2% fat content.

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TABLE 1 COMPOSITION OF THE FISH MEALS (as received)

	South American Meal (F1)	White Fish Meal (F2)	North European Herring Type Meal (F3)
Dry matter (%)	90.0	91.5	92.0
Ash (%)	17.7	21.8	11.2
Protein (%)	66.2	65.2	75.8
Fat (%)	5.8	6.3	6.9
Gross Energy (MJ/kg)	17.7	18.4	20.5

TABLE 2

DIGESTIBILITIES AND METABOLISABLE ENERGY VALUES FOR FISH MEALS[1]

(on as received basis)

	South American Meal		White fish Meal		North European Herring-type meal	
Organic matter digestibility	0.977	(0.048)[2]	0.930	(0.067)	0.953	(0.050)
N digestibility	0.908	(0.010)	0.936	(0.020)	0.967	(0.012)
Faecal energy MJ per kg fish meal	0.96		1.61		0.82	
Urinary energy MJ per kg fish meal	2.97		2.83		2.71	
Methane energy MJ per fish meal	0.70		0.53		0.57	
Metabolisable energy MJ/kg fish meal	13.1	(0.75)	13.4	(0.84)	16.4	(0.74)
TDN[3]	87.3		89.3		109.3	

[1] Calculated from linear relationship with amount of fish meal included

[2] Figures in brackets are pooled standard errors from regression equations for fish meal with each forage.

[3] Calculated from ME values, assuming 100 TDN = 15MJ

TABLE 3

COMPOSITION, DIGESTIBILITY AND ENERGY VALUE OF SIX UK PRODUCED FISH MEALS[1,2]

		Average (n = 6)[3]	Standard deviation[4]
Dry matter	%	92.0	1.51
Crude protein	%	63.7	1.36
Fat	%	7.7	2.15
Ash	%	19.3	1.49
Gross energy	MJ/kg	18.2	0.63
Digestibility of organic matter		0.93	0.036
Digestibility of nitrogen		0.85	0.016
Metabolisable energy	MJ/kg	15.1	2.05

[1] As received
[2] Data from UK Ministry of Agriculture Feed Evaluation Unit, Drayton 1985
[3] Values for individual fish meals have not yet been released
[4] Includes variability due to animals and fish meals