Part 1. Nutrition, feeding and management

Protein digestibility of some traditional and new feed ingredients for mink

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Abstract

The study comprised 19 protein sources, four meals made from salmon by-products, three enzyme-hydrolyzed protein concentrated products made from salmon by-products, two fish meals, three krill meals, two poultry meals, one lamb meal, raw poultry by-products, raw cod scraps, raw eggs and cooked eggs. Protein digestibility was measured in adult male mink. Protein digestibility was significantly different among the sources, it was highest for one of the hydrolyzed salmon protein concentrates, 91.4% (SD 0.5), and lowest for the lamb meal, 64.9% (SD 1.2). Within the different categories of protein meals (salmon by-products meals, the hydrolyzed by-products, krill meals) there were also significantly differences in protein digestibility. Some of these products revealed similar chemical content and protein digestibility as high quality fish meal, but some did not. Raw egg white has been shown to reduce protein digestibility in young dogs. No difference in protein digestibility between raw and cooked eggs was observed in mink. Generally, the raw protein sources revealed digestibility coefficients between 85 and 90%, while most of the meals revealed values between 75 and 85%. The study showed that animal derived meals most often have protein digestibility around 80%, but variation can be large and digestibility studies are needed to have exact information on each protein ingredient.

Keywords: protein sources, salmon by-products, krill meal, raw egg

Introduction

Numerous raw materials with various origin, conservation and storage are involved in fur animal feeding. Animal by-product ingredients have been the basis for the feed production because of the high value nutritional value and palatability for foxes and mink. These ingredients include fresh, frozen stored, acid preserved and dry meals made of raw materials of animal origin. Some of these raw materials have no other alternative use but destruction. The flexibility in choice of ingredients is high in fur animal production because the commercial product is none-food and concerns regarding product quality as in human food productions are not considered. Moreover, wet feed production allows for utilization of both wet and dry ingredients and the rapid turnover of the feed opens for short time changes in the ingredient composition if necessary. The feed industry will always search for new and cheaper feed raw materials and the market price will be a main decisive factor for which raw materials to be used. Nutritional quality is the important factor to take into consideration before new ingredients are incorporated into the feed. Protein supply, which is a main nutritional focus in fur animal production, is dependent on amino acid level, amino acid composition as well as digestibility. Digestibility values will directly affect the amino acids and energy supplied by the protein source. Protein digestibility is therefore an important factor in the evaluation of protein quality of feed ingredients.

Our study aimed at making screening of protein content and protein digestibility in some traditional and some new potential ingredients in fur animal feed. The inclusion of the traditional ingredients in study was done to make good a set of comparisons with the new ingredients.

Material and methods

Animals and diets

The digestibility study comprised 19 protein ingredients; four meals from salmon by-products (Marine Harvest, Bergen Norway), three enzyme hydrolyzed protein concentrate meals made of salmon by-products (Marine Bioproducts, Storbø, Norway), two fish meals (Nordsildmel, Bergen, Norway), three krill meals (Aker Biomarine, Oslo, Norway), one lamb meal (Norsk Protein, Ingeberg, Norway), two poultry meals (Meal A, low ash, Gepro, Diepholz, Germany, Meal B, Norsk Protein, Ingeberg, Norway), raw poultry by-products (deboned chicken meat, Prior, Rakkestad, Norway), raw cod scraps (Fryserienes Fôromsetning, Tromsø, Norway) and raw eggs and cooked eggs. The protein ingredients were added as the only protein source in the experimental diets. The other ingredients were soybean oil, precooked corn starch, cellulose powder, vitamin/mineral mixture and water. Protein, fat and carbohydrate accounted for approximately 32, 35 and 33% of dietary dry matter content in the experimental diets, respectively.

A group of 24 adult males of the black genotype (>6 months) comprised the experimental animals at the laboratory. Body weights (BW) of the males were between 2.0 and 2.5 kg. Four males were given each of diets and digestibility was calculated as the mean of the four replicates. Daily feed allowances were planned to approximately meet the maintenance metabolizable energy (ME) requirement. Daily rations were approximately 150 g per day corresponding to 60-65 g dry matter. The mink was kept in standard cages equipped for quantitative collection of faeces and separation of urine. The animals were fed once daily and had free access to drinking water. The experiment lasted for seven days of which the three first was an adaptation period. During the four last days the feed intake were measured precisely and faeces were collected daily. Faeces were kept frozen stored during the experiment and freeze dried before analysis.

Apparent protein digestibility was calculated quantitatively using this formula:

Digestibility (%) = ((Protein consumed – Protein excreted in faeces)/(Protein consumed) ×100

Chemical analyses

Samples of protein sources and faeces were analysed for dry matter (by heating at l05 °C for 16-18 h), ash (by combustion at 550 °C to constant weight), crude protein as nitrogen×6.25 (by the semi-micro-Kjeldahl method, Kjeltec-Auto System, Tecator, Sweden), fat (by diethylether extraction in a Fosstec analyzer (Tecator, Sweden) after HCl-hydrolysis.

Statistics

Differences in protein digestibility were tested by analyses of variance (GLM procedure by SAS) and difference between sources were tested with Students T test. Significant differences between products were set at $P<0.05$.

Results and discussion

All the digestibility experiments were carried out without any problems and the feed intakes were close to 100% for all diets. Thus, palatability of all the protein sources was satisfactory. The standard deviations in protein digestibility were minor among animals given each diet, mainly equal or less than 1.0 (Table 1).

Chemical content and digestibility

The four salmon by-products meals was produced from partly viscera and partly scraps. According to the producer the mixture of viscera and scraps were random and not identical

*Table 1. Chemical content (g/kg), apparent crude protein (N*6.25) digestibility (%). Standard deviation in parentheses.*

Product	Dry matter	Ash	Protein	Fat	Protein digestibility[1]
Salmon meal A	900	82	528	237	81.8 (0.6) f
Salmon meal B	918	118	644	100	74.7 (0.8) g
Salmon meal C	929	126	576	182	80.0 (1.4) f
Salmon meal D	923	115	622	161	84.4 (0.6) e
Hydrolyzate A	928	115	646	161	84.7 (1.2) de
Hydrolyzate B	597	64	519	12	91.4 (0.5) a
Hydrolyzate C	934	108	823	6	89.9 (0.9) ab
Norse LT 94	928	130	699	92	87.9 (0.5) bc
Norseamink	908	145	695	76	81.5 (0.6) f
Krill meal A	900	82	528	237	81.7 (1.0) f
Krill meal B	918	118	644	100	85.1 (0.6) de
Krill meal C	943	117	663	80	76.1 (1.0) g
Poultry meal A	938	110	658	139	80.9 (1.7) f
Poultry meal B	952	127	601	167	67.4 (1.8) i
Lamb meal	933	205	563	120	64.9 (1.2) h
Raw cod scraps	279	58	202	8	85.2 (0.4) de
Raw poultry by.	403	21	153	205	88.2 (0.9) bc
Raw eggs	352	11	100	77	86.8 (0.6) cde
Raw boiled eggs	362	11	101	81	87.4 (0.5) cd

[1] Different letters with protein digestibility values indicate significant difference ($P<0.05$).

among the batches of meal. Viscera contain more fat and less protein and ash compared with scraps. The chemical content analyses among the four meals confirmed that mixture of the two ingredients varied. Protein content varied from 528 to 622 g/kg and fat content from 100 to 237 g/kg and ash from 82 to 126 g/kg (Table 1). Compared with the guaranteed chemical content of Norse LT 94 and Norseamink qualities of fish meal, the protein levels of the salmon meals were lower. The minimum guaranteed protein content of Norse LT 94 and Norseamink is 680 g/kg and the typical content is even higher, 710 g/kg. Regarding the fat and ash content, Norse LT 94 and Norseamink have maximum guaranteed fat content of 115 g and 130 g/ kg, respectively, and a maximum ash content of 140 g/kg. Only Salmon meal B obtained such low fat content, while all four salmon meals had lower ash content than 140 g/kg. The protein digestibility varied among the salmon meals (Table 1). High ash content is known to be an indicator of low protein digestibility because of increased proportion of protein from structural proteins such as collagen from connective tissue and bone (Skrede, 1979a). No such relation was observed with the four salmon meals, but the ash content was generally low for all the salmon meals in the present study compared with other type by-product meals made of cod scraps (Ahlstrøm *et al.,* 2004). The variation in chemical content and protein digestibility for the salmon meals suggests that the quality of these meals was not as high as for Norse LT 94, but comparable to that of Norseamink.

The enzyme-hydrolyzed protein concentrated products were made of similar by-products from salmon as the meals described above. Two of them were meals and one was a liquid, hydrolyzed protein B. (Table 1). The hydrolyzed proteins are mainly used in pet-foods to provide higher protein digestibility in special purpose foods. The chemical compositions for the three products were in accordance with the product declarations given by the producer. Previous tests carried out by the producer have showed protein digestibility values of more than 90% in mink and roosters. However, our study revealed somewhat lower digestibility values, but still the highest among the products in the present study.

Norse LT 94 and Norseamink are produced from raw, whole fish that is cooked, pressed, dried and milled. The raw material is gently dried to avoid any heat damage that may reduce protein digestibility. Norse LT 94 have a minimum biological protein digestibility of 90% (true digestibility in mink), while the Norseamink quality meals have somewhat lower digestibility (Ahlstrøm *et al.,* 2004). The batches of Norse LT 94 and Norseamink meal that were included in the present experiment revealed declared values for chemical content and protein digestibility, except for slightly higher ash content than maximum level for the Norseamink fishmeal. The protein digestibility value given for the Norse LT fishmeal is the apparent value (Table 1). If true digestibility is estimated by applying endogenous protein factors determined by Skrede (1979b), digestibility will be higher than 90% in accordance with the declaration.

Utilization of Antartic krill (*Euphasia superba*) has increased during the last decade because higher demand for marine protein and fat sources. The three krill meals included in our study was produced at sea on the vessel. Two of the meals were defatted (B,C) and therefore contained more protein and less fat than the crude meal (A). Krill meal A revealed fairly similar chemical content as found in a recent published study by Øvrum Hansen *et al.* (2010). Protein digestibility varied significantly among the meals in our study, from 76.1 to 85.1%. The reason for this variation is not clear, but it could be caused by different content of krill shells that have been shown to reduce protein digestibility in Atlantic salmon (Øvrum Hansen *et al.*, 2010). When comparing the krill meals with the other protein sources in this study, they had comparable chemical content and protein digestibility as the salmon meals.

The chemical composition of the poultry meals A and B was similar, but the protein digestibility was much lower for poultry meal B. The most likely reason for the difference was the temperature during heat treatment. Poultry meal B was heat treated at 133°C, while the drying temperature for poultry meal A was not known, but it was probably considerably lower than that of poultry meal B. Similar to poultry meal B, the lamb meal had gone through the same harsh heat treatment and came out with even lower protein digestibility. The chemical content and protein digestibility of poultry meal B and the lamb meal is typical for meat-and bone meal (Ahlstrøm *et al.,* 2004; Cramer *et al.,* 2007). These two products revealed the poorest protein digestibility in the present study. Moreover, the amino acid composition and digestibility (not presented) revealed that these ingredients cannot be applied as the only protein sources in fur animal feed.

The chemical composition and digestibility of the raw cod scraps were typical and similar to results from other reports (Skrede, 1979; Ahlstrøm *et al.*, 2004). The low fat content and high protein content make this ingredient very useful for regulation of protein level of fur animal feed. In contrast, the raw poultry by-products contained more fat than protein and is therefore primarily a fat source. Both these ingredients showed very high protein digestibility in comparison with the different types of meals.

Protein digestibility of raw and cooked eggs was carried because previous studies in young dogs have indicated poor protein digestibility of raw eggs because of an anti-trypsin factors present in raw egg white, but not in cooked (Lineweaver *et al.,* 1947). Since the use of raw eggs in mink nutrition only has been an issue due to the content of avidin that can destroy biotin, we wanted to examine whether protein digestibility also was affected. The results showed no difference in protein digestibility between raw and cooked eggs in mink.

Conclusions

Protein sources such as salmon meals, enzyme-hydrolyzed protein concentrates and krill meals reveal high protein digestibility in mink. The study confirmed that most animal derived meals have protein digestibility around 80%, but variation can be large and digestibility studies are needed to have exact information on each protein ingredient.

References

Ahlstrøm Ø., Alden E., Børsting C.F., Dahlman T., Elnif J., Hansen N.E., Mäkelä J., Pölönen I. and Skrede A., 2004. Handbok for fôrmidler til pelsdyr, NJF-utredning/rapport nr. 502, Nordic Association of Agricultural Scientists, Subsection for fur animals, Ås, Norway, 74 p.

Cramer, K.R., Greenwood, M.W., Moritz, J.S., Beyer, R.S. and Parsons, C.M. 2007. Protein quality of various raw and rendered by-products meals commonly incorporatedinto companion animal diets. J Anim Sci 85: 3285-3293.

European Community Directive, 1998. Commision directive 98/64/EC. European Commission, Brussels.

Linewater, H. and Murray, C.W., 1947. Identification of the trypsin inhibitor of egg white with ovomucid. J. Biol. Chem 171: 565-581.

Skrede, A., 1979a. Utilization of fish and animal by-products in mink nutrition. V. Content and digestibility of amino acids in cod (*Gadus morrhua*) byproducts. Acta Agric. Scand. 29, 353-362.

Skrede, A., 1979b. Utilization of fish and animal by-products in mink nutrition. IV. Fecal excretion and digestibility of nitrogen and amino acids by mink fed cod (*Gadus morrhua*) fillet or meat and bone meal.

Øvrum Hansen, J., Penn, M., Øverland, M., Shearer, K.D., Krogdahl, Å., Mydland, L.T. and Storebakken, T. 2010. High inclusion of partially deshelled and whole krill meals in diets for Atlantic salmon (*Salmo salar).* Aquaculture 310: 164-172.