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Chemical composition and quality of some fish meals in Iran

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ABSTRACT

The raw material freshness and drying methods are determining factors of fish meal quality. Blue whiting, herring and capelin meals produced in commercial fish meal processing plants in Iran were obtained. The samples were categorized (according to the freshness of raw fish and processing technique) into three grades (low temperature (LT), Norsea Mink (NSM) and standard). Samples were tested for proximate composition. The results obtained indicated that the salt content of LT meal of blue whiting was comparatively higher than all the others and it was significantly higher ($p=0.001$) in LT meal of herring than in NSM and standard meal. These results suggest that the usage of fresh raw materials, low temperature and low retention time (during drying) for fish meal processing retains quality properties to a greater extent which is useful in the fish feed industry.

KEYWORDS

Chemical composition;
Fish meal;
Nutritive quality.

INTRODUCTION

Fish meal is the main dietary protein source in aquaculture feeds[1]. Fish oil is also used as the main oil supplement in fish diets in order to increase their energy content and provide essential fatty acids. The supply of these materials is limited and their cost is continuously increasing affecting in a direct way feeding costs and total production costs in aquaculture. For this reason considerable research efforts have been directed towards the evaluation of other ingredients as potential substitutes in fish diets. Sea bream and sea bass are the major marine fish cultured in Mediterranean countries. Intensive aquaculture of these species in Greece has greatly expanded during last years[2]. However there is a lack of information concerning the potential of including different feedstuffs in practical diets for these specie. High quality fishmeal is recognized by animal nutritionists as an excellent source of protein, energy, minerals and vitamins. Worldwide, millions of tons of fishmeal are produced annually. The majority of the fishmeal produced is included in commercial diets for poultry, swine, dairy cattle, mink and fish. Good quality fishmeal demands a higher price than other high protein feedstuffs. Its proper use, however, requires a knowledge of not only its nutrient profile but of how it was produced. An understanding of fishmeal production will give users a better understanding of how the various factors interact to influence the quality of fishmeal.

What types of fish are used?

Fishmeal can be made from almost any type of fish but is generally manufactured from two main types. These two types of fish differ both in their ability to store oil as well as where in the body oil is stored. The first type includes a group referred to as "lean fish." This includes

such species as cod and haddock. In these species the oil is stored primarily in the liver. The flesh (fillets) contains very little oil. Fishmeal from this type of fish has a low oil content (2 to 6%) since the livers are removed before processing. Of course, if the livers are added back, or the whole fish is used, the oil content would be higher. The whole fish is not usually used since cod and haddock are prized for the fillets. Since the fillets are used for human consumption, the fishmeal from these lean fish are made principally from the offal (white fish frames) remaining after filleting. "White" fishmeal commonly contains a higher concentration of ash (minerals) since the bony frames (head and racks) of previously filleted cod, haddocks, etc. are used. White fishmeal constitutes only 10% of the world fishmeal production. The second type of fish used to manufacture fish meal stores oil in certain parts of the flesh. They are high oil fish and, unlike the lean fish, are not prized for their fillets. They are commonly referred to as "industrial fish." Such species as herring, menhaden, anchovy, pilchard, sardines and mackerel fall into this category. Approximately 90% of the world fishmeal production is from these high oil species. Most species of fish used for the production of fishmeal have a similar protein content that averages approximately 16% in the whole fish. This whole body protein content will vary by only plus or minus 2 to 3%. The fishmeal derived from these fish will, therefore, all be fairly similar in protein content. The oil (fat) content in fish species is much more variable than their protein content. The amount of oil in fishmeal is directly dependent on the efficiency of the oil removal at the time of processing[3].

Where are the fish processed?

Fish can be processed at sea in factory ships or caught and stored until they are transported to a coastal processing factory. Fish is a highly perishable raw material and spoilage will occur if not processed in a timely manner. Preservation using chemicals, ice or refrigerated sea water is common.

How are the fish processed?

Fishmeal is made by cooking, pressing, drying and grinding the fish. When no oil needs to be removed, such as with lean fish, the pressing stage is often omitted. During cooking, the fish move through a long, steam-jacketed, screw conveyor cylinder. Cooking coagulates the proteins and is a critical process responsible for sterilizing the product and preparing it for liquor (a mixture of oil, water and protein) removal. Once cooked, the liquor is removed by pressing. The solid residue that remains after pressing is called "press cake." The liquor is centrifuged to remove the oil. This oil is often further refined before being transported to storage tanks. Prior to storage, it is essential to add an antioxidant. The antioxidant will stabilize the oil so that oxygen will not cause damage during storage. The stored oil must not come into contact with air, heat or light in order for its quality to be maintained until it can be incorporated into feeds for poultry, pets, fish or other uses. The liquid removed from press cake is referred to in the processing industry as "stick water." This liquid may contain as much as 20% soluble protein and is valuable. The stick water is evaporated to a thick syrup containing 30 to 50% solids. This material can be sold as "condensed fish solubles" or it can be added back to the press cake and dried with it. Therefore, one can purchase press cake meal or a whole meal (where all of the solubles have been added back). The meals are then dried so that the moisture content is low enough to allow the meal to be stored and transported without mold or bacterial growth. If over drying occurs, the meal can be scorched and the nutritional value of the meal will be adversely affected. Drying can be either direct or indirect. Direct drying is the most rapid and requires very hot air to be passed over the meal as it is rapidly tumbled in a cylindrical drum. If this process is not carefully controlled the fishmeal may be scorched. Indirect drying requires a steam-jacketed cylinder or a cylinder containing steam-heated discs which tumble the meal. Once the fishmeal is dried it has to be ground, screened to the correct particle size, packed in bags or stored in silos for bulk delivery to companies throughout the world[4].

How can you identify good quality fish meal?

Good quality fishmeal is a brown powder which will average between 60% and 70% protein. The oil content in the meal will range from 2% to greater than 14%. The moisture level will commonly range from 6 to 12%. The ash content will range from 18% (more common for an industrial fishmeal) to 25% (more common for a white fish meal). The odor of fishmeal, as

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would be expected, is that of fish. It is easily distinguished from other ingredients. If an acrid "scorched" smell is present this usually indicates overheating or scorching. If this occurs, a blackish dark-brown color is common and the quality of protein is usually affected in a negative manner[4].

MATERIALS AND METHODS

Diet preparation

All diets for gilthead bream were prepared in the laboratory after blending dry dietary ingredients thoroughly in a Hobart bench food mixer. The required amount of oil and an appropriate amount of water to form a soft dough were added into the dry mixture. Diets were cold pelleted and dried in convection dryer either at 40°C (experiments for testing fish meal replacers) or at ambient temperature (experiments for testing fish oil replacers). The diets for sea bass were prepared by a local factory using common compression procedures and supplemental oil was added on the pellets.

Analysis of samples

Commercial fish samples (Herring, Capelin, Blue whiting) produced in different regions in Iran were obtained from traditional markets and supermarkets in Busher. Two packets of each brand were picked at random and brought for analysis. Label informations on the package with ingredient listed were recorded. The fish meal were prepared by cooking in boiling water for 4 minutes. The proximate composition was determined using the method described by AOAC (1990). Crude protein content was determined using Kjeldahl method (Kjeltex System-Texator, Hagonas, Sweden). Crude lipid content was determined by Soxhlet method (Soxtec System-Texator, Hagonas, Sweden). Ash content was determined by ashing the samples overnight at 550 C. Moisture content was determined by drying the samples overnight at 105 C until constant weight was achieved. Fish meal samples from each packet was used for proximate analysis in triplicate. A completely random design was used for the study. Data were analyzed using General Linear Model procedures of Statistical Analysis Systems (SAS) version 6.11 (SAS 1994). Treatment showing significant differences ($p<0.05$) were subjected to Duncan's Multiple Range Test.

Proximate composition of fish

Mean values of percentage of protein, fat, moisture and salt as determined by standard methods are shown in TABLE 1. Protein content in herring meal ranged from 70.5% to 73.1% and in blue whiting and capelin from 68.0% to 70.8% and 69.6% to 72.7% respectively. As fish meals are obtained by separating protein and ash from water and oil, meals with very similar composition can be expected irrespective of the species being processed[5]. LT meal of blue whiting had higher concentration of salt than NSM and standard meal while it was significantly higher ($p=0.001$ and 0.0004) in LT meal of herring than in NSM and standard grades. Moisture content of all samples for all methods ranged from 6.0% to 8.5%.

TABLE 1 : Composition of the experimental fish meals

Type of meal	Crude Protein (N*6.25)%	Crude Fat %	Moisture %	Ash %
Blue whiting^{LT}	69.4 ± 0.02	8.3± 0.05	6.1 ± 0.22	24±0.5
Blue whiting^{NSM}	70.8 ± 0.20	6.7 ± 0.18	6.0 ± 0.01	21.5±0.02
Blue whitingST	68.0 ± 0.01	9.5±0.17	7.0 ± 0.01	22±0.07
Herring^{LT}	70.5 ± 0.16	10.5 ±0.04	6.8 ± 0.02	23±0.05
Herring^{NSM}	73.1 ± 0.27	8.0 ± 0.06	7.0 ± 0.06	24±0.01
HerringST	72.2 ± 0.06	8.9 ± 0.13	7.2 ± 0.06	21±0.03
HerringST	71.1 ± 0.12	8.1± 0.15	8.5 ± 0.11	22±0.05
HerringST	72.7 ± 0.02	9.0 ± 0.02	6.4 ± 0.08	21±0.07
Capelin^{LT}	69.6 ± 0.01	11.6± 0.04	7.0 ± 0.27	21±0.09
Capelin^{NSM}	71.1± 0.02	12.2 ±0.27	7.3 ± 0.04	23±0.1

Note: Values are mean ± standard deviation of 2 replicates; LT: Low temperature; NSM: Norsea mink; ST: Standard

DISCUSSION

The fat content of the fish meal normally indicates the species used. Fluctuations in oil and moisture levels are seasonal and occur within species. Herring and capelin are fatty fish while blue whiting is considered a lean fish. Fish meals from white fish are naturally low in fat. Moisture contents between 5% and 10% are quite normal[6]. According to Burt[2] the salt content in the body fluids of all fish is nearly the same. Increased effort has been put into maintaining the freshness of the raw material on board fishing vessel by cooling directly after catch. Various types of refrigerated sea water (RSW) and chilled sea water (CSW) systems have been used on board fishing vessels[7]. LT meal of blue whit-

ing and herring contained very high amounts of salt 4.05% and 3.92% respectively. This may be because of a long storage time of raw fish in RSW tank before processing on shore. Unbound ammonia content in fish meal reflects the TVN content of the raw material used. Since cultured aquatic species are more sensitive to the quality of raw feed ingredients than other livestock and have higher nutritional requirements, only high quality raw materials are needed in aqua feeds[7].

CONCLUSION

The raw material freshness has a significant effect on compounds contents in fish meal, which was irrespective of the fish species used. The use of fresh raw material and low temperature drying of fish meal for less retention time (Dyno air dryer) has a significant effect on quality properties such as water holding capacity of fish meal. Fish meals with low moisture content and low water activity, produced stable products whose properties were not changed at high temperature.

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