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Identification and Evaluation of Fish Feed Ingredients in Supporting the Development of Different Feed Mills in Bangladesh

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Abstract: The present study was conducted to identify and evaluate the feed ingredients to promote the development of different feed mills in Bangladesh. Identified ingredients were maize, rice polish, rice bran, wheat, wheat dust, wheat flour, soyabean and soyabean meal, rapeseed meal, meat and bone meal, mustard cake, dry fish, lime stone/ground shell and salt. Samples were analyzed under microscope and using normal features of the ingredients found in all the ingredients. Maximum ingredients were in powder form except maize, wheat, fish meal, soybean meal, and some broken part of the rice. Soybean meal and fish meal were in crumble size. No urea was found. Fine particles, some cheaper fine materials, oyster shell, feather meal, rice hall and bran, some crumble stones, sand particles, and finely ground limestone or rock dust, soyabean hulls and stones from soyabean seeds were found during the investigation. A little number of rice bran was found mixed with rice polish. Rice polish were also slightly contaminated or adulterated by fibrous materials, hulls and husks. Some organic residues, part of vegetables and animal hair, meat fraction from bone, and feather from dry fish were also found. Homogeneity of ingredients was good and found no abnormality. Touch was done and rude fiber level was low and it would become like a solid mass. No abnormal color was found in the feed ingredients except some fade color in maize. During experiment there was no change in the normal smell of the ingredients. No bitter taste was found and ingredients were not mixed with salts. The dry ingredients spilling coins sound were found by pouring down or by biting to each other. Contamination level in the investigated feed ingredients was found up to 1.5 % which was very low and the ingredients were good in quality and swelling of maize, wheat and soyabean seeds were 14%, 14.29% and 15% respectively. In floatation test about 10% samples were floated and 90% samples were immersed during experiment.

Keywords: Identification, Evaluation, Feed Ingredients, Fish, Development

1. Introduction

Characteristic of feed ingredients is not the first thought in the mind of aquaculture feed formulation [1]. Physical form describes the physical description of feed ingredients such as a seed or meal and is characteristic of the dimension or size of the seed or particle measured by screening or other processes. It does however have an impact in the decisions that need to be made when planning and designing the farm or commercial feed formulation and feed storage [2]. A discussion of the basic terminology and identification of physical properties of feed ingredients should help the fanner or feed professionals to recognize the important considerations such as volume of ingredients harvest and storage required and handling options that need to be addressed [3].

An investigation of feed ingredients is necessary for identification of the structure, determination of proportion of mixed feed, and adulteration [4]. Proper quality estimation depends upon physical, chemical and microbiological analysis of feed ingredients and all the results should be considered together. Feed ingredients can be judged by external and surface structure or features, components of internal structure, its physical appearance, color, smell or flavor, odor, taste, touch, sound, texture, size, shape and by evaluating the degree of adulteration of substances [5]. These

factors in feed ingredients are related to the feed composition and the manufacturing process. Ingredient texture is also important for some aquatic species because feed quality including moist or dry feed, sinking or floating characteristics of feed depends on the texture consistency of feed ingredients [6]. For this point of view the present study was conducted to identify and evaluate of feed ingredients for the development of different feed mills in Bangladesh.

2. Materials and Methods

2.1. Sample Collection and Processing

Survey of feed ingredients

An extensive survey was made for identification and collection of ingredients presently used in different feed mills as per follows:

1. Market survey of ingredients where available
2. Survey of ingredients suppliers and counseling
3. Survey of ingredients importers and counseling
4. Survey of ingredients both local and imported
5. Selection of sampling spot
6. Selection of ingredients and finally
7. Collection of ingredients

2.2. Sampling Procedure

Sampling of feed ingredients was the most important job in quality control, because no analysis can be better than the sample from which it was made. Proper procedures for taking representative samples were essential. Sampling of bagged ingredients was done with a spear probe. The probe was inserted diagonally and as horizontally as possible, from one corner of the bag to the other. In lots of 1-10 bags, all bags were sampled. Coarse materials were sampled by random selection of pieces from different parts of the entire consignment. Five pieces per ton of materials were considered sufficient. The pieces were then grounded, mixed thoroughly and the sample was reduced in size to between 0.250 kg and 0.50 kg. Samples carried out to the biochemistry and feed technology laboratory, of Institute of Marine Sciences and Fisheries, University of Chittagong, placed in tightly sealed containers. For evaluation samples were taken from three different open markets and observed their storage conditions. Maximum ingredients were taken up to 5-10kg and those were taken for three times in the same season in three consecutive years.

2.3. Grinding and Sub-sampling

Samples taken in the above manner were pooled, thoroughly mixed, and ground to pass through 1 mm screen and then reduced to size by quartering *to between 0.250 and 0.50 kg in weight.* Precautions were made to mix ground samples well before sub-sampling. Meal was a feed which has been ground or otherwise reduced in particulate size. Many ingredients of feeds were whole gains, parts of the whole grain**,** or have gone through under processing which have reduced the particle size. Screenings (soyabean screenings) were done and passed through one or more screens which separated various size particles and was obtained from the cleaning of grains.

2.4. Labelling / Recording

At the time a sample being collected, a tag was attached. The following information's were maintained for each sample: sample identification number, name of material, and date of sampling, description of material from which it originated, details of sampling method used to derive from the whole in question to this sample representing the whole, name and contact information of the person who took the sample, name and contact information of the person to whom the sample belongs or who have the primary interest in the sample, place of sampling, suggested date up to which the sample should be kept (expiry date), prescribed storage conditions and location for storage of the specific sample.

2.5. Laboratory Sample Numbers

At the time the sample comes to the laboratory, it was given a laboratory sample number and was preserved for analysis.

2.6. Analytical Procedures

2.6.1. Microscopic Analysis

For microscopic analysis microscope, sieves and pan, sharp pointed forceps and needle, petridish, beaker (100-150 ml) and stainless spoon and mortar and pestle were used.

2.6.2. Photo-Micrographic Analysis

Photo microscopic analysis was done to determine the general features of feed ingredients which include size, shape, consistency of components and adulteration.

(i). Size and Shape

Size of grains governs its energy value due to the proportional decrease or increase in seed and its coat. Smaller the grain lower will be the metabolic energy (ME) value due to more proportion of coater hulls. To evaluate the cereals size and shape a fixed number of grains should be taken and in this research usually 250 gm grains were taken for three times.

(ii). Adulteration

Adulteration is defined as the admixture of a pure substance with some cheaper and low quality substances. It is done intentionally usually to make money. In costly feed ingredients like oil seed cakes and ingredients of animal origin like fish meal, adulteration is done by spraying urea in order to raise their protein content. However, sometimes bran, molasses are also added. Besides urea, oilseed cakes are adulterated with husk, non-edible oil seed cakes. To evaluate adulteration collected samples were compared with the fresh samples.

2.6.3. Visual and Feeling Analysis

Some visual and feeling analysis were done to determine the color, homogeneity, smell, taste, touch and sound of the feed ingredients.

(i). Homogeneity

Homogeneity of ingredients were analyzed to observe the presence of contaminants like other grains, husks broken grains, weed seeds, infested seeds.

(ii). Touch

By feeling method dryness, chilliness, presence of clumps of the ingredients was measured.

(iii). Color

The appearance of the ingredients will reveal its quality. Any change in the color of the feed ingredients will give an indication of the maturity of the grain, storage conditions, presence of toxins and contamination due to sand, possible use of insecticides and fungicides, which will give dull and dusty appearance. Color was examined by eye vision, taking of photograph and evaluate under microscopic study.

(iv). Smell

Normal smell and odorous smell were taken by standing near the stock because smell is the best indicator to evaluate the quality of ingredients immediately which indicate any difference with the normal smell.

(v). Taste

Taste by own was taken because each ingredients has a different taste, any change in the taste will indicate some abnormalities.

2.6.4. Contaminant Level Analysis

Hundred grams of each ingredient was weighed in triplicate and spread on a clean sheet of paper; a magnet was run on the samples to see if they contain any metallic materials. Both the metallic and non-metallic contaminants were handpicked and weighed. The percentage contaminants were determined by adding all contaminants together thus;

$$\text{Percentage of contaminants} = \frac{(\text{Weight of contaminants})}{(\text{Total weight of sample taken})} \times 100$$

2.6.5. Swelling Test

Swelling test of the feed ingredients was performed with water at room temperature for 01 hour. The photograph of ingredient before and after the test was taken and analyzed using Able Image Analyzer version 3.1b. The percentage of swelling for each ingredient was calculated using the following equation:

$$\text{Swelling } (\%) = ((d1 - d0))/d0 \times 100$$

Where, d_0 = diameter of dry ingredient and
d_1 = diameter of swollen ingredient

2.6.6. Percentage of Dust in the Bags

Sieving process was done to evaluate the percentage of dust present in the feed ingredients and was calculated by separating the dust particle from the ingredients.

$$\%\ \text{Dust} = \frac{(\text{Dust weight/bag (g)})}{(\text{Ingredients weight/bag (g)})} \times 100$$

2.6.7. Floatation Techniques for Estimation of Residues in Feed Ingredients

Organic and inorganic residues, vegetable cellulose & animal hair, meat fraction from bone fraction, blood from meat products, feather meal from dry fish and meal, rice products, corn cob from ground corn, soyabean hulls from soyabean meal and cottonseed hulls from cottonseed meal will be analyzed by floatation technique described by [7].

3. Results

Different markets were surveyed including Khatungonj in Chittagong, Daudkandi and Sadar Dakhkhin in Comilla, Asugonj in B-baria, Dolarhat in Bhola, Madla in Bogra and some markets in Hobigonj, Lalmonirhat and Dinajpur to observe and collection of samples. About 25 ingredients suppliers were interrogated and interviewed in the surveyed markets during sample collection. It was revealed that the suppliers were collecting ingredients from local market and from the house of the farmers in rural village with a variable price. The suppliers collected and deposited all the ingredients in ware house and supplied those materials to the feed mills. It was not possible to talk to the importers but their subordinates were interrogated and interviewed at Khatungonj, Asugonj Bazar and Habigonj. Maximum ingredients except soyabean were imported from India. Source of soyabean was almost from U.S.A. Ingredients coming from local and abroad were surveyed and collected and taken to the research lab for physical examination. Imported maize was better than the local market. Soyabean coming from U.S.A was better than that of locally produced soyabean.

3.1. Analytical Findings

Identified ingredients were maize, rice polish, rice bran, wheat, wheat dust, wheat flour, soyabean and soyabean meal, mustard cake, rape seed, dry fish, meat and bone meal, lime stone and salt.

Maize, bran coat appeared, glossy, semi-transparent, and thin with parallel. Endosperm had two types of endosperm starch, hard and soft. Hard or horny starch had a yellow translucent characteristic, soft starch was floury, white opaque and with luster. Germ was cream colored, soft and oily.

Rice bran, barn appearing in very small pieces was oily, cream or pale yellow and agglomerated. In defatted rice bran,

it was not agglomerated. Grain fragment, had a smooth surface, was small irregularly shaped, translucent, hard and white in color, a yellow brown color in parboiled broken rice. The particle size of broken rice was bigger than grain fragment in rice bran or rough rice, and had an oval outline for its broken surface.

Rice polish, rice polish was a powder which is made by grinding of rice hulls. Polish particles were yellow brown, oily small pieces, grain fragments had a smooth surface, were very small and regular in size and shape.

Wheat, bran particles were yellowish brown, thin and finely wrinkled on outer surface. Opaque white starch granules adhere to inner surface. Tip particle was thin, transparent and attached with a tuft of long lustrous hairs. Germ appeared as soft, flat, nearly oval in outline, oily and pale yellow. Starch particle was white small, flinty, irregularly shaped, semi-translucent with some opaque or glossy attachments on bran particles.

Wheat flour, wheat Flour is a powder which is made by grinding of wheat grains. Flour particles were white small, flinty, regular in shape. Starch was floury, white opaque and lustrous.

Wheat dust, the particles of the hull were different in size, length and shape hard and brittle, and were white or white and black striped. Some particles appear to be cream colored when white and black stripes were lost, and were smooth, lustrous and rough on the inner surface.

Soybean meal, hull had smooth, shiny and pin pointed markings on the outer surface. The inner surface was whitish yellow, uneven and porous. The particles of the hull were ordinarily tightly curled. The particles of the kernel appeared to be dull, opaque, or cream to yellowish brown in color. Expired meal, normally, was a conglomerate of particles of kernels and hulls that had been forced together in the processing. They appeared in rough, granular chunks and darker in color on the outer surface than the inner.

Rapeseed meal, rapeseed was small globular or spheroid, with a slightly smooth or reticulate surface, and in different in color. Kernel was small fragments, irregularly shaped, yellow in color, dul and brittle. Seed coats were thin, hard, red-brown or black on outer surface. Inner surface was delicate semi-translucent, white sheet adhering to surface.

Meat and bone meal, meat and bone meal is the dried and rendered product from mammal tissues. It did not contain horn, hair; hide trimmings, manure, stomach contents and added blood meal. Bone particles was seen in small pieces, opaque, white, dull, with rough surface and meat particles appear as small pieces, irregularly shaped, semi-translucent, yellowish brown, hard, with a dull or smooth surface.

Mustard cake, mustard cake has a good balance of essential amino acids and relatively high methionine content. Identification of mastered cake was done and was found in normal color and shape. It was small globular or spheroid, with a slightly smooth or reticulate surface.

Dry fish (fish meal), fish meal appeared in small particles, with a dull surface; yellow to yellow brown in color, rather hard but easy to break muscle fiber fragments with just a tweezers. Muscle fiber was mostly found in short fragments, somewhat flat, bent, dull, and smooth surface and semi-transparent. Eye ball, crystalline eye lenses, was semi-transparent with a dull luster, very hard, in round or broken spherical pieces.

Lime stone/ground shell, limestone is usually described as rock made from calcium carbonate, $CaCO_3$. Limestone identified in this study was as usual in color. In this experiment, a sample of limestone was analyzed to find its existence in feed pellets and some other ground shells were identified and found hard, opaque white to grey or pink, dull to semi-translucent. The surface of the shell particles was smooth on both sides.

Salt, salt that was identified composed primarily of sodium chloride (NaCl) and normal in looking. Salt is one of the oldest and most ubiquitous of food seasonings and salting an important method of pellet preservation.

3.2. Findings from Photo-Micrographic Analysis

Size shape and adulteration

Maximum ingredients were in powder form except maize, wheat, dry fish, mustard cake, soybean meal, rape seed and some broken part of the rice. Soybean meal and fish meal were in crumble size.

No urea was found virtually. Fine particles, some cheaper fine materials, oyster shell, feather meal, rice hall and bran, some crumble stones, sand particles, and finely ground limestone or rock dust were found during the investigation.

3.3. Results from Visual and Feeling Analysis

Homogeneity, homogeneity of ingredients were analyzed to observe the presence of contaminants like other grains, husks broken grains, weed seeds, infested seeds. A little number of rice bran was found mixed with rice polish. Rice polish were also slightly contaminated or adulterated by fibrous materials, hulls and husks.

Touch, touch was done for analyzing the crude fiber levels by taking rice-polish on the palm of the hand and closing the finger tightly. After some times the fingers were then opened. Crude fiber level was low and it would become like a solid mass.

Color, color was examined by eye vision, taking of photograph, and evaluate under microscopic study. In this research no abnormal color was found in the feed ingredients except some fade color in maize.

Smell, normal smell and odorous smell were taken by standing near the stock because smell is the best indicator to evaluate the quality of ingredients immediately which indicate any difference with the normal smell. During experiment there was no change in the normal smell of the ingredients.

Taste, taste by own was taken because bitter taste and presence of salt indicates any change in the taste or some abnormalities. The samples were not in bitter taste and were not mixed with salts.

3.4. Percentage Contaminant Level Analysis

Contamination level in the investigated feed ingredients was found up to 1.5 % by the above formula and calculation, which was very low.

3.5. Swelling Test

Swelling test was performed with some of the feed ingredients including maize, wheat and soyabean seeds for 01 hour. Swelling of maize, wheat and soyabean seeds were 14%, 14.29% and 15% respectively after 01 hour immersion in water.

3.6. Percentage of Dust in the Bags

After examination 1.16% dust was found in some of the collected samples.

3.7. Floatation Techniques for Estimation of Residues

Some organic residues, part of vegetables & animal hair, meat fraction from bone, feather from dry fish, rice products, and soyabean hulls and stones from soyabean seeds were found in collected ingredients.

4. Discussion

Microscopic study was done according to the manual [7] and was reported this work as stated in that manual. Characteristics or properties of the feedstuffs very influential in the processing of feed ingredients. Classify the nature of the material to be: a) the biological and physiological characteristics, the nature of which is closely related to the activity of the material as biological creatures like metabolism activity, photosynthesis, respiration, fermentation, climacteric and withering, b) physical characteristics, including dimensions shape, density, texture, hardness, bulk density, and angle of repose, color and appearance, specific heat, thermal conductivity and diffusivity. The physical properties are much related to the processing or handling of feed material mechanically [8]. Knowledge of the physical properties of the feed is important to note that affect the storage, drying and processing of feed materials [9]. The design of storage, handling and processing systems for bulk materials requires data on bulk and handling properties namely, size dimensions, bulk and particle densities, and friction coefficients of bulk materials on most commonly used structural surface materials. Theories used to predict the pressures and loads on storage structures require bulk density, angle of repose and friction coefficients against bin wall materials. Also the design of hoppers for processing machinery requires data on bulk density and angle of repose. Bulk density is used in design of drying and aeration systems because it affects the resistance to airflow of a stored bulk [10].

Physical quality of pellets (pellet durability and hardness) is greatly influenced by the ingredient composition of the diet [11-12]. Wood [13] reported that the degree of starch gelatinization and protein denaturation greatly influences durability and hardness of pellet. Generally, higher rate of starch gelatinization and protein denaturation gave higher durability and hardness of the pellet. High moisture content during extrusion gives complete starch gelatinization and affects rheological properties of feed. Increased moisture content causes low melt viscosity and consequently result low pressure build-up, which in turn gives low expansion at the die. The processing condition and ingredients used have an effect on extradite expansion. A low starch content of the recipe and low degree of gelatinization result in low expansion. Similarly, lower viscosity will impact the expansion [14]. Sorensen et al. [15] reported that types of starch sources have different impact on physical pellet quality. Lipids also affect the extradite expansion. Bhattacharya and Hanna [16] indicated that an increase in fish solids content in the formulation caused an increase in the lipid as well as the protein causing reduced expansion. Similarly, Bhattacharya and Hanna [16] and Smith et al. [17] reported reduced expansion with increasing temperature for waxy maize starch.

The physical characteristics of alternative feeds are not the first thought in the mind of farmers, cattlemen, or feed professionals as they plan feed rations. It does however have an impact in the decisions that need to be made when planning and designing the on farm feed storage. A discussion of the basic terminology and physical properties of alternative feeds should help the fanner or feed professional recognize the important considerations such as volume of storage required and handling options that need to be addressed in planning for storage [18]. The physical properties of the feed are a very important factor to note in feed processing. The efficiency of a process of handling, processing and storage of feed in feed mills not only requires information about the chemical nature and nutritive value, but the physical properties of the feed should also be known that the loss due to the handling of feed can be avoided [19].

5. Conclusion

This identification work is related to fisheries research study and its current science and policy agenda especially on scarcity of food production, and its impact on human malnutrition. Therefore, these issues needed to be addressed earlier prior to policy formation and implementation. Present study on identification of feed ingredients has made to assess the quality of aquaculture feed ingredients, identify substances adulteration, quality production of aquaculture feeds for aquaculture production to meet the livilihood options of rural farmers related to the small and commercial production of fishery products. Feed ingredients quality provided an insight on what is the present state of produced fish quality weather it is safe for human health or not. Identification of less quality feed ingredients ensured less environmental and ecosystem degradation, and suggested best options which would be environmentally feasible and economically viable. Identification of external or surface

features of feed ingredients helped to control nutritional composition in feed formulation.

Proper identification or characteristics of feed ingredients are the prime thought for fish farming and it is an important thought in the mind of aquaculture feed formulation. An investigation of feed ingredients is necessary for identification of the structure of feed ingredients, determination of proportion of mixed feed, and adulteration, all areas that cannot be studied in chemical and microbiological analysis. It does however have an impact in the decisions that need to be made when planning and designing the on farm or commercial feed formulation and feed storage.

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