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Biochemical characterization of ingredients for supplementary fish feed formulation

K. Sivagami[1]* and J. Ronald[2]

[1]Department of Zoology, Sree Devi Kumari Women's College, Kuzhithurai,K.K. District, Tamilnadu, India.

[2]Department of Zoology, St. Xavier's College (Autonomous), Palayamkottai, Tamilnadu, India.

*Corresponding Author Email: svgamizoo@gmail.com

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Abstract

Fish diet production starts with ingredients selection and feed formulation. Selection of ingredients can be done from a wide range of choices, such as availability, cost and quality. The evaluation of feed ingredient is mandatory to nutritional research and feed development for carp culture. Usually quality of depends on the quality of feed ingredients used. High level of difference between common ingredients is well recognized and this will affect the nutritional value. Biochemical analysis constitutes variables such as; crude protein, carbohydrates, total lipids, ash, fiber and moisture contents. the results revealed that the highest percentage of protein, carbohydrate, fat, total fiber, moisture and ash content was 49.00, 83.00, 13.36, 6.30, 8.26 and 5.46% in silk moth powder, tapioca, rice bran, silk moth powder, corn flour and wheat flour respectively. Whereas the lowest percentage of protein (1.00%), carbohydrate (30.60%), fat (1.10%), fiber (1.94%), moisture (2.50%) and ash (2.96%) was recorded in tapioca, silk moth powder, corn flour, wheat flour and corn flour respectively.

Key words: Ingredients, Biochemical analysis, Corn flour, Wheat flour, Silk moth powder

Introduction

Aquaculture is one of the fast-growing systems in the world, which has emerged as an industry possible to supply protein rich food throughout the world. According to nutritionist's fish is an excellent source of protein red meat. Fish flesh contains all the essential amino acids and minerals. The quality and quantity of fish feed consumed have a pronounced effect on growth rate, efficiency of feed conversion and chemical composition of fish. Use of well- balanced artificial feed is the primary basis for success of intensive aquaculture. To meet this requirement, it is essential to formulate a low cost fish diet from locally available ingredients. Success of larval rearing depends mainly on the availability of suitable diets than readily consumed, efficiently digested and that provide the required nutrients to support good growth and health (Akbary *et al*., 2010).

Food is the principal operating cost in the fish production. Fish requires adequate nutrition to grow and survive (Abdul Majid Khan *et al*., 2011). The nutritional value of feed ingredients is not solely on its chemical constituents but also on the amount of nutrient. All types of feed stuffs from animal (silk moth, maggot, termite, earthworm, etc) and plant wastes (Soya bean meal, Rice bran, groundnut cake, etc.) are used as non- conventional feed resources for fish artificial diet formulation (Govind Pandey, 2013).

Ingredients should be used to make feeds. Quality, quantity and cost are three factors to consider in the choice of ingredients. Knowing the composition of the available ingredients and the basic nutritional requirements of fish being cultured, it is usually possible to formulate a diet that will promote optimum survival and growth. Sometime, expensive ingredients can be substituted by a single alternative ingredient or a combination of ingredients to provide cost savings. Formulating diets to meet nutritional specification by selecting the cheapest available ingredient is called 'least cost formulation".

The evaluation of feed ingredients is crucial to nutritional research and feed formulation for fishes. Fish diets of the future will include a wider range of alternative ingredients to fish meal. Many ingredients are more complex and required thorough nutritional evaluation in order to determine their nutritional value and appropriate use levels in prospective supplementary feed (Swarnendu *et al*., 2010).

The success of fish farming depends on the formulation of a fish feed that contains an optimum level of protein and energy necessary for the growth of fishes. It is obviously necessary to formulate and preparation of fish feed from locally available fish ingredients. There are some ingredients which are locally available that can replace the fishmeal without changing the protein level. Soya bean meal, ground nut cake and cotton seed cake is most important locally available protein rich ingredients, which can be used instead of fishmeal (Veni *et al*., 2012).

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The quality and cost effectiveness of commercial feed are primary concern for feed manufacturers. The rapid development of aquaculture farm has increased feed ingredients demand and its prices. In this regard, aquaculture industry development has become a great challenge for future generations, not only for feeding expenses but also from availability of fish meal and other ingredients. Consequently, alternative feed formulation ingredients selection is urgent. Keeping in this view, the present study was conducted to evaluate the biochemical constituents of locally available feed ingredients to prepare artificial diets for fish.

Materials and methods

Feed Ingredients

The ingredients were selected based on nutrient status, texture, flavor, cost effectiveness, attractiveness, quality and steady availability. The experimental feed ingredients are corn flour, wheat flour, Rice bran, Groundnut oil cake, tapioca and silk moth power. Biochemical analysis of feed ingredients (AOAC, 2005).

Proximate Composition

The proximate composition of all the ingredients was determined as follows:

Crude Protein

The crude protein content was determined following the micro Kjeldahl method Percentage of nitrogen (N) was calculated using the following equation

Nitrogen (%) = {(S-B) × N × 0.014 × D× 100} / (weight of sample × V) Where

D = Dilution factor,
T = Titration value = (S-B), W = weight of sample, 0.014 = Constant value. Crude protein was obtained by multiplying the corresponding total nitrogen content by a conventional factor of 6.25. Thus crude protein (%) = % of N × 6.25.

Carbohydrate

The carbohydrate content was estimated by the difference method. It was calculated by subtracting the sum of percentage of moisture, fat, protein and ash contents from 100%.

Carbohydrate (%) = 100 – (moisture% + Fat % + Protein % + Ash %)

Crude Fat

Crude fat was determined by the Soxhlet extraction technique. Fat content of the dried samples can easily have extracted into organic solvent (petroleum ether) at 40-60 0C and followed to reflux for 6 hr. Percentage of fat content was calculated using the following formula.

Crude Fat (%) = Weight of fat in sample × 100/ Weight of dry sample.

Crude Fiber

The bulk of roughage in food is referred to as the fiber and is called crude fiber. Milled sample was dried, defatted with ethanol acetone mixture and then the experiment was carried out using the standard method.
Crude Fiber (%) = (Weight of residue – weight of Ash) × 100 / Weight of sample.

Moisture Content

Moisture content was determined by oven-dry method as the loss in weight due to evaporation from sample at a temperature of 100 ± 2^0C. The weight loss in each case represented the amount of moisture present in the sample.
Moisture (%) = {(Weight of original sample – weight of dried sample)} × 100 / (Weight of original sample)

Ash Content

Ash content was determined by combusting the samples in a muffle furnace at 6000C for 8 h according to the method of AOAC (2005).
Ash content (%) = Weight of Ash × 100/ Weight of sample

Statistical Methods

Data obtained were subjected to the analysis of variance (ANOVA) and correlation analysis. SPSS (V 20.0) was applied to determine whether significant variations between control and experiment values. Difference between means were determined and compared by Duncan multiple range test (DMRT) and the significances are mentioned. The data are represented as mean ± standard deviation.

Results and Discussion

The proximate composition of all ingredients was shown in table 1, 2 and 3. During the current study, 11.10% of protein content was estimated in corn flour. This result was found closely related to those reported (Sule Enyisi *et al*., 2014). In the present work, the percentage of carbohydrate in corn flour was 74.16. This result was similar to the findings of Mlay *et al*., (2005), who recorded a higher carbohydrate content of 73.3% in corn flour. The fat content of corn flour was found to be `1.53%. The percentage fat obtained in corn flour in this work was inconsistent and in agreement with other

researchers (Ikenie *et al*., 2002; Sule Enyisi *et al*., 2014). In the present analysis, fiber content of corn flour was 1.94%, the results of fiber content in this study was in agreement with the findings of Sule Enyisi *et al*., (2014). The moisture and ash content of corn flour was noticed as 8.26 and 2.90%. Mlay *et al*., (2005) also reported ash content of corn four was 2 to 5.1%. The moisture content of corn flour (8.26%) value agreed with 8.3% moisture content reported (Adeyeye Samuel and Akingbala John, 2014). The protein content of wheat flour reported in this study was found to be 15.56 %. The protein value was supported to the work of Ahmad *et al*., (2005), who studied that wheat flour contains 10.32 to 15.58% proteins. Wheat flour had highest level of 65.16% carbohydrate content (figure-2). Analyzing the data obtained in the current study, the fat content of wheat flour was 6.73 %. This result in line with the findings of Baljeet *et al*., (2010), who found that fat content in wheat flour was (5.81%). In the present investigation, the fiber, moisture and ash content of wheat flour was found to be 4.56, 2.50 and 5.46% respectively. The moisture content is one of the important factors to determine the quality of flavor and its shelf life the results in the present study correlates with the findings of Syeda et al., (2012), who reported that the moisture content of wheat flour ranged from 4.00 to 14.00%.

Table 1: Biochemical constituents of feed Ingredients used in experimental diets

S. No	Ingredient's	Crude protein (%)	Crude carbohydrates (%)	Crude lipid content (%)
1	Corn flour	11.10 ± 0.55	74.16 ± 1.10	01.53 ± 0.53
2	Wheat flour	15.56 ± 1.09	65.16 ± 2.31	06.73 ± 0.56
3	Rice Bran	13.00 ± 0.43	48.33 ± 0.92	13..36 ± 0.23
4	Ground nut cake	40.23 ± 1.78	32.24 ± 1.53	13.04 ± 0.89
5	Silk moth powder	49.00 ± 0.66	30.60 ± 0.83	04.34 ± 0.36
6	Tapioca	01.00 ± 0.33	83.00 ± 1.00	01.10 ± 0.66

Table 2: Fiber contents of feed Ingredients used in experimental diets

S. No	Ingredient's	Soluble fiber (%)	Insoluble fiber (%)	Total fiber content (%)
1	Corn flour	± 0.00	01.93 ± 0.32	01.94 ± 0.31
2	Wheat flour	01.66 ± 0.37	02.90 ± 0.20	04.56 ± 0.56
3	Rice Bran	02.66 ± 0.25	10.60 ± 0.55	13.26 ± 0.41
4	Ground nut cake	01.57 ± 0.32	02.36 ± 0.30	03.93 ± 0.60
5	Silk moth powder	01.39 ± 0.17	01.39 ± 0.17	06.30 ± 0.34
6	Tapioca	01.00 ± 0.33	03.30 ± 0.20	04.30 ± 0.33

Table 3: Moisture and Ash contents of feed Ingredients used in experimental diets

S. No	Ingredient's	Moisture Content (%)	Ash content (%)
1	Corn flour	8.26 ± 0.30	2.96 ± 0.64
2	Wheat flour	2.50 ± 0.20	5.46 ± 0.37
3	Rice Bran	7.35 ± 0.20	4.33 ± 0.15
4	Groundnut cake	7.30 ± 0.95	3.26 ± 1.01
5	Silk moth powder	6.30 ± 0.29	3.18 ± 0.49
6	Tapioca	7.60 ± 0.56	3.00± 0.33

The crude protein content of rice bran was 13.00 %, which is similar to the findings of Changynan Wang *et al*., (2015), who reported that the rice bran contains 14-16% of crude protein. The protein found in rice bran is reported approximately 12-15% (Mohammed *et al*., (2014). The Carbohydrate content of rice bran was 48.33 %(figure-2). Results are in accordance with the findings of Syeda *et al*., (2012). The ash content of rice bran was 4.33%. The result of ash content was in correlation with the study conducted by Kaur *et al*., (2011). The total fiber content of rice bran obtained in this study was 13.26%. Considering the present work, rice bran is a natural source of lipid, and could contained 13.36% of fat (figure-3). The fat content of rice bran was previously reported by Silva et al., (2006) and Simone Aparecida *et al*., (2012). The moisture content of rice bran was 7.35 %(figure-5). This result pertaining to moisture content of rice bran was in conformity with the finding of Mohammed *et al*., (2104). Who found moisture of rice bran was ranged from 6.54 to 9.48%.

Groundnut oil cake powder provides an in expansive source of high quality dietary protein. In the present study, Ground cake powder had 40.23% (figure-1) protein, similar pattern of results was obtained by Ayoola *et al*., (2012). They found that the ground nut cake contains 44-56% protein. The ash content of groundnut oil cake flour was found to be 3.26%. Nagre *et al*., (2012), reported that the ash content of groundnut cake fall within the range of 3-5%. In the present work, crude carbohydrate and fat content of groundnut cake was 32.24 and 13.04%. The fiber amount was 3.93 %. The crude fat values obtained lie within the range of fat value between 13.00 and 33.60% reported by Asibuo *et al*., (2008). Crude fiber values for groundnut ranged from 2.69 to 5.55% (Guy Eshun *et al*., 2013). Similar results for ash content in defatted ground nut oil cake flour were reported to range from 3.00 to 4.80% (Desai *et al*., 1999). Fish growth increased significantly with the increased inclusion of silk moth pupa and adult. In the present research work, the results of proximate analysis revealed that the protein content of dry silk moth powder was 49.00 %. Longvah *et al*., (2011) reported that the protein content of silkworm was 44.00% and they also reported dry silk worm powder can be used in animal nutrition. In silk moth powder values obtained for moisture, fiber and ash content from the present investigation are 6.30, 6.30 and 3.18% respectively. The findings are in agreement with the values reported by (Pu and Chen, 2002) 7.60% (fiber content) and 4.00% (Ash content). In the present study, the value of carbohydrate and fat in silk moth powder was 30.00 and 4.34%. The value of Carbohydrate in silk moth powder was lower than the value (38.4 - 40.9%) reported in *Bombyx mori* by Olumuyiwa, (2015).

The tapioca flour is a rich source of carbohydrate. The maximum amount 83.00% of carbohydrate was observed in tapioca flour (figure-2). Similar results were observed in Balamurugan and Anbuselvi (2013). The protein content of tapioca flour was 1.00%, similar lowest percentage (1.3%) protein was reported by Omole (2003). The fiber content of tapioca flour was found to be 4.30 %(figure-1). The result obtained in the present study was similar to the findings of Ooye *et al*., (2014). High content of 83.00% carbohydrate

was recorded in tapioca flour. Similar trend of results was reported by Ooye *et al*., (2014). The fiber content of tapioca flour was observed as 4.30 %. The fiber content of wheat flour depends on the variety and the age of the root. Usually it does not exceed 1.50% in fresh root and 4.00% root flour (Julie et al., 2009). Among the all ingredients, the highest percentage of protein, carbohydrate, fat, total fiber, moisture and ash content was 49.00,83.00,13.36,6.30,8.36 and 5.46% in silk moth powder, tapioca, rice bran, silk moth powder, corn flour and wheat flour respectively.

Conclusion

In aquaculture development, there will be an increasing need to select alternative raw materials to prepare low cost fish feeds with high nutritive value. The study reveals that the flours of wheat, corn, groundnut oil cake, rice bran and tapioca have appreciable level of nutrient components. The biochemical constituents of feed ingredients were play vital role in functional properties of fish feeds. This study recommended that silk moth powder could be used as value added feed ingredients in supplementary fish feeds. One of the promising alternatives to the fish meal is silk moth (*Bombyx mori*) powder. A waste product of silk moth could be used as a cheaper alternative and non-conventional protein feed.

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