Formulation, Stability and Keeping Quality of Three Pelleted Feeds Used in Carp Culture*

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Three dry pelleted feeds incorporating fish meal, fish silage or a mixture of colocasia leaf powder and fish meal were formulated for use in carp culture. The diets formulated were tested for water stability and also for changes in their quality parameters over storage of three months. The different pellets showed satisfactory water stability. The variations recorded in the proximate composition during the period of storage did not bring about any drastic change in the overall keeping quality of the feeds. Therefore, the three formulated feeds are considered suitable for use in the culture of carps.

In India, chiefly the conventional feed (1:1 mixture of rice bran and oil cake) is employed in fish culture; this is nutritionally poor and imbalanced (Varghese *et al.*, 1976). Pelleted feeds have advantage over the conventional feed in that the nutrient composition can be adjusted according to requirement and also nutrients can be pooled from cheaper sources. Recently, pelleted diets have been formulated and employed in experimental culture of carps. These feeds contain fish meal or other materials as the main protein source (Varghese *et al.* 1976; Jayachandran & Paulraj, 1976, 1977; Venugopal, 1980; Jayaram & Shetty, 1980a; Anil, 1981). In addition to promoting good growth, artificial feeds should exhibit good water stability and shelf life, in order to be effective and economical. This paper deals with the formulation of three pelleted diets incorporating fish meal (FM), fish silage (FS) or a mixture of powdered colocasia leaf and fish meal (FC), their water stability and keeping quality.

Materials and Methods

The various ingredients namely, rice bran, groundnut oil cake, tapioca flour and fish meal were purchased from the local market. Colocasia *(Colocasia esculenta)* leaf powder was obtained by sun drying the fresh leaves for 2 days and further drying them in a hot air oven at 60°C for 2 h. Fish silage was prepared from fish waste and uneconomic fishes, by adding commercial grade formic acid (3.5%) to avoid spoilage. The silage thus obtained was concentrated to a moisture level of 37.67% by sun drying to achieve the required protein level in the feed.

Artificial diets namely, pellets FM, FC and FS were prepared using finely powdered ingredients. The proportion of the different ingredients used for each feed is given in Table 1. In all the feeds, the protein content was kept around 33%, by varying the ingredient proportion. Carbohydrate and caloric values were also maintained more or less at the same level in the different feeds. The feeds were prepared separately by mixing weighed amounts of the ingredients. The ingredients were mixed well and hand knead with just sufficient quantity of water to get the soft consistency. The dough thus obtained was autoclaved at 105°C for 30 min. The cooked dough was cooled and extruded in the form of noodles, using a mechanical noodle making machine, with a die of 3 mm diameter. The noodles were sun dried to a moisture content of less than 12% and were broken manually to a size of 5–10 mm length, packed in heavy duty plastic bags and stored at room temperature for further studies. The method described by Jayaram & Shetty (1981) was followed to determine the water stability of the three pelleted feeds over a period of 7 h. Samples of pelleted feeds stored at room temperature for 3 months

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Table 1. *Proportion of different ingredients in the formulated feeds*

Feed	Ingrediens					
	Fish meal	Fish silage*	Groundnut oil cake	Rice bran	Tapioca powder	Colocasia leaf powder
	%	%	%	%	%	%
Pellet FM	32	—	22	25	21	—
Pellet FC	18	—	23	16	7	36
Pellet FS	—	40	32	8	20	—
Conventional feed	—	—	50	50	—	—

*Fish silage of 62.33% dry matter

were drawn and analysed for changes in their proximate composition, sinking rate and water stability, during the period of storage. Moisture content was estimated by heating the samples at 105°C for 30 min and then drying to a constant weight at 65°C. Protein was determined by the AOAC (1975) method. Crude fat value was determined by petroleum ether (40–60°C BP) extraction for 16 h with Soxhlet apparatus and ash by heating the samples at 550°C for 6 h in a muffle furnace. The method of Pearson (1976) was followed to analyse the crude fibre. Carbohydrate content was calculated by subtracting the percentage of crude protein, fat, ash and fibre from 100 (Hastings, 1976). The sinking rate of the pelleted feeds was determined in an aquarium tank of 1.2 x 0.5 x 0.5 m size. Five uniform sized (1 cm long) pellets of each feed were gently dropped into the aquarium one at a time and the time taken by them to traverse the water column was noted using a stop watch. The average time taken by each type of pellet was calculated separately and the average sinking rate was expressed as cm/sec.

Results and Discussion

Feed formulation

In the present study, the dough was prepared using just enough water to get the desired consistency. However, a 1:1 ratio of ingredients to water is known to give a proper consistency to the dough (Hastings, 1976). Too much or too little water would lead to improper pelletization. The dough was cooked at a temperature of 105°C and according to Lovell (1976) this temperature kills all the pathogenic bacteria, besides helping in proper cooking, thereby improving nutrient utilization.

Water stability

The data on the water stability of the feeds are presented in Table 2. At the end of 1 h, pellet FM was more stable than pellets FC and FS. A sharp fall in the stability of pellet FS was observed at the end of 3 h,

Table 2. *Water stability (%) of pelleted feeds. Percentage dry matter obtained after exposing the pellets in water over varying durations**

Feed	Time, h			
	1	3	5	7
Pellet FM	92.81	90.14	88.79	84.54
Pellet FC	91.91	87.86	86.43	83.19
Pellet FS	87.77	79.83	76.89	74.49

* Average of 3 values

while in the case of pellets FM and FC, it was not drastic. The same trend was observed at the end of 5 and 7 h. Variation in the ingredient composition appears to be mainly responsible for the differences in the stability of the three feeds. Ingredient composition, nature of ingredients, type of processing and moisture content are known to influence feed stability (Hastings, 1971; Kainz, 1977). According to Stivers (1971), the degree of stability is dependent on the

Table 3. *Effect of storage on the quality of formulated feeds**

	Pellet FM feed			Pellet FC feed			Pellet FS feed		
	Fresh	After 3 months storage	Percent difference	Fresh	After 3 months storage	Percent difference	Fresh	After 3 months storage	Percent difference
Average sinking rate, cm/sec	8.2	10.42	—	8.68	9.37	—	13.1	14.75	—
Stability, %	92.81	89.50	3.56	91.91	87.51	4.78	87.77	80.83	7.91
Moisture, %	7.21	8.34	15.67	5.59	6.40	14.49	9.83	11.23	14.24
Crude protein, %	34.58	31.75	8.18	33.38	32.96	1.26	34.70	32.94	5.07
Crude fat, % (Ether extract)	5.62	4.67	16.90	6.07	4.94	18.62	6.68	5.68	14.97
Ash, %	16.61	16.62	0.06	13.39	12.63	5.67	12.15	11.41	6.09
Crude fibre, %	8.71	7.30	16.18	8.51	7.82	8.12	4.54	3.46	23.78
Carbohydrate, % (N=Free extract)	27.27	31.32	14.85	33.06	35.25	6.62	31.90	35.28	10.59

*Average of 3 values

gelatinization of starch content of the feed during cooking. Hastings (1971) has stated that higher fat content, affects gelatinization, thereby reducing the stability of feed. The poor stability observed in the case of pellet FS could be due to improper gelatinization caused by its high fat content (Table 3) and also due to less gelatinizable material, as reported by Jayaram & Shetty (1981). The feeds employed for carp culture should have good stability, since carps take at least 1 h for consuming formulated feeds (Ghittino, 1971). All the three pelleted feeds tested during the present investigation showed satisfactory stability upto 3 h. Too much stability is also not desirable because the nutrients in them become unavailable to the fish, owing to their bound form, in addition to the higher production cost (Balazs *et al.*, 1973).

Keeping quality

Table 3 gives the details regarding the variation in the keeping quality of the different feeds during the three month storage period. The shelf life of processed fish feeds is dependent on the type of processing, storage, temperature and moisture content of the diet (Hilton *et al.*, 1977). At the end of 3 months of storage, the moisture content had increased in all the three types of pellets, the percentage increase being maximum in pellet FM (15.67%), followed by pellet FC (14.49%) and FS (14.24%). Due to increase in the moisture content, the pellets became heavier; this was evidenced by their increased sinking rate. The uptake of moisture during storage is due to the presence of hygroscopic ingredients, mainly starch (Hastings, 1971) and the porosity of the feeds (Jayaram & Shetty, 1980b). Among the three feeds, pellet FS showed the least increase in moisture level which could be due to its higher fat content.

The crude protein content decreased in the different types of pellets during storage, the percentage decrease for pellets FM, FS and FC being 8.18%, 5.07% and 1.26% respectively. This decrease may be due to the increase in moisture level which would have facilitated the breakdown of protein. Jayaram & Shetty (1980b) have also recorded similar observation.

The percentage decrease in crude fat content over the storage period was 18.62%, 16.90% and 14.97% respectively in pellets FC, FM and FS. This reduction is probably related to the difference in their moisture content and also to the degree of unsaturation of oils present, as observed by Jayaram & Shetty (1980b). The variation noted in the values of ash and crude fibre is mainly due to the moisture content of the feed, associated with changes during the period of storage. The differences in the carbohydrate content is directly linked to the changes in other components during storage.

The percentage decrease on the water stability of the feeds stored for 3 months was 3.56%, 4.8% and 7.9% respectively for pellets FM, FC and FS, after 1 h durability test (Table 3). Fowler & Banks (1967) have found no alterations in nutritional status of the pellets stored at room temperature for a few weeks, but storage for greater periods had deleterious effect on the growth performance of fish. A good quality feed is one which is able to maintain its nutritional status for a few weeks of storage. The feeds employed in the present investigation showed good keeping quality upto a period of 3 months. This coupled with their satisfactory water stability make them suitable for use in carp culture.

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