

Formulation, Stability and Effect of Storage on the Quality of Three Artificial Feeds used in Carp Culture

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Three artificial feeds namely, EF, PF and SF incorporating leaf powders of *Eichhornia*, *Pistia* and *Salvinia* respectively were formulated and compared with conventional feed (CF) for their water stability and keeping quality. After 1 h in water PF was found more stable than other feeds. The moisture content increased in all the feeds by 4 months storage and all the feeds showed the same keeping quality.

Conventional fish feed used in India is the mixture of oil cake and rice bran in equal proportions by weight, which is nutritionally poor and imbalanced (Varghese *et al.*, 1976). Formulated feeds have advantages over the conventional feed because the nutrient composition can be adjusted as per the requirement. Protein is the major component of feed which can be derived from cheaper and locally available sources so as to reduce the cost of feeds. Recently, formulated and pelleted diets have been employed in the experimental culture of carps. These feeds contain fish meal, silk worm pupae, aquatic weeds and other materials (Varghese *et al.*, 1976; Jayachandran & Paulraj, 1976, 1977; Jayaram & Shetty, 1980 a, b; Anil 1981; Venugopal & Keshavanath, 1984; Shivananda Murthy, 1989). These artificial feeds in addition to being cheaper and promoting good growth should exhibit good water stability and shelf life. This paper deals with the formulation of 3 supplementary feeds incorporating one floating aquatic weed in each feed namely, *Eichhornia* (EF), *Pistia* (PF) and *Salvinia* (SF); their water stability and keeping quality were compared with the conventional feed (CF).

Materials and Methods

The major ingredients namely, *Eichhornia* (*E.crassipes*), *Pistia* (*P.stratiotes*) and *Sal-*

vinia (*S.molesta*) leaf powders were obtained by sun drying the fresh leaves for 2-3 days and further drying them in hot air oven at 60° for 2 h. Other ingredients such as rice bran, oil cake, edible oil and fish meal were purchased from the local market.

Artificial diets namely EF, PF, SF and CF 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 maintained around 28% and they were made iso-caloric feeds (3 Kcal/g) by varying the ingredient proportion. The feeds were prepared separately by mixing weighed amounts of the ingredients. The ingredients were mixed and hand kneaded with just sufficient quantity of water to get soft consistency. The dough thus obtained was cooked in a pressure cooker at 105°C for 30 min. The cooked feed was cooled by spreading under the fan. The vitamin-mineral premix and edible oil were added and mixed uniformly. After that they were sun dried till the moisture content was lowered to less than 10%. Then the feeds were packed in high density plastic bags and stored at room temperature for further studies.

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Table 1. *Proportion of different ingredients in the formulated feeds (figures in parenthesis indicate protein contribution)*

Ingredients	Eichhornia based feed (EF)	Pistia based feed (PF)	Salvinia based feed (SF)	Conventional feed (CF)
Eichhornia leaf powder	50(10.46)	-	-	-
Pistia leaf powder	-	50(9.96)	-	-
Salvinia leaf powder	-	-	50(8.13)	-
Groundnut cake	21(10.52)	22(11.02)	24(12.02)	50(25.05)
Rice bran	15(0.89)	14(0.83)	11(0.66)	50(2.97)
Fish meal	10(6.05)	10(6.05)	11(6.66)	-
Vitamin mineral premix	1	1	1	-
Edible oil	3	3	3	-
Total	100(27.92)	100(27.86)	100(27.47)	100(28.02)

The method described by Jayaram & Shetty (1981) was followed to determine the water stability of the 4 formulated feeds over a period of 6 h. Samples of different artificial feeds were analysed for their proximate composition initially and after 4 months storage. Moisture, crude protein, crude fat and ash were estimated (AOAC, 1975). The method of Pearson (1976) was followed to analyse the crude fibre and the carbohydrate content was calculated as nitrogen free extract (NFE) by the difference method (Hastings, 1976).

Results and Discussion

The data on the water stability of different feeds are presented in Table 2. At the end of 1 h, feed PF was more stable, which was followed by CF and SF. At the end of 3 h, CF was found to be more stable than other feeds and next in the order was PF. After 6 h, the diet CF continued to be more stable while SF was the least stable. The variation in the ingredient composition appears to be mainly responsible for differences in the stability of the different

feeds. Venugopal & Keshavanath (1984) reported higher stability of three pelleted feeds varying from 74 to 84% after 7 h immersion. According to Stivers (1971) the degree of stability is dependent on the gelatinisation of starch content of the feed during cooking. Hastings (1971) reported that higher fat content affects gelatinization thereby reducing the stability of feeds. Ingredient composition, nature of ingredients, type of processing and moisture content are known to influence feed stability (Hastings, 1971; Kainz, 1977). In the present study poor or better stability observed in the feeds SF and CF respectively could be due to the nature of the major ingredients present namely, Salvinia leaf powder in the former and groundnut cake in the latter. Ghittino (1971) opined that feeds used in carp culture should have good stability, since carps take at least 1 h for consuming formulated feeds. Too much stability of feed is not desirable because nutrients in them become unavailable to the fish owing to their bound form in addition to the higher production cost of such a feed (Balazs *et al.*, 1973).

Table 2. *Water stability (%) of formulated feeds: Percentage of dry matter obtained after immersing the feeds in water over varying duration*

Feed	Period of immersion, h					
	1	2	3	4	5	6
EF	68.12	57.25	48.65	42.02	36.10	31.02
PF	79.50	69.32	60.15	52.28	50.45	49.62
SF	64.50	52.52	43.44	30.54	27.51	25.16
CF	76.68	71.50	69.40	67.36	64.05	63.13

Details with regard to variation in the nutritive components of different feeds after four months storage period are presented in Table 3. Shelf life of processed fish feeds is dependent on the type of processing, storage, temperature and moisture of the diet (Hilton *et al.*, 1977). At the end of four months storage, moisture content had increased in all the four feeds. In the present study storage period coincided with mon-

other components during storage. Fowler & Banks (1967) 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. The feeds employed in the present investigation showed satisfactory keeping quality upto a period of four months.

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

	EF		PF		SF		CF	
	Fresh	After 4 months storage	Fresh	After 4 months storage	Fresh	After 4 months storage	Fresh	After 4 months storage
Moisture %	5.35	9.22	7.01	8.69	6.68	8.75	4.66	7.69
Crude protein %	27.92	24.60	27.86	24.69	27.47	24.78	28.02	24.89
Crude fat %	8.83	5.70	6.89	5.91	5.99	4.62	4.38	3.10
Ash %	12.11	11.90	20.10	19.89	14.24	14.02	13.62	13.35
Crude fibre %	15.78	14.52	12.92	12.61	19.22	18.80	17.02	16.05
Carbohydrate %	32.01	30.06	25.22	24.21	26.40	25.03	33.30	31.92

soon season, when atmospheric humidity was high and this could be one of the reasons for increase in moisture content. Crude protein content decreased in the feeds during storage. Crude fat content was also decreased. 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

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