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Development of formulated dry feed for marine aquariculture

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Breeding and seed production of marine ornamental fishes in India was pioneered by CMFRI. Clown fishes and damsel fishes were the candidate species in aquariculture whose life cycles were closed and batches of 1000-1500 fishes from one brood were available for scientific investigations and sale from 2006 onwards. Destructive fishing methods are practiced to capture these coral reef fishes from natural ecosystems for clandestine trade. In this scenario, when the hatchery reared fishes were made available for sale legitimately by CMFRI in the larger interest of conservation mariculture, added emphasis is required in the areas of nutrition and health in order to refine the artificial breeding and seed production of these marine ornamentals. Addressing nutrition first, weaning these fishes to a dry diet became imperative because, present use of wet feed, a paste of clam and fish meat, creates water quality deterioration and health problems. Over-feeding this wet material became detrimental to the maintenance of water quality which has to be kept at reef quality level. Moreover, scientifically, feeding a single ingredient for a long time would naturally lead to nutritional inadequacies, however attractive the wet feed is to the fishes. Hobbyists may also find the wet processing of feed material a drab routine.

Fig. 1. Striped damsel or Humbug damsel (*Dascyllus aruanus*)

With this back drop, development of a dry diet and its evaluation was done in the marine ornamental fish striped damsel or humbug damsel, *Dascyllus aruanus* (Fig.1).

At first, a common ingredient mixture consisting of equal quantities of squid meal, fish meal, shrimp meal and soy flour was made which had the nutrient composition of 66% crude protein, 5% fat, 3% fiber, 11% carbohydrates and 15% ash. This mixture provides a mix of vegetable and animal (marine) proteins expecting a balanced amino-acid profile. Further, this common ingredient mixture in ascending levels as shown in Table 1, was blended with wheat flour, fish oil, vitamin and mineral mixtures and fortified with certain additives making it complete nutritionally (Fig. 2). This wet mixture was extruded in a laboratory model extruder from Basic Technologies Pvt. Ltd., Kolkata with a time-temperature combination of

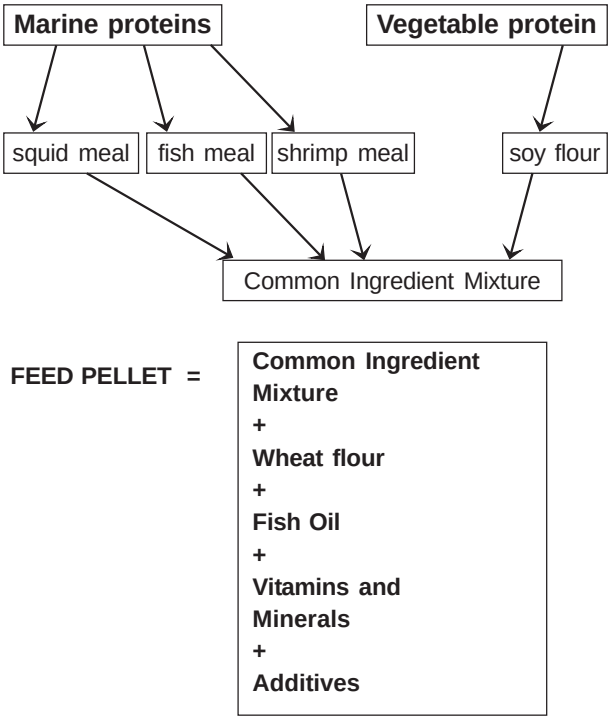

Fig. 2. Diagrammatic sketch of feed design

Table 1. Feed ingredient proximate composition[1] (% DM matter), ingredient composition (g kg^{-1}) of experimental diets and their proximate composition (% DM matter)

Ingredients	CP	EE	CF	NFE	Ash
Squid meal	61.42	6.81	0.98	11.91	18.88
Shrimp meal	65.46	3.78	5.29	0.04	18.35
Fishmeal	69.54	7.22	0.23	0.07	17.69
Soya flour	51.95	0.59	2.91	26.98	6.96
Wheat flour	13.45	1.39	2.95	75.79	0.73
			Feed Nos.		
Ingredients	18	25	36	47	56
CIM[2]	10	180	380	580	780
Wheat flour	865	685	505	315	120
Fish oil	40	50	30	20	15
Vitamin Mixture	20	20	20	20	20
Mineral mixture	10	10	10	10	10
Other additives	55	55	55	55	55
Added water 180 g kg^{-1}					
Proximate composition of experimental feeds					
CP	18.34	25.35	36.27	46.61	56.28
EE	5.30	5.84	5.47	5.11	5.25
CF	0.91	0.92	1.11	1.41	1.60
NFE	72.78	64.12	51.50	38.09	25.14
Ash	3.43	4.46	6.13	9.21	12.63
AIA	0.00	0.01	0.45	0.57	0.84
[3]DE MJ $100g^{-1}$	14.170	14.512	14.744	14.781	14.924
[4]GE MJ $100g^{-1}$	19.180	19.460	19.586	19.446	19.424

[1]CP - crude protein, EE - either extract or crude fat, CF - crude fiber, NFE - nitrogen free extract or soluble carbohydrates
[2]Common ingredient mixture
[3]Digestible energy in mega joules
[4]Gross energy in mega joules

10 seconds and 80 ºC, to obtain 2 mm pellets as shown in Fig. 3. Five experimental feed with their protein content varying from 18-50% were made and evaluated for their physical qualities and nutritional appropriateness.

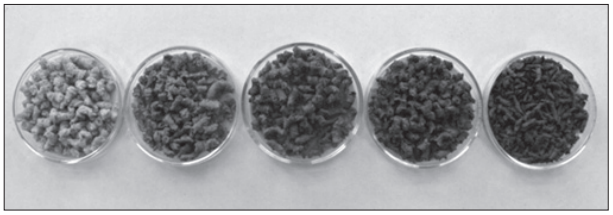

Fig. 3. Extruded marine ornamental fish feed

These feed pellets were then crushed and sieved to obtain particle sizes of ≤0.5 mm, 1.0 mm and 1.5 mm as shown in Fig. 4 and used for physical evaluation and to feed the fishes for nutritional evaluation.

Physical properties evaluated were bulk density and water stability. Feed nos. 18, 25, 36 and 47 floated and feed 56 sank in the uncrushed form. When crushed and sieved, all feed float initially and sink slowly on absorption of water. Generally, feed with less than 0.480 g ml^{-1}, float in seawater. Feeding activity was noticed within a few seconds of dispensing the feed and possibility of nutrient loss to the abovementioned level is there only if the feed remained uneaten in water for 15 minutes.

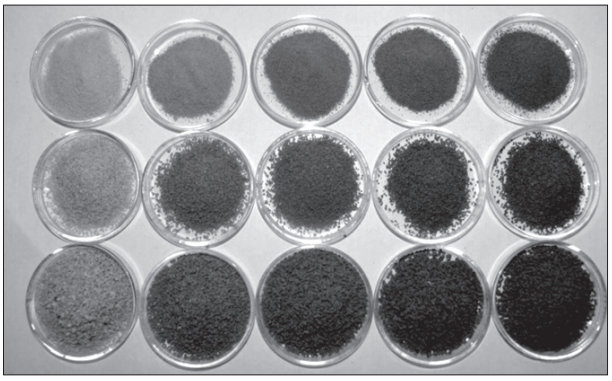

Fig. 4. Feed crushed and sieved to particle sizes of 0.5 mm, 0.75 mm and 1 mm

The feed were tested for their efficacy in two groups of animals weighing less than 200 mg and more than 200 mg for the optimum growth, health and colour retention. Amino acid profiles of two of the feed formulations is shown in Table 3. The cost of these feed range from Rs. 75-150 kg^{-1}. With

Table 3. Amino acid composition of the feed indicating optimum performance (g kg^{-1})

Amino acids	Feed Nos.	
	36	47
Asp	26.23	43.34
Glu	47.94	68.40
Ser	17.95	28.91
Gly	34.73	33.50
His	6.93	10.55
Arg	14.23	22.30
Thr	13.36	19.06
Ala	25.81	27.92
Pro	27.39	31.68
Tyr	9.09	10.51
Val	18.34	21.26
Met	6.64	4.93
Cys	0.87	2.66
Ile	15.53	18.63
Leu	27.85	36.29
Phe	22.60	19.35
Lys	25.46	41.83

imported and repacked freshwater ornamental fish feed retailing at Rs. 500 kg^{-1}, these feed would serve as good import substitutes. This is the first effort towards development of indigenous fish feed technology for marine ornamental fish. Instead of extruding pellets of larger dimension and crushing them to smaller particles of desirable size manually, state-of the-art feed technology is available today for the manufacture of these types of feed. Sphere-izer Agglomeration technology (SAS system ™ www.extru-technic.com) with capability to extrude feed of 300 microns to 1.2 mm having international acceptance as shown in Fig. 5 can be adopted for commercial scale production.

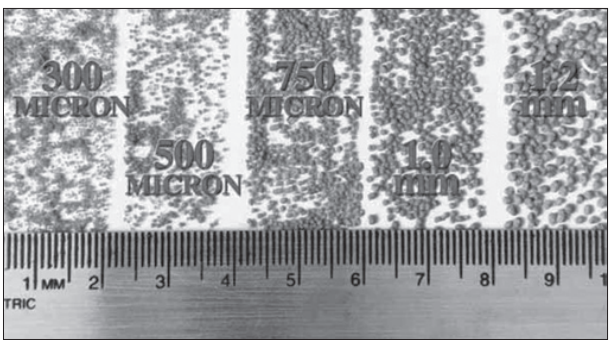

Fig. 5. Feeds produced by SAS™ system by Extru-tech, Inc.

For more details refer: *Aquaculture Research*, 2008, 1-8 doi:10.1111/j.1365-2109.2008.02039.x online

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