WATER STABILITY OF PRAWN FEED PELLETS PREPARED USING DIFFERENT BINDING MATERIALS WITH SPECIAL REFERENCE TO TAPIOCA

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ABSTRACT

The water stability of prawn feed pellets, made using *agar agar* (AA), polyvinyl alcohol (PVA), sodium alginate (SA), gelatin, starch and tapioca as binders, was studied by determining the loss in weight in water. AA, PVA and SA were used at 2% level and gelatin and starch were used at 10% and 40% level respectively. Whereas tapioca was tested at six levels of 9.0, 16.6, 23.0, 28.5, 33.3 and 37.5%.

AA, PVA and SA have same binding capacity (the loss in weight of pellets was around 24% at the end of 8 hours), while gelatin resulted in higher loss in weight (28%) of pellets. Starch was found to be a poor binder (weight loss of pellets 48%).

The binding capacity of tapioca at 9% level was comparable to that of AA, PVA and SA at 2% level. The loss in weight of pellets decreased from 24% to 15% as the amount of tapioca in the feed increased from 9 to 37.5% at the end of 8 hours. Aeration of the water resulted in higher loss in weight of pellets in the first four hours compared to the loss in weight without aeration. However, at the end of 8 hours there is no significant difference in the weight loss between the two treatments. The advantages of using tapioca as binder in prawn feeds are discussed.

INTRODUCTION

The water stability of aquatic feed pellets depends upon the nature and quantity of the binding material used. If the pellet is too hard it is difficult for the animals to ingest and if it is loosly blend, the pellet would disintegrate faster, leading to wastage of the feed and spoilage of the water. An efficient binder, if it is highly expensive would make the final cost of the feed uneconomical. It is essential to consider these facts while selecting a binding agent. Mayers *et al.* (1972) discussed the range of substances available for binding aquatic feeds. Forster (1972 a and b) examined the effect of different binders on the assimilation efficiency of the feeds for prawns. Ali (1982 a) reported the use of tapioca as binding agent in prawn feed. But the information on the quantitative loss in weight of pellets in the water with time, in respect of individual binding agents is scanty. In the present study an attempt is made to study the quantitative loss of weight of a prawn feed pellets prepared using selected binding agents with special reference to tapioca.

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MATERIALS AND METHODS

Agar agar (AA), gelatin, polyvinyl alcohol (PVA), sodium alginate (SA), starch and tapioca powder, obtained from the following sources were selected as binding agents:

Agar agar	:	BDH
Gelatin	:	BDH
Polyvinyl alcohol	:	Kinjal Chemicals, Bombay
Sodium alginate	:	Johnson Chemicals, Bombay

Starch	:	BDH
Tapioca	:	It is a tuber *(Manihot esculenta)*, also known as 'Cassava' cultivated in southern India for food purpose. It is obtained as fine powder from the local market. Its proximate composition given in Table 1.

TABLE 1. *Proximate composition of tapioca powder*

Constituent	Percent
Moisture	9.5
Crude protein	0.54
Lipid	2.0
Ash	1.45
Carbohydrate	85.71
Crude fibre	0.8

A feed base compounded by prawn waste, mantis shrimp, fish meal, and groundnut cake, developed at Marine Prawn Hatchery Laboratory of C.M.F.R.I, for feeding prawns, was used for preparing pellets with each of the above selected binding agents.

Formulation and preparation of feed pellets

The first set consisted of five feeds, B1 B2, B3, B4 and B5 prepared using AA, gelatin, PVA, SA and starch respectively. AA, PVA and SA were used at 2% level and gelatin and starch at 10 and 40% level. The feed was prepared adding 80 ml of water to 100 g of feed base and binder.

In the second set, six feeds numbered as B6, B7, B8, B9, B10 and B11 were formulated using tapioca as binder. It was used at six different levels of 9.0, 16.6, 23.0, 28.5, 33.3 and 37.5% respectively. The feed was prepared by adding 60 ml of water to 100 g of feed base and the binder.

The ingredients of the feed base were separately powdered in a micro-pulverizer using 1 mm screen and blended in accordance with its composition. In the case of feeds B1 to B5 the binding agent was dissolved/melted in boiling water, feed base was added and mixed into dough. the feeds B6 to B11 were prepared by mixing the feed base with tapioca and water into a dough. In both the cases, the dough was steamed for ten minutes, extruded through 3 mm diameter die and dried in the oven at 70°C to constant weight.

Evaluation of water stability of pellets

Experiment I

The water stability of feed pellets was evaluated by determining the loss in weight of pellets under water at specified time interval. For this purpose cone shaped pouches were made with nylon (1 mm mesh) cloth. These were thoroughly washed with water and dried at 70°C to constant weight. The feed pellets were cut into pieces of approximately 5 mm length. Fifty pellets were kept in each pouch and the initial weight of pellets was recorded. For each feed, nine samples were weighed. The pouches along with the pellets were carefully lowered into the water and placed in petri dishes kept at the bottom of a plastic lined pool 90 cm of diameter contair.nig 300 litres (40 cm depth) of water of salinity 20‰. The temperature and pH of the water were respectively 29 and 7.85°C. At the end of one hour one pouch along with pellets was carefully taken out of the water. After noting the physical shape of the pellets, it was gently dipped in a container of fresh water for five minutes to remove the adhering salt. It was then transferred to the oven and dried at 70°C to constant weight. In this manner the samples were taken out at the end of 2, 3, 4, 5, 6, 8, 12 and 24 hours and were treated as above and recorded the weight. The loss in the weight of pellets was calculated by the difference in the weight before and after the immersion of the pellets. The experiment was repeated twice and the average values were taken.

Experiment II

In this experiment the influence of aeration on the loss in weight of pellets of the feeds B6 to B11 was studied. The procedure followed was same as in experiment 1 except that aeration was provided for 15 minutes for every one hour with the help of an air blower by keeping the air stone at the middle of the pool. The strength of the aeration was moderate just sufficient to lift the bottom layer of water to the surface.

RESULTS

The loss in weight of pellets prepared using AA, PVA, SA, gelatin and starch at the end of 1, 4 and 8 hours is given in Table 2. For the first hour the weight loss was between 10 and 12% in the pellets prepared with AA, PVA, SA and gelatin. But it was 17.02% in the pellets containing starch. At the end of 4 and 8 hours, the loss was between 21 and 25% in the case of AA, PVA and SA whereas it was 30.16 and 28.12% in the case of gelatin. The pellets having starch had shown a loss of 43.89% and 42.19% at the same time intervals. The physical shape of the pellets having AA, PVA, SA and gelatin remained intact at the end of 8 hours, but the pellets having starch crumbled.

The data were subjected to analysis of variance (ANOVA) and the comparison of means had shown that there was no significant difference ($p < 0.05$) among the treatments B1, B2 and B3 at all the three time intervals. However, the difference was significant ($p < 0.05$) between the first three treatments and the treatment B4 only at 4 and 8 hour intervals. And the difference was highly significant ($p < 0.05$) between the first four treatments and the treatment B5 at all the three time intervals.

The trend in the weight loss of pellets with time over 24 hours is shown in Fig. 1. In the case of feed pellets with AA, PVA and SA the loss in weight was almost identical and the major loss in weight occurred in the first three hours. The difference in loss in weight of pellets with gelatin and starch was in the first three hours and the trend continued till end of 24 hours. The results had indicated that AA, PVA and SA had the same binding capacity. Gelatin and starch even at 10 and 40% levels respectively, were poor in their binding capacity.

TABLE 2. *Loss in weight and physical shape of pellets of feeds B1 to B5 at the end of 1, 4 and 8 hours*

Treatment	Loss in weight %			Physical shape of pellets		
	1 hour	4 hours	8 hours	1 hour	4 hours	8 hours
B1	10.83	21.51	24.43	IN	IN	IN
B2	10.55	23.42	24.98	IN	IN	IN
B3	10.14	23.83	22.91	IN	IN	IN
B4	11.31	30.16	28.12	IN	IN	IN
B5	17.02	43.89	42.19	IN	IN	CR
Analysis of Variance						
'F' value calculated	10.91	25.67	65.92			
Standard error	1.3139	1.5699	0.8431			
Least significant difference (at $P = 0.05$)%	3.38	4.04	2.17			

IN = Intact, CR = Crumbled.

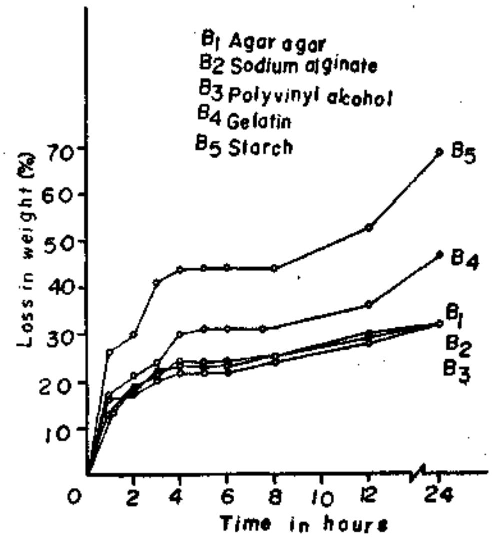

FIG. 1. Loss of weight in pellets of feeds B1 to B5 over 24 hours.

When tapioca was used as binder in the feeds B6 to B11, the loss in weight of pellets (Table 3) was between 6 and 8% in the first hour, between 11 and 16% at the end of 4 hours and it was between 15 and 24% at the end of 8 hours. ANOVA of the data had shown that there was no significant difference ($p < 0.05$) among the treatments in the first hour. At the end of 4 and 8 hours the difference was significant ($p < 0.05$) between the first three (B6, B7, B8) treatments and the next three (B9, B10, B11) treatments. The loss in weight came down from 24.07 to 16.65% as the tapioca level in the pellets was raised from 9 to 28.5%. Further increase in the tapioca content of the pellets had no beneficial effect on the weight loss. The physical shape of the pellets remained intact at the end of 8 hours for all the feeds.

TABLE 3. *Loss in weight and physical shape of pellets of feeds B6 to B11 at the end of 1, 4 and 8 hours with and without aeration*

Treatment	Loss in weight of pellets (%)						Physical shape of pellets					
	without aeration			with aeration			without aeration			with aeration		
	1 hr	4 hrs	8 hrs	1 hr	4 hrs	8 hrs	1 hr	4 hrs	8 hrs	1 hr	4 hrs	8 hrs
B6	8.09	15.77	24.07	13.72	23.69	21.21	IN	IN	IN	IN	CR	CR
B7	7.46	17.25	22.24	12.01	19.26	21.30	IN	IN	IN	IN	CR	CR
B8	6.84	14.33	21.60	11.32	18.80	20.25	IN	IN	IN	IN	CR	CR
B9	7.09	11.84	16.65	9.83	16.49	18.41	IN	IN	IN	IN	IN	IN
B10	7.09	11.57	17.04	10.50	17.15	16.20	IN	IN	IN	IN	IN	IN
B11	7.06	12.38	15.08	10.04	16.65	17.70	IN	IN	IN	IN	IN	IN
Analysis of Variance												
'F' Value calculated	1.14 (N.S.)	8.28	20.30	3.31 (N.S.)	4.42	3.11 (N.S.)						
Standard error	—	0.9116	0.8370	—	1.3125	—						
Least significant difference (P = 0.05)%	—	2.21	2.05	—	3.21	—						

NS = Not significant, IN = Intact, CR = Cracked.

The trend in weight loss over 24 hours is shown in Fig. 2. The loss was rapid in the first 4 hours and then gradual until 8 hours beyond which the loss in weight was again very rapid especially between 8 and 12 hours. At the end of 24 hours the loss in weight was as high as 70% in the pellets with 9% tapioca and 55% in the case of pellets with 37.5% tapioca. The physical shape of pellets of all the feeds was completely disturbed and the pellets crumbled at the end of this period.

Aeration of the water had resulted in an approximately 5% higher rate of loss in the weight of pellets (Table 3) in the first 4 hours compared to the loss without aeration. With aeration the pellet shape of the feeds B6 and B7 was disturbed at the end of 4 hours and that of feed B8 at the end of 8 hours, while they were intact without aeration. There was no significant difference ($p < 0.05$) among the treatments. However, at the end of 8 hours the difference in the loss in weight of pellets with and without aeration was not significant ($p < 0.05$).

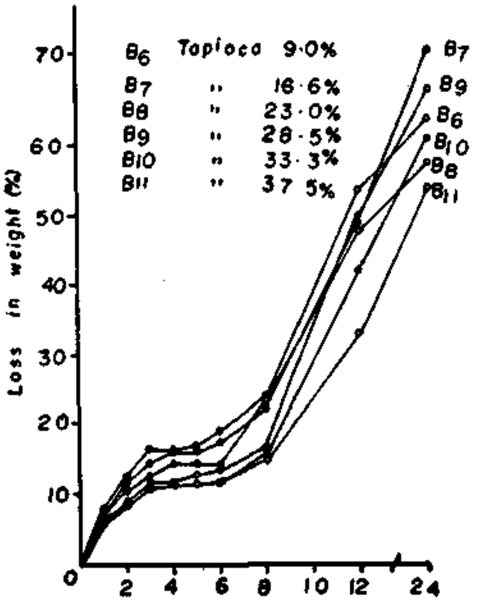

FIG. 2. Loss of weight in pellets of feeds B6 to B11 over 24 hours.

The binding capacity of tapioca at 9% level was comparable to that of AA, PVA, SA at 2% level and gelatin at 10% level at the end of 8 hours. It was far superior to pure starch. At 28.5% level, tapioca was superior to the other binders tested, however, beyond 8 hour period starch is a poor binder compared to the other binders tested.

Discussion

Apart from the nature of binder used, the water stability of feed pellets depends upon the nature of ingredients constituting the feed. Feeds having water soluble and rough ingredients disintegrate faster (Meyers and Zei-Eldin, 1972) and require higher amount of binder. The feed tested in the present experiments consisted of rough ingredients such as prawn waste, and mantis shrimp which contain chitinous shell material. Pure starch and gelatin even at higher levels are found to be poor binders for this type of feed composition. Goswami and Goswami (1979) found that shrimp feed pellets prepared with starch as binder disintegrated faster. The results of the present study in the case of starch are in agreement with their findings. AA, PVA, SA and tapioca are found to be more suitable binders for this type of feed and the pellets prepared with these binders have shown good water stability for a period of 8 hours. In aquatic systems it is expected that the feed given will be consumed within 8 hours time. Taking this into consideration, tapioca, AA, PVA and SA can be successfully employed as binders. Where high water stability of feed pellets is required for more than 8 hours, the latter three binders are recommended.

The use of tapioca as binder has double advantage. While good water stability of the feed pellets could be achieved at 28.5% level, it enhances the calorific value of the feed simultaneously by supplying good source of carbohydrate. Starch in the diet was found to be better utilized by the penaeid prawns (Abdel Rehman *et al.*, 1979) and at 40% level in the diet produced faster growth rate (Ali, 1982 b) in the prawn *Penaeus indicus*. Ali (1982 a) first used tapioca for binding prawn diets. Subsequently the author (unpublished) obtained enhanced growth and better food conversion ratio in *P. indicus* by using 37% tapioca in the same feed which is tested in the present study. Tapioca is very cheap (retail price one rupee per kg of powder at the time of experiment) compared to any other chemical binder. Use of tapioca as binding material helps in bringing down the final cost of the feed. Thus tapioca is a potential double action material for prawn feeds.

Conclusions

Among the binding materials tested, agar agar, polyvintyl alcohol, sodium alginate and tapioca are found to have good binding capacity.

Gelatin and pure starch have poor binding capacity.

At 9% level the binding capacity of tapioca is comparable to that of AA, PVA and SA for a period of 8 hours. At 28.5% level tapioca has shown highest binding capacity with minimum loss in weight of pellets for a period of 8 hours.

Use of tapioca as binder has double advantage. It acts as good binder and at the same time enhances the calorific value of feed by supplying good source of carbohydrate.

Tapioca is very cheap compared to any other chemical binder and its use will help in bringing down the final cost of the feed.

Where the water stability of the feed pellets required beyond 8 hours, AA, PVA and SA are recommended as binders.

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