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Preliminary Investigation on the Role of a Novel Organic Feed Binder, Carboxy Methyl Tamarind (CMT) in the Aqua Feeds

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Abstract: Feed is the major input in aquaculture systems impacting on the cost of production. While energy nutrients contribute for the growth and success of the feed in production, non-energy ingredients in the feed can contribute to the effective utilization of the feeds. Nutrient sparing action is an essential prerequisite for the binder that is used in the feed besides offerings hydro stability. Carboxy Methyl Tamarind (CMT), an organic binder was used at 1% level in the freshwater prawn feed and the efficiency of the feed was tested against two feeds prepared with conventional binders, such as tapioca flour and wheat maida. At the end of 28 days of trial feeding, CMT incorporated feed could give higher weight gain (378.74%) with higher SGR (5.59). The performance was better than the two other feeds tried which vouch for the fact that the CMT could well be sued as a feed binder for aquatic organisms. Since no negative effects noticed in the trials, it could also be concluded that in the light of increasing demand for good quality aqua feed, CMT as an organic feed binder might be of great use for the aquaculture industry. This will, also pave way for the enhanced utilization of the feed and subsequent economic benefits.

Key words: *M. rsoenbergii*, organic feed binder, CMT, PL, bio-growth parameters, feed utilization

INTRODUCTION

Aquaculture is a rapidly growing food sector with a total production of 66.63 million ton of fishes and other aquatic animals in 2012 (FAO, 2014). One of the major challenges in this sector is the availability of quality feed in required quantity. According to Kazamzadeh (1989), the feed production and processing are real challenges in the aquaculture sector. Production of low cost and protein rich feeds that would enhance growth of the fishes and other cultured organisms is the need of the hour as stated by Lovell (1988), Davis and Stickney (1978) and Keong (2003). In aquaculture, the efficacy of the feed and feeding management can be seen when there is a perfect ingestion of the feed by the cultured organism. But, the distribution of feed in the medium makes it disbursed by the water leading to a sufficient loss before ingestion. If the water stability of the pellet is relatively higher (2-3 h) the feed will be available for longer time, so that the target organism can consume it. This will lead to the higher amount of feed ingestion. Nevertheless higher intake, if not resulted in the proportionate growth and production of flesh may adversely affect the cost of production also.

Water stability of pellets is influenced by a number of factors, foremost amongst which are diet composition, manufacturing process and nature of the binder used (De Silva and Anderson, 1995; Goddard, 1996). Thus, the binder used in the feed processing is the most important ingredient that decides the stability of the pellets in the water. Therefore, selection of the binder is more important in the feed making.

Binders used in aqua feeds can be classified, as plant extracts (carrageenan, alginates, agar, starches, pectin's, molasses and wide variety of gums), animal extracts (collagen), polymers (urea formaldehyde condensation polymer), wood processing by-products (lignin sulfonate, hemicelluloses and carboxy methyl cellulose) and minerals (bentonite). Inclusion level of non-nutritive binders are limited to only 2% of the feed while nutritive binders may be included up to 20-30%. Increasing the strength of the pellets increases feed efficiency by reducing the production of fines, as observed in the feeding management.

Tamarind Kernel Powder (TKP) is derived from the seeds of *Tamarindus indica* Linn. commonly found in India and South East Asia. Due to its unpleasant odor, dull color, presence of water insolubles, low solubility in cold water and fast biodegradability, its various derivatives like acetyl, hydroxyalkyl and carboxymethyl have been prepared (Rao and Beri, 1955; Prabhanjan, 1989). Carboxy Methyl Tamarind Kernel Powder (CMTKP)

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is a carboxymethylated derivative of tamarind kernel powder. The incorporation of a carboxylic group imparts anionic character to CMTKP, thus allowing the formation of interpolymer complex between CMTKP and cationic polymers (Kaur *et al*., 2010).

Reports on the use of CMKTP in aqua feeds, as a binder or energy ingredient are very scanty and it is understood from the avaibale reports that CMKTP possess enough qualities to be used, as a binder in the aqua feed. Therefore, the present study was carried out for evaluating the suitability of CMKTP for using in the aqua feed, as a binder and it was also compared with other two commonly used binders on the growth and survival of *Macrobranchium rosenbergii* Post Larvae (PL).

MATERIALS AND METHODS

The 3 supplementary feeds F_1-F_3 were prepared with the identical ingredients which are listed in Table 1. The 3 feed binders viz., Tapioca flour, Wheat maida and Carboxy Methyl Tamarind (CMT) (M/s Balasanka Mills Pvt. Ltd., Theni, Tamil Nadu) were incorporated at 1% level in all the 3 feeds F_1-F_3, respectively. All the three treatments (F_1-F_3 fed group) consisted of 2 replications with 10 prawn PL each. The proximate analysis (moisture content, lipid and crude protein) of all the 3 diets are presented in Table 2.

Post Larvae (PL) of *Macrobrachium rosenbergii* were procured from the hatchery and acclimatized to the lab conditions in large troughs. The feeding experiments were carried out in circular plastic troughs (40 L capacity) in which PL of *M. rosenbergii* with ABW of 0.0615±20 g were initially stocked. The duration of the experiment was 28 days and observations were made once in 7 days.

Table 1: Ingredients used in the supplementary feed

Ingredients	Inclusion level (%)
Rice bran	30.00
Fish meal	24.00
GNOC	10.00
Shrimp head meal	10.00
Soya meal	6.00
Wheat bran	10.00
Binder	1.00
Mineral and vitamins	0.25
Fish oil	2.00
Ragi flour	6.00
Salt	0.50
Vit. C and E	0.25

Table 2: Proximate composition of experimental diets

	Proximate composition (%)		
Feeds	Moisture	Crude protein	Lipid
F_1	6	28	6
F_2	6	28	6
F_3	11	29	6

Biogrowth parameters such as initial and final mean weight, weight gain percentage, Specific Growth Rate (SGR) and survival were recorded. Feeding was done *ad libitum* with daily removal of fecal matter and 10-15% of water exchange. Aeration was given throughout excepting the cleaning and feeding time and troughs were kept undisturbed with L:D of 14:10 h. The basic water quality parameters such as pH, total hardness and ammonia-N were estimated once in 2 days before the cleaning using the water quality test kits (Merck Ltd.).

Following formulae were employed to estimate the bio-growth parameters in the present study. These parameters were statistically analysed using t-test for finding out level of significance:

$$\text{Weight gain}(\text{g}) = \text{Final weight} - \text{Initial weight}$$

$$\text{Weight gain}(\%) = \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$$

$$\text{Specific growth rate} = \frac{\text{Final weight} - \text{Initial weight}}{\text{No. of days}}$$

RESULTS

The PL of *M. rosenbergii* in the experimental troughs attained the final mean weight of 0.2736±0.009, 0.1850±0.004 and 0.3040±0.36 g in F_1-F_3 fed group, respectively. The lowest weight gain was observed in F_2 fed group (0.1235±0.008 g) after 28 days of feeding and the highest weight gain (0.2405±0.036 g) was seen in F_3 group. The percentage weight gain was also the highest in the F_3 group (378.74±60.15) compared to F_1 and F_2 fed group. The SGR of F_1-F_3 were 5.22±0.26, 3.93±0.29 and 5.59±0.45 indicating the better growth performance of the prawn PL in F_3 group. The survival of F_1-F_3 group were 100±0, 95±5 and 95±5%, respectively. The biogrowth parameters of *M. rosenbergii* post larvae estimated after the 28 days of study period are presented in Table 3. The growth pattern during the 28 days of feeding in all the 3 groups is depicted in Fig. 1. The ranges of water quality parameters in the experimental troughs are given in Table 4.

The growth pattern depicted in Fig. 1 indicates that the growth was more or less similar during the first 7 days which started moving in different patterns afterwards. The deviation could be attributed to the different binders used in the feed, as reported by Storebakken and Austreng (1987) for rainbow trout.

Table 3: Biogrowth parameters estimated in the feeding experiment with 3 types of feeds (F_1-F_3) for *M. rosenbergii* PL

Feeds	Initial mean weight (g)	Final mean weight (g)	Weight gain (g)	Weight gain (%)	SGR	Survival (%)
F_1	0.0625±0.006	0.2736±0.029	0.2111±0.011	337.76±31.5	5.22±0.26	100±0
F_2	0.0615±0.004	0.1850±0.014	0.1235±0.008	200.81±23.9	3.93±0.29	95±5
F_3	0.0635±0.005	0.3040±0.036	0.2405±0.036	378.74±60.1*	5.59±0.45*	95±5

*p>0.05

Table 4: Water quality parameters in the brooder pond

Parameters	Range values
Temperature (°C)	26-31
Dissolved oxygen (ppm)	3-5
pH	7.2-8.7
Ammonia (mg L^{-1})	<0.001
Nitrate (mg L^{-1})	<2.3

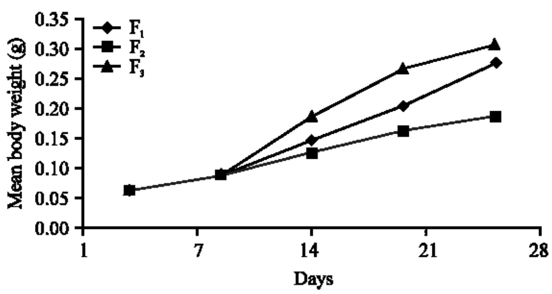

Fig. 1: The growth pattern of *M. rosenbergii* PL fed with 3 types of feeds (F_1-F_3)

DISCUSSION

The effect of binders on the feed utilization and growth promotion has been studied by many researchers. Reports are, also available on the utility of the binders for aqua feeds and based on that binders, such as tapioca flour, alginates, guar gum and CMC have been commonly used as binder in the aqua feeds (Storebekken, 1985; Storebakken and Austreng, 1987; Penaflorida and Golez, 1996; Pearce *et al*., 2002; Brinker, 2007). Tapioca flour is a compound extracted from the dried roots of Cassava plant and has a considerably higher proportion of amylopectin compared to other starch sources (Daniel, 1985). It could result in better expansion and functional properties of aqua feeds (Kannadhason *et al*., 2009). Therefore, its use in aqua feeds is well justified. Wheat flour or maida is a derivative of wheat and its binding properties are well known from the reports of Penaflorida and Golez (1996) who contended that wheat flour, upto 5% *Kappaphycia alvarezii* or 10% *Gracilaria heteroclada* meal could be used as binder in diet for juvenile shrimp *Penaeus monodon*.

In the present study, the comparison of tapioca flour and wheat maida with the CMT revealed that the CMT used feed had given the better advantages of weight gain, weight gain percentage and SGR. The biogrowth parameters were higher in the prawn PL fed with a feed containing CMT as binder. There was a difference of 95% between the treatments indicating the statistical significance (p>0.05). Normally starch based binders are used for the aqua feeds because of its binding properties. Starch is a biopolymer consisting of amylase and amylopectin (Brouillet-Fourmann *et al*., 2003). Starch is characterized by loss of crystallinity and gelatinization during extrusion (Colonna and Mercier, 1983; Gomez and Aguilera, 1984; Chinnaswamy *et al*., 1989) and it also acts as a binder and impacts product expansion. Therefore, CMT being a starch based product would have been more suitable for the binding of the ingredients.

The feeds contained a CP level of 28-29% and according to New (1987, 1988, 1990, 1995), the protein level is ideal and sufficient for the *M. rosenbergii* larvae. It has been earlier reported by Storebakken (1985) that alginate and guar gum in feed reduced the apparent digestibility of protein and fat of rainbow trout. Storebakken and Austreng (1987) when reported their observation on the effect of 6 different alginates on the digestibility of macronutrient in rainbow trout (*Salmo gairdneri*), made a mention that all 6 alginates reduced the apparent digestibility of nitrogen, fat, ash and calcium. But, such a situation did not seem to have occurred here in this study with *M. rosenbergii* indicating supporting action of the CMT.

There was no big difference in the water quality parameters in the experimental troughs and therefore, the effect on the growth can be attributed to the binder used when all the other variables are identical in all the 3 experimental troughs. Although, the survival was higher for F_1 group containing tapioca flour, as binder (100%) that was not statistically significant.

CONCLUSION

It is seen from the reports and documents that the total industrial compounded aqua feed production increased >3 fold from 7.6 million ton in 1995 to 29.2 million ton in 2008 with an average growth rate of 11% year^{-1}. Aqua feed production is expected to grow continuously, at a similar rate to 71.0 million ton by 2020 (Tacon *et al*., 2011). Therefore, the use of a suitable binder is more essential and indispensable in the aqua feed industry. In the light of the above, the present study assumes importance by bringing into light the possibility of using CMT, popularly known as Carboxy Methyl Tamarind Kernel Powder (CMTKP), as a feed binder in aquaculture sector. In the laboratory level, the prepared supplementary feed did well. However, further research is needed in commercial usage of this binder in the large scale feed preparation for all aquaculture species. There might be species specific impact of this binder in the farm level application that has to be further investigated.

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