Effects of Teaseed Cake on Selective Elimination of Finfish in Shrimp Ponds*

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Abstract

Teaseed cake contains 5.2-7.2% saponin, a glucoside that causes hemolysis in organisms. The higher sensitivity of finfish than crustaceans to the glucoside has made it an effective pesticide in shrimp ponds. To develop management techniques for the use of teaseed cake, the effect of dissolved oxygen (DO) and temperature at levels normally found in shrimp ponds on the potency of the toxicant and its rate of degradation when mixed with water were investigated. The experiments were conducted in 20-l plastic tanks, using two species of finfish, *Oreochromis mossambicus* and *Glossogobius giurus*, and two species of crustaceans, *Metapenaeus ensis* and *Penaeus monodon*. The experiments were run on a completely randomized design with three replicate tanks for each treatment. In experiment 1, 15 ppm of teaseed cake was needed to eliminate both species of finfishes within six hours of application. Significant differences in the response of the two species of finfishes were observed. Both species of crustaceans survived concentrations of up to 20 ppm. Results of experiment 2 showed that the decrease of DO levels due to lack of aeration and the increase in water temperature resulting from exposure to sunlight significantly increased the sensitivity of finfish to teaseed cake. Exposure to sunlight for about 12 hours significantly decreased the potency of the glucoside on *O. mossambicus* in another experiment. The change was small and was not observed with *G. giurus*. It is recommended that the water level in shrimp ponds be reduced to one third before application, that teaseed cake be applied in shrimp ponds in minimum dosages towards noon when water temperature is higher and that the water depth be restored after about six hours of application.

Introduction

Predators and competitors adversely affect the growth and survival of shrimps cultured in earthen ponds. The resultant losses increase with increasing intensity of culture of the shrimps. This necessitates the application of a toxicant, which at certain concentrations specifically kills finfish and which is naturally degradable. None of the inorganic pesticides meet the requirement for specificity. Furthermore, these chemicals, particularly the chlorinated hydrocarbons such as endrin, thiodan and DDT remain persistent in the environment, resulting in cumulative effects on other organisms.

Toxicants which are naturally occurring in plants are degradable and finfish can be more sensitive to its toxic properties than crustaceans. Rotenone, the toxin derived from *Derris* sp. was demonstrated to eradicate *O. mossambicus* without affecting the survival of shrimps (Peterson 1976). A similar effect on the undesirable fish in shrimp ponds in Taiwan with teaseed cake has been observed (Terazaki et al. 1980). Teaseed cake, the residue of *Camellia* sp. seeds after oil extraction, contains 5.2-7.2% saponin (Terazaki et al. 1980), a water soluble glucoside which destroys red blood cells.

Teaseed cake may vary in saponin content. Recommended levels for use in eradicating undesirable fish in shrimp ponds are 10-25 ppm of pond water (Cook 1976) or 1.1 ppm of crude saponin which is equivalent to 21 ppm of pond water if the teaseed cake contains 5.2% saponin (Terazaki et al. 1980). It is of great interest for a fish farmer to know the conditions that can make the minimum concentration of teaseed cake effective. Such knowledge can minimize expenses for teaseed cake and energy to pump water to dilute teaseed cake to levels not stressful for shrimps.

A series of studies was conducted to refine the methods of applying teaseed cake in shrimp ponds. Specifically, the studies aimed to determine: the minimum concentration of teaseed cake that would effect a selective elimination of finfish within three to six hours; the differences in the response of *O. mossambicus* and *Glossogobius giurus* to teaseed cake; the effect of temperature and dissolved oxygen levels, within the ranges normally found in ponds, on the potency of teaseed cake as a toxicant; and whether substantial degradation of teaseed cake can occur within 24 hours.

Materials and Methods

The experiments were conducted in 20-l round plastic tanks, using three replicate tanks for each treatment and two pieces each of the following finfish and shrimps in each tank: *O. mossambicus, G. giurus, Metapenaeus ensis* and *Penaeus monodon*. Finfish of 10.6-18.6 g and

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shrimps of 2.7-5.6 g were stocked in the tanks containing water at 21-31 ppt salinity and exposed to the various treatments in completely randomized design. Teaseed cake used in the experiments was imported from Taiwan.

In experiment 1, the concentration of teaseed cake that would effectively eliminate finfish within three to six hours, without adversely affecting the survival of shrimps was determined. The test species were exposed to 2.5, 5, 10, 15 and 20 ppm of teaseed cake for 48 hours. Mortalities were monitored every hour for the first eight hours and at the 24th and 48th hour. Results were expressed at LT_{50} or LT_{100}, representing the time required for half or all the test animals to be killed, respectively.

In experiment 2, the effect of temperature and DO on the potency of teaseed cake was evaluated at 2.5-15 ppm concentrations in tanks, with or without exposure to sunlight or aeration in a 2 x 2 factorial design. Sunlight was used to raise temperature to simulate the temperature range observed in shrimp ponds. A marginal concentration of 2.5 ppm was used to better evaluate the extent of the effects of the temperature and DO ranges used. Water temperature and DO levels were monitored every two hours and mortality every hour. Teaseed cake was applied at 9 a.m. The test species were exposed to the various experimental conditions for six hours.

To determine whether significant degradation of teaseed cake occurred within 24 hours, tanks containing 15 ppm of the toxicant were exposed for various durations (0, 4, 12, or 24 hours) prior to stocking in experiment 3. Five of each species of finfish and shrimps were stocked in each tank. Water temperature and DO levels were monitored every two hours and mortality every hour. Aeration was provided in all tanks.

Results

Table 1 shows that the survival of the shrimps was not affected by the range of concentration of teaseed cake used during the period of observation. Both species tolerated up to 20 ppm of teaseed cake.

Significant differences in the response of the finfish were observed. *O. mossambicus* was more sensitive to the toxicant, with an LT_{100} of 3 hr compared to an LT_{100} of 7 hr for *G. giurus* when exposed to 10 ppm teaseed cake (Table 1). The survival of *G. giurus* was, however, higher with longer exposure to concentrations below 10 ppm. Fifteen ppm was needed to completely eradicate this species within 6 hours: thus, this concentration was recommended as the lethal dosage.

Similar results were observed in a study conducted in 40-m^2 earthen ponds. Neither *O. mossambicus* nor *G. giurus* survived after exposure to 10 ppm teaseed cake after 48 hours.

Tanks exposed to sunlight increased steadily in temperature from mean of 29°C at 8 a.m. to 35°C at 12 noon. Temperature decreased only by 1°C thereafter (Fig. 1). Tanks not exposed to sunlight maintained a temperature range between 27 and 29.2°C.

Tanks provided with aeration maintained DO levels above 2 ppm throughout the experiment (Fig. 2). DO levels in tanks not aerated steadily decreased from an average of 3.6 ppm at 8 a.m. to less than 1 ppm at 2 p.m.

Table 2 shows that both species of finfish did not survive a three-hour exposure to teaseed cake at 15 ppm. Consistent with experiment 1, *O. mossambicus* responded faster to teaseed cake at 15 ppm, but fewer *G. giurus* survived a longer exposure (six hours) at 2.5 ppm.

Higher temperature resulted in significantly lower survival of *O. mossambicus* during hour 1 at 15 ppm ($P < 0.10$) and a signicantly lower survival ($P < 0.01$) at high temperature after a three-hour exposure to 2.5 ppm (Table 2). Likewise, aeration, which resulted in an average difference of 2.5 ppm in DO levels, effected significantly higher ($P < 0.05$) survival of *O. mossambicus* at hour 1 at 15 ppm and of both species at hour 6 at 2.5 ppm. Higher survival for *G. giurus* exposed to aeration at 15 ppm of teaseed cake was also observed at hour 1.

Consistent with experiments 1 and 2, *O. mossambicus* responded faster to exposure to teaseed cake at 15 ppm than *G. giurus* (Table 3). The teaseed cake was exposed in the tank with water for varying periods (0, 4, 12 and 24 hours) prior to stocking of the test species. After two hours of exposure, *O. mossambicus* treated with teaseed cake exposed earlier by 12 and 24 hours, had significantly ($P < 0.05$) higher survival than those treated with teaseed cake exposed earlier to four hours or less. No such difference was observed with the slower responding *G. giurus*.

Discussion

The rate of response of finfish to teaseed cake demonstrates that *O. mossambicus* is more sensitive to saponin than *G. giurus*. At 2.5 ppm, however, longer exposure resulted in more mortalities for *G. giurus*. On the other hand, Terazaki et al. (1980) observed that *O. mossambicus* was more resistant to saponin than *Eleutheronema tetradactylum, Mugil tade* and *Scatophagus argus*. Organisms generally exhibit distinct differences in sensitivity to toxicants, both at the individual and species level (Khan and Bederka 1973). Temperature and DO levels affect the response of the organims to toxicants. The response generally increases at higher temperature as a result of increased rate of

metabolism. DO levels, when limiting, can cause stress and result in increased sensitivity of organisms to toxicants.

This study showed that both high temperature and low DO can result in increased sensitivity of the finfish to the toxicant. In practice, the higher range of temperature (35°C) is normally observed in shrimp ponds at about noontime when DO levels are relatively high. Moreover, the low range of DO is not observed by those who provide aeration by paddlewheels.

In experiment 1, 15 ppm was defined as the recommended dosage for teaseed cake, being the level which resulted in the complete eradication of the finfish within six hours. The results of experiment 2 suggest that in practice, 10 ppm concentration can be used with the same effects if the toxicant is applied about noontime when the temperature is highest. This can result in tremendous savings, not only by 33% of the cost of teaseed cake but also in the reduction of energy required to pump water for flushing the pond to bring down the levels of saponin to that not stressful for shrimps. In a field trial, shrimps were observed not to feed normally when 15 ppm teaseed cake was applied. They appeared to return to normal feeding after the concentration was reduced to about 3 ppm. Experiment 3 demonstrated that although the degradation of teaseed cake may be significant after a 12-hour exposure to water, the rate of degradation is slow. This suggests the need to dilute pond water as soon as possible, so that shrimp production will not be adversely affected by the application of teaseed cake. From the series of experiments conducted, it is recommended that the water level in shrimp ponds be reduced to one third before application, that teaseed cake be applied after 10 a.m. on a sunny day and that water depth be restored after about six hours of application.

The dosages reported here need not be absolutely followed. Terazaki et al. (1980) reported different levels of saponin from teaseed cake from different sources, and varying responses to saponin resulting from differences in fish sizes and salinity levels. Preliminary assays of different batches of teaseed cake are therefore recommended prior to use in shrimp ponds.

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References

Cook, H. 1976. Problems in shrimp culture in the South China Sea region. SCS/WP/40. 29 p. South China Sea Fisheries Development and Coordinating Programme. Manila, Philippines.

Khan, M.A.Q. and J.P. Bederka, Jr. 1973. Survival in toxic environments. Academic Press, New York, U.S.A. 553 p.

Peterson, P.D. 1976. A review of some botanical fish toxicant and preliminary observations on the toxicity of *Derris* sp. (as a rotenone source) to *Tilapia mossambica*. Paper presented at the 12th Annual Convention of the Philippine Federation of Fish Farm Producers, Inc., 26-28 August 1976. Iloilo City.

Terazaki, M., P. Tharnbuppa and Y. Nakayama. 1980. Eradication of predatory fishes in shrimp farms by utilization of Thai teaseed. Aquaculture 19:235-242.

* University of the Philippines/University of Hawaii CRSP Contribution No. 86:5.

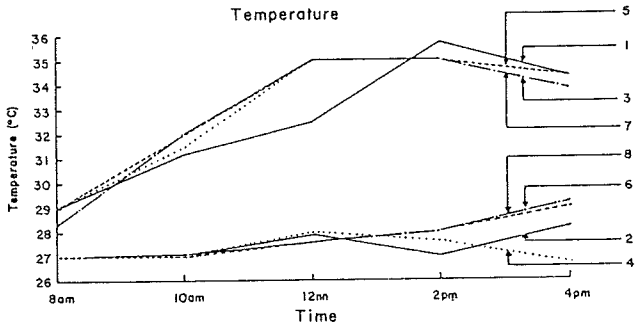

Fig. 1. Temperature (°C) among different treatments. Numbers represent the same treatments as presented in Table 2.

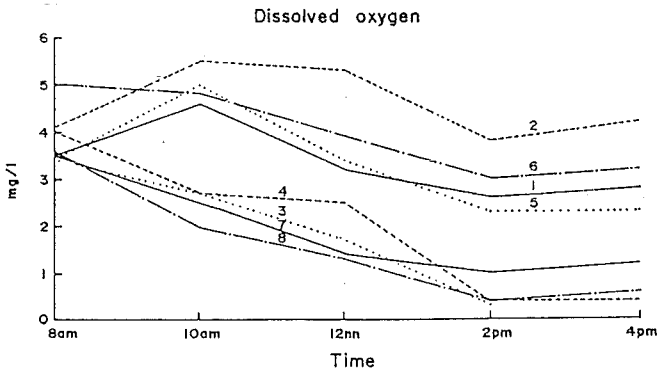

Fig. 2. Dissolved oxygen (mg/l) among different treatments. Numbers represent the same treatments as presented in Table 2.

Table 3. Effect of exposing *O. mossambicus* and *G. giurus* to teaseed cake for various durations befo stocking (Experiment 3).

Exposure time of teaseed cake (hr)	% Survival					
	1	2	3	4	5	6
O. mossambicus						
0	100	7	0	0	0	
4	7	7	0	0	0	
12	80	33	0	0	0	
24	100	20	0	0	0	
G. giurus						
0	93	93	93	93	67	4
4	100	100	80	53	27	2
12	100	87	87	80	47	4
24	100	100	100	100	67	4

Table 1. LT_{50} and LT_{100} of finfishes and shrimps at different dosages of teaseed cake (Experiment 1).

Species	Dosage of teaseed cake (ppm)	LT_{50} (hr)	LT_{100} (hr)
O. mossambicus	2.5	*	*
	5.0	3.0	6
	10.0	2.5	3
	15.0	2.0	3
	20.0	1.5	2
G. giurus	2.5	6.0	> 48
	5.0	3.0	8
	10.0	5.0	7
	15.0	4.0	6
	20.0	3.5	6
M. ensis	2.5	*	*
	5.0	*	*
	10.0	*	*
	15.0	*	*
	20.0	*	*
P. monodon	2.5	*	*
	5.0	*	*
	10.0	*	*
	15.0	*	*
	20.0	*	*

*Not observed within 48 hr.

Table 2. Effect of temperature and dissolved oxygen on the survival of *O. mossambicus* and *G. giurus* at different concentrations of teaseed cake (Experiment 2).

Treatment	% Survival[1] Hr 1	2	3	6	1	2	3	6
	O. mossambicus				*G. giurus*			
I – 15 ppm, aerated, high temp	17	17	0	0	50	17	0	0
II – 15 ppm, aerated, low temp	100	0	0	0	67	33	0	0
III – 15 ppm, not aerated, high temp	0	0	0	0	17	17	0	0
IV – 15 ppm, not aerated, low	0	0	0	0	33	33	0	0
V – 2.5 ppm, aerated, high temp	100	100	83	83	83	33	17	17
VI – 2.5 ppm, aerated, low temp	100	100	83	83	83	83	83	50
VII – 2.5 ppm, not aerated, high temp	100	67	33	0	67	33	0	0
VIII – 2.5 ppm, not aerated, low temp	100	100	100	67	67	33	33	17
Analysis of variance					p values[2]			
Concentration	.01	.01	.01	.01	.05	.10	.01	.01
Aeration	.01	.05	NS	.05	NS	NS	.05	.05
Temperature	.01	NS	.05	NS	NS	.10	.01	NS
Concentration x Aeration	.01	NS	NS	.05	NS	NS	.05	.05
Concentration x Temperature	.01	.05	.05	NS	NS	NS	.01	NS
Aeration x Temperature	.01	.05	.05	NS	NS	NS	NS	NS
Concentration x Aeration x Temperature	.01	NS	.05	NS	NS	NS	NS	NS

[1] Values represent the mean of 3 replicates.
[2] Source of variation indicated as significant ($P < 0.10$, $P < 0.05$, $P < 0.01$).

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