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Effects of Feeding Pelleted versus Non-pelleted Defatted Rice Bran on Nile Tilapia *Oreochromis niloticus* Production and Water Quality in Ponds

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Abstract

Effects of pelleted versus non-pelleted defatted rice bran on fish production and water quality were evaluated at the Aquaculture Research Station, University of Arkansas at Pine Bluff. Mixed-sex Nile tilapia (*Oreochromis niloticus*) were stocked at 2.3/m-2 into each of six 0.04-ha earthen ponds. Largemouth bass (*Micropterus salmoides*) were added at 0.17/m-2 for population control. Defatted rice bran was fed to fish at 2% body weight daily. After 169 days, tilapia harvests averaged 2,924 kg/ha in pellet-fed and 3,031 kg/ha in loose bran-fed treatments (a non-significant difference). Stocked fish comprised an average of 52% and 39%, respectively, in these treatments, and approached a significant difference (P=0.2). Average amounts of inorganic fertilizer required to maintain chloro-phyll *a* levels of 100-150 mg/m-3 were significantly different at 736 and 1,108 kg/ha in pelleted and loose bran treatments, respectively.

Introduction

Agricultural by-products are a major source of supplemental feeds in regions without commercially prepared feeds and for limited-resource farmers. In tropical regions, especially Southeast Asia, rice bran is one of the most common by-products for fish culture (Jhingran and Pullin 1985). The estimated production of rice bran worldwide is 27.3 million metric tons (mmt), of which 24.9 mmt is produced in Asia (Prakash 1996). Rice bran oil can be extracted from full-fat rice bran at a cost comparable to peanut oil. Rice bran oil is considered to be superior to peanut oil by Japanese consumers (Young *et al.* 1994). The resulting defatted rice bran is higher in protein and carbohydrate, and lower in fat and fiber than full-fat rice bran. In addition, the lower oil content improves storage properties.

It is hypothesized that utilization of rice bran by fish is affected by the form of the bran given. Unconsolidated, "loose" rice bran is a fine dust, and is susceptible to rapid dispersal by wind and in water (Jayaram and Shetty 1981). It is proposed that a pelleted form of rice bran would reduce loss and be primarily consumed by larger fish, leading to greater production in that segment of the population. Small fish are the major undesirable aspect of mixed-sex tilapia culture. Pelleted feeds of rice bran and other by-products have been evaluated in tilapia culture as a desirable culture practice (Thomforde 1987; Nitithamyong *et al.* 1991a,b). The effects of pelleted versus loose rice bran on production of mixed-sex tilapia and water quality in earthen ponds is investigated in this study.

Materials and Methods

The study was conducted at the Aquaculture Research Station, University of Arkansas at Pine Bluff (UAPB). Mixed-sex Nile tilapia with an average individual weight of 9.8 g were stocked at 2.3/m-2 or 23,000/ha on 20 April 1994 into each of six 0.04-ha earthen ponds. Water hardness and alkalinity was 130 mg/l and the soil was a fine clay. Largemouth bass were obtained from a local hatchery as young-of-the year fingerlings (3.8 cm TL, 4.5 g) and stocked into all earthen ponds on 3 June 1994 at 0.17/m-2 or 1500/ha after Wurts *et al.* 1993 for population control of the tilapia (Swingle 1960; Shafland and Pestrak 1982; Nitithamyong 1991b; Tave *et al.* 1991).

Defatted rice bran was fed as a supplement to natural productivity at 2% body weight of stocked tilapia daily, divided into a morning and afternoon feeding. Stocked tilapia were sampled from each pond and weighed every two weeks to adjust feeding rates. Tilapia in three ponds were fed unconsolidated rice bran and fish in three ponds were fed pelleted rice bran. Initially, the pellets were crumbled due to the small fish size. Unconsolidated and pelleted defatted rice brans were supplied by Riceland Foods Inc. and were the same as their commercial products. Proximate analyses are presented in Table 1. Pellets were 0.5 cm in diameter and 2-4 cm in length. Ponds were drained and all fish were harvested on 6-7 October 1994 or after 169 days. Survival of stocked fish was estimated by counting and sexing all large fish.

All ponds were fertilized using inorganic fertilizers as needed to maintain a secchi disk level of 20 cm. Each addition was 0.45 kg of liquid fertilizer (11-37-0) and 1.5 kg of urea (45-0-0). Later, due to clay-turbidity interferences in secchi readings, additions of fertilizer were made to maintain minimum chlorophyll a levels of 100-150 mg/m-3. To insure survival of bass, ponds were mechanically aerated when morning dissolved oxygen levels were below 3 mg/l or afternoon levels were below 5 mg/l.

Water quality measurements were conducted daily and weekly. Daily measurements were taken at daybreak (0600 h) and late afternoon (1600-1700 h) and included water temperature and dissolved oxygen level in each pond. Weekly measurements were taken at 0800-0900 h and included secchi disk, chlorophyll a corrected for pheophytin a, pH, nitrite, and total ammonia.

Paired treatment means were compared using Student's t test. Significance was established at the $P \leq 0.05$ level.

Results

Gross and net yields were 2924.5 kg/ha and 2697.2 kg/ha, respectively, in pellet-fed ponds, and 3030.7 kg/ha and 2803.4 kg/ha, respectively, in loose defatted rice bran-fed ponds (Table 2). Differences between treatments were not significant. Stocked fish comprised an average of 52% of harvest weight in pellet-fed treatments and 39% in loose-fed treatments ($P=0.2$). Stocked males at harvest averaged 148.6 g and females 52.2 g, with an average survival estimated at 48% in pellet-fed ponds. In the loose treatment, stocked males averaged 133.8 g and females 46.1 g, with an estimated average survival of 50%. Survivals were low due to abundant snake and bird predators, possible stunting of some stocked fish resulting in their being lumped into a reproduction category, and possible consumption by the largemouth bass which grew to a larger size than the stocked tilapia. The harvested reproduction, which was graded into 40 g, 17 g, and 3 g groups by mechanical graders, comprised an average 31%, 16% and 1% by weight, respectively, in pellet-fed ponds. In loose-fed ponds, these groups comprised 40.5%, 20% and 1%, respectively (Table 2).

Bass yields were not significantly different (Table 2). Average net yields and survivals were 154.1±35.8 kg/ha and 39% in loose-fed ponds, and 131.6± 51.5 kg/ha and 38.6% in pellet-fed ponds. Average sizes were 236.5 g and 198.0 g, respectively. On an annual basis, the bass yield was 454 and 387 kg/ha, respectively. Addition of the bass production to that of tilapia resulted in 2828.8 kg/ha from pelleted, defatted rice bran and 2957.5 kg/ha from loose, defatted

Table 1. Proximate composition of defatted rice bran. Analyses performed by Riceland Foods, Inc., Suttgart, AR.

Component	%
Moisture	12.85
Fat	2.25
Protein	18.00
Crude Fiber	8.06
Ash	13.07
Nitrogen Free Extract	46.48
TDN (total digestible N)	62.24
Carbohydrates	54.54
Phosphorus	0.890
Calcium	0.920
Sodium	0.09
Potassium	0.360
Iron	0.006
Choline	0.081
Pantothenic Acid	0.005
Inositol	0.002
Vitamin B1	0.0012
Vitamin B6	0.0039
Biotin	0.46 ppm
Vitamin B2	4.85 ppm

Table 2. Mean fish harvests and water quality in ponds containing Nile tilapia fed pelleted and loose defatted rice bran for 169 d.

Parameter	Pellet	Loose
Gross Yields (kg)		
Stocked Nile tilapia	60.42±12.66	46.96±2.88
40g tilapia reproduction	36.40±5.78	50.55±16.19
16g tilapia reproduction	21.54±23.60	24.23±2.78
3g tilapia reproduction	0.82±0.49	0.63±0.52
Total tilapia	119.18±23.58	122.38±15.71
Stocked largemouth bass	5.47±2.08	6.45±1.45
Water Quality		
[a]Chlorophyll *a* (ug/l)	114.9±27.3	87.5±7.4
Morning D.O. (mg/l)		
May	6.4±0.6	5.9±0.7
June	3.8±0.5	3.5±0.4
July	3.3±0.6	3.0±0.1
August	3.8±0.8	3.4±0.4
September	4.5±1.1	4.4±1.1
TAN (mg/l)	0.90±0.47	1.28±0.48
Nitrite-N (mg/l)	0.06±0.02	0.13±0.03

[a]corrected for pheophytin *a*

rice bran. On an annual basis, these yields would be 6110 kg/ha and 6388 kg/ha, respectively.

Maximum feeding rate was 46 kg/ha^{-1}/d^{-1}. Tilapia were observed at the surface consuming floating unconsolidated rice bran particles, but were not observed at the surface when fed the sinking pellets. Bass were not observed feeding on rice bran. The 2% rice bran rate is estimated to have produced an additional 1500 kg/ha tilapia production, based on our unpublished data of production from fertilization-only. This would equate to a food conversion ratio (FCR) of 1.51±0.03 for loose bran and 1.72±0.19 for pelleted bran, a nonsignificant difference.

Chlorophyll *a* averaged 114.9 ug/l in the pellet treatment and 87.5 ug/l in the loose rice bran treatment (Table 2). The difference approached significance (P=0.2). Fertilizer applications required an average of 15.3 and 23.0 times, equivalent to a total of 736 and 1108 kg/ha, in pellet and loose treatments, respectively. This was a significant difference.

Water quality was within acceptable limits for tilapia and bass, and no mortalities and good growth were observed during growout. Total ammonia and nitrite did not significantly differ, although means in the pellet treatment were lower than those in the loose treatment (Table 2) and nitrite differences approached significance (P=0.1). Dissolved oxygen levels were higher, but not significantly so, in the pelleted treatment during all months in morning readings and in five of six months for the afternoon readings. Instances of emergency aeration totalled an average of 45 in the pelleted treatment and 55 in the loose bran treatment, but were only significantly less during the month of June in the morning.

Discussion

Significantly less fertilizer (66%) was required to maintain minimum levels of chlorophyll *a* in ponds receiving pellets. This was attributed primarily to the higher clay turbidity observed in the loose-fed ponds. Higher turbidity is presumed to have resulted from tilapia seeking small rice bran particles in the sediment. Rice bran added as an organic fertilizer has also resulted in brown coloration ("staining") of water and beneficial shading of filamentous algae (Mims *et al.* 1993). However, no staining was noticed in defatted rice bran at the levels used. If zooplankton biomass was higher from the organic fertilization of loose bran or if tilapia were relying on phytoplankton more in the loose bran than pellet treatment, chlorophyll could also be reduced. Nile tilapia have reduced numbers of phytoplankton in experimental tank trials (Perschbacher and Lorio 1993) and mesocosms (Perschbacher, unpubl. data)

Even with less fertilizer added, mean chlorophyll *a* level was higher in the pellet-fed treatment. The higher primary productivity undoubtedly contributed to the better water quality in pellet-fed ponds, and the reduced requirements for aeration and fertilizer would lead to lower production costs.

The mean yield of stocked fish fed pelleted bran, compared to stocked fish fed loose bran, was higher. This 13% difference, together with the larger harvest size of stocked fish fed pelleted bran, would add to gross income by increasing production of larger (marketable) fish. On an annual basis, this might translate to approximately 600 kg/ha more of this potentially higher value component.

Small tilapia (≤16 g) comprised only 20% of total harvest, and was assumed to be the result of largemouth bass predation. In addition, 200 kg/ha of high-value predator species were produced on an annual basis. The young-of-the year bass grew at a rapid rate and attained a larger size than the stocked tilapia (average 200 g, maximum 430 g). Aggressive predators exhibiting feeding habits similar to largemouth bass are found in most countries and could successfully control reproduction and add income, i.e., cichlids in Ivory Coast (Lazard and Oswald 1995), serranid basses in Israel (Hepher and Pruginin 1981) and snakeheads in Thailand (Nitithamyong *et al.* 1991b).

Based on the FCR of 1.72 for pellets and the December 1997 price of pelleted, defatted rice bran of $0.10/kg, the cost in pellets would be $0.172/kg total fish produced. Pelleting costs were $0.020/kg (S. Brantley, Byproducts Division of Riceland Foods, pers. comm.). A similar conversion rate of 1.67 for a pellet of similar nutritional composition fed at 2-3% body weight to red tilapia (*Oreochromis* spp.) was found by Thomforde (1989). The pellet diet in that study was profitable in the Philippines. Fertilizer costs based on 0.27 kg fertilizer/kg fish produced and at a December 1997 cost of $0.28/kg would add $0.076/kg fish to the pellet treatment. Loose bran costs, based on the FCR of

1.51 and an estimated loose bran cost of $0.08/kg, would be $0.12/kg fish. Fertilizer costs for fish in the loose treatment would add $0.111/kg fish. Thus, feed and fertilizer costs for the pellet and loose bran treatments were similar at $0.248 and $0.231/kg fish, respectively.

In conclusion, pelleted rice bran was easier to apply and was more efficiently stored and transported compared with loose rice bran. With the apparent increase in yield of stocked fish and less need for fertilizer and aeration, the added expense of pelleting the rice bran appears worthwhile.

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