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Production of hatchery-bred early juvenile Milkfish (*Chanos chanos)* in nursery ponds through supplemental feeding

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Abstract. Hatchery-bred early juvenile Milkfish (*Chanos chanos* Forsskål, 1755*)* (average weight of 0.45 g) were stocked in a 500 m^2 nursery pond at a density of 16 juveniles/m^2 during the dry months (March-May). The early juveniles were reared for two months with natural food followed by supplemental feeding. Upon the harvest the fish reached an average weight of 9.30 g and a survival rate of 86.9%. A feed conversion ratio (FCR) of 1.08 was attained, with specific growth rate (SGR) of 4.96%/day. The high survival rate and good production could be attributed to the time of the year when the nursery production trial was conducted. The nursery of milkfish in ponds during the summer months ensures sufficient supply of natural food and stable water quality during the crucial phase in the nursery production. This strategy of rearing early juveniles (< 1g) of milkfish in nursery ponds at high stocking densities using a combination of natural food and supplemental feeding could be one of the alternative approaches in the nursery production of this fish.

Key Words: Milkfish, *Chanos chanos*, nursery ponds, supplemental feeding.

Introduction. The culture of Milkfish (*Chanos chanos* Forsskål, 1775*)* in the Philippines has many variations in terms of practices, systems and intensity of operation. The shift from extensive to intensive systems is characterized by increased stocking density, inputs and provision of life-support systems such as aerators and pumps. Due to this tremendous demand for seed stock, there is increased pressure especially to the small-scale milkfish fry gatherers to supply the growing needs of the culture sector. However, the supply of milkfish fry from the wild is not able to cope with the requirements, hence, seed stock must be produced in the hatcheries. Milkfish is the only species of fish whose fry is produced in large quantities by hatcheries in Southeast Asian countries including Indonesia and the Philippines (Marte 2003). Industry estimates showed that both countries need more than a billion milkfish fry annually to be stocked in ponds and cages (Bagarinao 1998; Patadjai 2001).

Milkfish has a short hatchery period, usually 18-21 days (Marte 2003). The pre-metamorphic larvae are hardy and they can be directly stocked in culture ponds as well as they are not cannibalistic and have high tolerance to salinity changes (Duenas & Young 1984). These characteristics make this fish popular for culture. While the farming operations for milkfish can take place the whole year round, the abundance of wild-caught fry is seasonal. Moreover, hatchery operations also take place at certain times of the year depending on the conditions of the spawners. The problem of ensuring continuous supply of seed stock for milkfish, aquaculture has resulted in the use of nursery systems for milkfish such that the fry are reared to juvenile sizes in ponds then later re-stocked in grow-out ponds where they are reared until harvest.

The stunting of milkfish in nursery ponds particularly at high stocking densities followed by transferring to grow-out ponds has resulted in rapid increment in the growth of the fish. This is brought about by the compensatory growth characteristic of this fish, where sudden increases in growth in terms of length and weight are observed when stunted fish are provided with much bigger culture area and ample food supply. In addition to that, the fish that are stocked in the nursery ponds can be kept year-round; thus, providing continuous and stable supply of juveniles during the culture operations.

Previously, we described a protocol for the nursery production of milkfish in earthen ponds (Jaspe & Caipang 2011). Trials were done both during the dry and the wet months. Hatchery-reared milkfish fry were stocked in ponds at a density of at least 20 pcs/m^2 and reared for over a month using entirely on natural food. Nursery production of the fish resulted in high survival and good growth at the end of the cycle. These juveniles are then used to stock grow-out ponds and cultured until they reached marketable sizes. However, there are other innovations in the nursery production of milkfish. These include supplemental feeding and keeping the fish longer in the nursery ponds in order to attain bigger sizes. Thus, in this study we described another approach in the nursery production of milkfish. Instead of using pre-metamorphic larvae, we used early juveniles of milkfish and reared them at a much bigger size in nursery ponds through a combination of natural food and supplemental feeds.

Materials and Methods

Preparation of nursery pond. One 500m^2 earthen pond was prepared for the nursery production of milkfish following the procedures described by Jaspe & Caipang (2011). Fine-meshed net was installed in the main gate to prevent the milkfish stock from escaping during the nursery phase. A 2-hp water pump was also installed at the water supply canal with pipes connecting the nursery pond. This is to maintain a water depth of at least 70 cm in the nursery pond even during low tide.

Source of fish and stocking. Eight thousand hatchery-bred early juvenile milkfish with body weight of approximately 0.45 g were obtained from a private milkfish nursery pond that is located within the locality.

Stocking of fish was done at 8 AM and the different water quality parameters such as salinity, temperature and dissolved oxygen from the source and the nursery pond were checked prior to stocking.

Feeding management. The early juveniles feed on both benthic and filamentous algae that grew in the nursery pond for three weeks. On the 4th week, when the natural food in the pond was almost depleted, supplemental feed was given at a rate of 5-6% of fish body weight using a commercial milkfish feed (Tateh Phils). The fish were fed thrice daily at 8 AM, 12 NN and 4 PM.

Water management and sampling. The water depth in the nursery pond was maintained at 30 cm during the first month after stocking and 70 cm thereafter until harvest. Water in the nursery pond was changed every spring tide. The water volume was reduced to 50-70% and replenished thereafter by gravity flow. However, during neap tide, water is pumped into the pond with the use of a 2-hp water pump that is located in the main water supply canal. During heavy rains, the uppermost water layer that consisted mainly of freshwater was drained to prevent fluctuation in salinity levels.

Water quality parameters including temperature, dissolved oxygen, salinity, pH and ammonia-N (NH_3-N) were sampled once a week at 8:30 AM. Dissolved oxygen and temperature was measured using YSI model DO meter. Salinity was determined using a Master –AS/M11 refractometer, water pH using pH pen and ammonia was determined using standard procedures (Strickland & Parsons 1972).

Fish sampling. The fish were sampled for growth before stocking and during harvest. The different growth parameters including daily weight gain (DWG), expressed as g/day, specific growth rate (SGR in %/day), survival rate (%) and feed conversion ratio (FCR) were also computed.

Results and Discussion. Early milkfish juveniles (average body weight 0.45 g) were stocked in a nursery pond and reared for 2 months until they reached the late juvenile stage. Table 1 shows the growth and production of milkfish juveniles in a nursery pond over a 2 month culture period. The pond was stocked with milkfish at a stocking density of 16 pcs/m^2. The fish reached an average weight of 9.3 g at harvest with a survival rate of 86.9%. The FCR was 1.08 and this was due to supplemental feeding at 1 month post-stocking. The fish attained a daily weight gain of 0.14 g/day with a specific growth rate of 4.96%/day.

Table 1
Growth and production of milkfish juveniles in a nursery pond with supplemental feeding

Parameter	*Measurement unit*	*Value*
Initial average body weight	g	0.45
Final average body weight	g	9.3
Stocking density (SD)	pcs/m^2	16
Survival rate	%	86.9
Feed conversion ratio (FCR)	-	1.08
Specific growth rate (SGR/day)	%	4.96
Daily weight gain (DWG)	g	0.14
Duration of culture	days	60

Table 2 shows the levels of the different physico-chemical parameters of the water during the nursery production phase. There were no wide fluctuations in the readings for salinity, pH, water temperature and ammonia levels during the production period. There were occasional levels of low dissolved oxygen in the pond, but the levels were still within the tolerable levels for milkfish that are reared in modified extensive systems.

In this study, hatchery-bred early juvenile milkfish were stocked in a nursery pond and reared for two months until they reached the late juvenile stage. During the first month, the fish relied mainly on the natural food that is present in the pond. These were mainly periphyton (benthic organisms) and filamentous algae. When the natural food in pond was depleted, the fish were fed with a commercial feed to ensure faster growth rates. Milkfish are known to exhibit compensatory growth and this was observed in the high SGR (4.96%/day) that was noted in the present study when supplemental feeding was given. Previously, we have also shown that milkfish exhibited such growth pattern when fed solely with natural food throughout the nursery production phase (Jaspe & Caipang 2011). Both systems of rearing milkfish to the juvenile stage ensure continuous supply of stock that is needed for the grow-out culture of this fish.

Table 2
Physico-chemical parameters of the water in the nursery pond during the production run

Parameter	*Sampling*											
	1	2	3	4	5	6	7	8	9	10	11	12
Salinity	29.0	33.0	33.0	30.0	30.0	24.0	26.0	35.0	34.0	37.0	38.0	31.0
pH	8.3	8.5	8.5	8.6	8.5	8.5	8.7	8.4	8.2	8.1	8.1	8.1
Temp	28.2	27.2	26.6	29.1	27.6	28.8	27.6	28.7	26.9	29.5	30.9	3.4
D.O.	8.4	4.2	6.6	4.6	4.6	4.8	3.2	2.3	3.9	4.2	3.4	2.9
NH_3-N	0.04	0.03	0.06	0.06	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03

D.O. - dissolved oxygen

Natural food in the ponds plays an important role during the first two months of culturing milkfish because the stock is heavily dependent on these food organisms (Kühlmann et al

2009). The natural food in milkfish ponds is predominantly composed of greenish algal mats with unicellular organisms and crustaceans (Fortes & Piñosa 2007). Jana et al (2006) showed that the level of natural food especially the density of periphyton in milkfish ponds gradually decrease after the first month. In a high stocking density such as in this study, the natural food is depleted quite fast and if re-fertilization cannot augment the growth of natural food, supplemental feeding is done until harvest.

There was high survival rate of the milkfish juveniles in the nursery pond during the two-month rearing phase. This was comparable to a previous study on the nursery production of this fish fed entirely with natural food (Jaspe & Caipang 2011). The study was done during the dry months (March-May) and during this time natural food production in ponds in terms of quality and quantity is better compared during the wet months (Fortes & Piñosa 2007; Kühlmann et al 2009). In addition, the natural food production during the first month of the nursery production is stable during the dry months in contrast during the wet months when there are erratic changes in salinity levels that could result in the collapse of natural food in the pond (Kado et al 1989).

All physico-chemical parameters that were monitored in the water during nursery production were within the desired levels for milkfish culture. The lowest dissolved oxygen reading during the two-month nursery production was 2.3 ppm, but this was temporary because the levels of dissolved oxygen increase during intense photosynthetic activity at daytime. Milkfish can survive at a dissolved oxygen concentration of 1 ppm (Schroeder 1996), but stop feeding at this level (Chiu et al 1986). However, they can start feeding before sunrise and will continue even after sunset as long as dissolved oxygen in the water is at least 3 ppm (Chiu et al 1986). Dissolved oxygen has a crucial role in the holding capacity of milkfish ponds (Sumagaysay 1998). An earlier study demonstrated that the holding capacity of semi-intensive milkfish ponds that are not aerated should be below 1,348 kg/ha or 54 kg/ha/day at a dissolved oxygen concentration of less than 1 ppm (Sumagaysay-Chavoso & San Diego-McGlone 2003). This limit of holding capacity was not reached in our present study because the milkfish were reared only in the nursery phase. Thus, even if the level of dissolved oxygen in the nursery pond goes below critical levels, these may not adversely affect the survival rate of the stock. The optimum temperature for milkfish culture is 20-43^{o}C (Villaluz & Unggui 1983), and our readings were within this range. Milkfish are able to tolerate hypersaline conditions (Crear 1980). Their tolerance limits are at salinities ranging from 0 to 158 ppt (Crear 1980). The salinity readings that we obtained in the nursery pond were within the tolerance limits of the fish.

We observed that three percent (3%) of the stock were found to have deformities which include folded operculum, deformed dorsal and caudal fins, and the presence of dark brown spots in the scales. These are common problems observed in hatchery-bred milkfish fry (Hilomen-Garcia 1997, 1998), and these are predetermined conditions that take place during the fry stage. These abnormalities were observed to affect growth; for example, upon sampling at one month post-stocking, the average body weight of the normal fish in the population was 4.5 g, while those with abnormalities was only about 0.7 g. Mortality was also evident when the fish were exposed to stress and handling. Fish that have those conditions were segregated from the normal fish during harvest of the late juveniles to ensure that the grow-out ponds or cages stocked with these milkfish are free from these abnormalities. Thus, it results in good survival and high growth rates during the later stages of culture.

Conclusions. In summary, we described an innovative approach in the nursery production of hatchery-bred milkfish in ponds. Using early juveniles (0.45 g average body weight), they were stocked in a pond at a stocking density of 16 pcs/m^2 and reared to the late juvenile stage (9.30 g average weight) for two months through a combination of natural food and supplemental feeding. There was high survival rate and good production, which can be attributed to the favorable conditions (dry months) during the nursery phase. This option of growing milkfish to late juvenile stage in nursery ponds is a viable strategy to maintain a stable year-round supply of fingerlings to be stocked in ponds or cages and with high survival rates until they reach marketable size.

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