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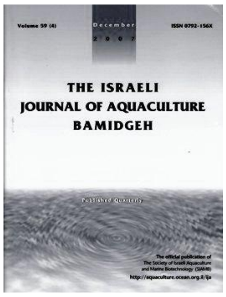

Implementation of Biosecurity Measures in Commercial Shrimp Hatcheries in India

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Abstract

Infectious diseases are a major problem in shrimp aquaculture. Strict biosecurity measures should be implemented to control horizontal and vertical transmission of pathogens. However, implementation of biosecurity measures is neither consistent nor uniform. In this study, we generate baseline information on the variety and degree of adoption of biosecurity measures in shrimp hatcheries in India. Data were collected from 96 hatcheries using a structured questionnaire. Hatcheries were classified as small (<50.6 million seed/annum), medium (50.6-102 million seed/annum), or large (>102 million seed/annum), according to seed production capacity. Biosecurity measures were categorized as personnel, operational, or screening for pathogens in broodfish and live feeds. The highest biosecurity implementation rate of personnel procedures was 50% in small and medium hatcheries and 40% in large hatcheries. The highest implementation rate of operational measures was 63% in small hatcheries, 84% in medium, and 47% in large. The highest rates for screening of pathogens was 50% in small and large hatcheries and 25% in medium. The only measures implemented in all 96 hatcheries were use of foot baths, disinfecting hands after handling brooders/larvae/live feed, and virus screening of broodfish, indicating consistent practice in all hatcheries and an implementation gap of 0%. A lack of understanding, reluctance to implement, and the need for large financial inputs are responsible for the poor implementation of biosecurity measures. The baseline information generated in this study exposes the challenges in implementation of biosecurity in shrimp hatcheries. The collected data can be used to further refine and implement biosecurity practices.

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Introduction

India is one of the largest shrimp-farming countries in Asia, with annual production of 95,919 tons, primarily from the states of Andhra Pradesh and Tamil Nadu (MPEDA, 2010). Infectious diseases are a bottleneck for shrimp aquaculture. Explosive growth of shrimp aquaculture has led to the spread of serious shrimp diseases (Hedrick, 1996; Hill, 2000; Flegel, 2009), leading to worldwide losses of billions of dollars (Lightner, 2003). Asian countries lost US$1 billion in 1994 due to viral diseases (FAO/NACA, 1995).

In response, national and international agencies are formulating and initiating preventive measures to halt the spread of disease in shrimp. Shrimp seed is a primary carrier of pathogens from hatcheries to farms (Lotz, 1997). Therefore, high quality disease-free seed is key to successful shrimp production. Implementation of strict biosecurity measures can control horizontal and vertical transmission of pathogens (Raja, 2011) while poor implementation of biosecurity measures cannot ensure quality seed (Moss et al., 2012). Lack of biosecurity measures is an opening to endemic disease (Rogers and Cogger, 2010).

Biosecurity includes a set of standard scientific measures, adopted to exclude pathogens from culture environments and hosts and, more broadly, limit the establishment and spread of pathogens (Mohan et al., 2003; Moss et al., 2012). Key elements of biosecurity are reliable sources of stocks, adequate detection and diagnostic methods for excludable diseases, disinfection and pathogen-eradication, and practical accepted legislation. Such measures protect seed from transmissible infectious agents and reduce the consequences of infection (Toma et al., 1999). Screening of pathogens is vital to shutter entry routes (Hewitt and Campbell, 2007).

Many shrimp hatcheries in Asia, including about 283 in India, are actively involved in meeting the regional demand for shrimp seed. However, there is no uniformity in implementation of standard operating procedures or biosecurity measures. Specific pathogen-free (SPF) shrimp seed are an important component of biosecurity implementation (Moss et al., 2012). Some Asian countries produce SPF Pacific white shrimp, *Litopenaeus vannamei*, and this species was brought to India by the Indian government in 2008, but production of SPF *P. monodon* seed is still experimental (Howel et al., 2012). In this study, information was gathered on the degree of biosecurity implementation in shrimp hatcheries. Such information could be useful to government and non-governmental agencies in making policies for sustainable shrimp production.

Materials and Methods

Selection of shrimp hatcheries. Using a proportionate random sampling procedure, 96 hatcheries (54 in Andhra Pradesh and 42 in Tamil Nadu) were selected from 283 Indian shrimp hatcheries with a combined annual production of 12 billion seed (MPDEA, 2006; FAO, 2007). Details of the selected hatcheries, including names and addresses, were obtained from the office of the All India Shrimp Hatcheries Association (AISHA) in Chennai, Tamilnadu, India, and a comprehensive survey was conducted to collect data regarding biosecurity measures. The measures were categorized into three types: (a) personnel, i.e., measures that are directly and only related to people (workers and outsiders), (b) operational, i.e., measures that are influenced by the operational procedures of the hatchery, and (c) screening of brooders and live foods for viral pathogens. Each procedure has significance in terms of human effort and financial input but all procedures are important to keep a system secure from pathogens.

Questionnaire and data collection. A questionnaire was designed in two stages. Initially, a model questionnaire for a pilot study involved about 10 hatcheries. Based on responses to this questionnaire and discussions with hatchery operators, the questionnaire was improved and expanded to contain 40 items on 5 printed pages. Most of the questions were semi-closed. Questions were presented in three languages: Tamil, Telugu, and English. The questionnaires were identical and checked for consistency by bilingual researchers. The questionnaires included a demographic profile of the hatchery operators, seed production capacity, and detailed biosecurity measures. Data collection began in November 2007 and continued to the end of March 2009. Data were compiled on the questionnaire during face-to-face interviews between the first author of this paper and hatchery operators.

Data analysis. Hatcheries were classified according to production capacity into three categories: small (0-50 million seed/annum), medium (51-102 million seed/annum), and large (>102 million seed/annum). Data were processed by size of hatchery and biosecurity measure. Information from questionnaires was coded and entered into a database (MS Access, 2003, Microsoft Cooperation, Redmond WA, USA) by double entry to enhance accuracy. Data were exported for analysis in MS Excel 2003 (Microsoft Corporation, Redmond WA, USA). A score of 1 or 0 was assigned to adopted and non-adopted measures, respectively. Implementation was measured by: (a) rate of implementation = A/R × 100 and (b) implementation gap = 100(R - A/R), where R= recommended and A = adopted measure (Kumaran et al., 2003; Haque, 2007).

Results

Of the 96 hatcheries, 56, 35, and 5 were identified as small, medium, and large, respectively. Ten personnel biosecurity measures, 19 operational measures, and four procedures for screening for pathogens were surveyed (Table 1). Implementation rates

Table 1. Biosecurity measures: implementation frequency and gaps in 96 Indian shrimp hatcheries.

Measure		*Frequency*	*Gap (%)*
Personnel			
1	Use of disinfected clothing and boots	0	100
2	Hygienic handling of wild broodstock by fishermen	0	100
3	Use of gloves for handling brooders	1	99
4	Restriction of seafood consumption on premises	1	99
5	Dressing room and shower near main entrance	11	89
6	Disinfection of hands before handling brooders/larvae/live feed	15	84
7	Specific place for dining	21	78
8	Prohibition of smoking	62	35
9	Use of foot bath	96	0
10	Disinfection of hands after handling broodstock/ larvae/live feed	96	0
Operational			
1	Individual water supply for different sections of the hatchery	0	100
2	Incineration of dead shrimp	0	100
3	Control of pests	1	99
4	Treatment of discharged water	1	99
5	Restriction of pet animals on hatchery premises	1	99
6	Recirculatory system	8	92
7	Wheel bath at entry points	10	90
8	Isolation of quarantine facility	17	82
9	Exclusive personnel for each section	18	81
10	Disinfection of litter equipment	18	81
11	Restricted movement of outsiders	42	56
12	Isolated vehicle parking and record keeping*	49	49
13	Separate place for live feed storage	61	36
14	Hygienic way to collect dead shrimp	65	32
15	Separate equipment for each section	68	29
16	Disinfection of water and air filtration system	73	24
17	Disinfection of tanks	90	6
18	Use of pressure washer for cleaning	93	3
19	Periodic removal of molted shells	94	2
Screening for pathogens			
1	Use of specific pathogen-free brooders	0	100
2	Bacterial screening of brooders	0	100
3	Screening of live feeds	4	96
4	Virus screening of brooders	96	0

* Vehicles should be parked away from the shrimp hatchery and details such as vehicle registration number, address of owner, purpose of visit, entry and exit times should be recorded.

for hatcheries according to size are presented in Table 2. There was little variation in implementation rates between hatchery size groups, but average implementation of personnel (33%), operational (39%), and screening for pathogens (27%) measures distinctly varied (Fig. 1).

Table 2. Frequency (F) and rate of adoption (RA) of biosecurity measures in relation to hatchery size (% within size group).

Small (n = 56)						*Medium (n = 35)*						*Large (n = 5)*					
Personnel		*Operational*		*Screening for pathogens*		*Personnel*		*Operational*		*Screening for pathogens*		*Personnel*		*Operational*		*Screening for pathogens*	
F	RA	F	RA	F	RA	F	RA	F	RA	F	RA	F	RA	F	RA	F	RA
3	50	2	63	3	50	4	50	1	84	35	25	2	40	2	47	1	50
9	40	7	58	53	25	13	40	2	63			3	30	2	37	4	25
24	30	6	53			15	30	3	47					1	26		
20	20	5	47			3	20	8	42								
		2	42					11	37								
		14	37					5	32								
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		3	26					3	21								
		3	21														
		3	16														
		2	5														

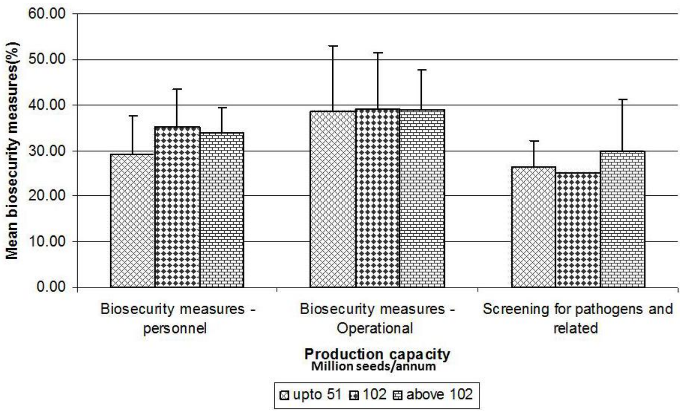

Fig. 1. Average rates of implementation of biosecurity measures according to capacity of hatchery.

Discussion

For six of the ten personnel measures, the implementation gap was over 80%. The wearing of disinfected clothing and boots by visitors and employees can prevent the horizontal transmission of infection vectors (FAO, 2007). However, the implementation gap of this measure was 100%, indicating that this measure is never used by hatchery managements. The implementation gap for use of foot bath and disinfection of hands after handling of brooders/larvae/live feed was 0%, indicating that these are consistent practices in all hatcheries. Disinfected protective clothing and boots, and the use of footbaths and hand sanitation, are effective personnel biosecurity measures that considerably reduce the transmission of pathogens (Pollard et al., 2008). The frequency of hand washing can influence the entry of pathogens in poultry facilities (Christensen et al., 1994). In the present study, the implementation gap was 84% for disinfection of hands before handling brooders/larvae/live feed, showing a lack of awareness among hatchery operators about the dispersal of microbes.

Of the 19 operational measures, 10 had an immplementation gap exceeding 80%. Some measures, such as individual water supply for different sections of the hatchery and incineration of dead shrimps, were not adopted in any hatchery, with a gap of 100%. Others, such as periodic removal of molted shells, use of a pressure washer for cleaning, and disinfecting tanks were fairly well adopted, showing low implementation gaps, 2%, 3%, and 6%, respectively. Dead shrimp tissues can harbor pathogens and act as sources of pathogens for healthy animals since aquatic animals normally eat dead tissues of their own species (Delabbio et al., 2004). Removing dead tissue from the environment reduces the pathogen load in the water, reducing the risk of spreading pathogens. Periodic removal of molted shells and dead animals from the maturation and rearing system was the most unanimously used biosecurity measure.

The presence of pet animals inside a hatchery can be a mechanism for rapid dissemination of infection (Guthrie et al., 1999). Pests are a major cause of biosecurity problems in cattle and poultry because they can introduce pathogens into systems (Stewart, 1987; DEFRA, 2002). These two factors can be high-risk in shrimp hatcheries because pet dogs and pests such as rats and birds may capture and feed on the shrimp or other aquatic animals, potentially carrying shrimp pathogens. However, our results indicate high implementation gaps (99%) for restriction of pet animals inside hatcheries and pest control.

Visits of outsiders to the hatchery is a biosecurity risk (FAO, 2007). In our study, the implementation gap of restricted movement of outsiders was 56%. Complete (100%) restriction of outsiders is impractical because shrimp farmers often travel from one hatchery to another in quest of the best seed. Thus, close monitoring of site visits is necessary when farmers visit a hatchery to check seed quality. In addition to restricting the movement of visitors, hatchery managements should be very careful to implement hygienic measures; the implementation gap for wheel bath at entry is 90%, i.e., a majority of hatchery operators ignore the disinfecting of vehicle wheels at the point of entry.

Viral pathogens can be vertically transmitted from mother shrimp to larvae through ovarian tissue. Pathogens in postlarvae and broodstock can be eliminated by depopulating, disinfecting, and restocking affected tanks with SPF shrimp (Lightner, 2003). However, it may be necessary to depopulate the entire stock and fallow the entire facility if partial disinfection (lime, chlorine, or drying) is unsuccessful. For this reason, screening for pathogens is essential to avoid transmission of pathogens from parent shrimps to larvae (Hewitt and Campbell, 2007). We divided this measure into four submeasures. Screening of brood parents for virus is widely adopted and the implementation gap was 0%. Use of SPF brooders to produce disease-free seed is recent (Lightner, 2005; Moss et al., 2012), and nowhere practiced in the hatcheries included in this study because SPF *P. monodon* have not yet been achieved. Further, because of practical difficulties, none of the hatcheries showed interest in adopting bacterial screening in their biosecurity protocol (implementation gap = 100%).

Results of the current survey show that, although biosecurity is a fairly recent concept in Indian shrimp aquaculture, a strong willingness for biosecurity measures exists in some hatcheries and measures are slowly being adopted among hatchery operators. However, a lack of thorough understanding of biosecurity, a reluctance to implement, and the need for huge financial inputs may be responsible for their poor adoption. We hope this study will give policy makers and others baseline data on this emerging and essential area that has the potential to combat rapidly-spreading viral diseases in the shrimp industry.

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