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Evaluating biosecurity policy implementation in microalgae culture premises of different shrimp hatchery in Cox's Bazar, Bangladesh: Using the quantitative knowledge, attitude, and practices (KAP) survey technique

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Abstract
The study evaluated the present scenario and effectiveness of the prevailing systems of biosecurity policy in microalgae culture premises of different shrimp hatchery in Cox's Bazar, Bangladesh. The knowledge, attitude and practice (KAP) survey tool was used to assess the effectiveness of the biosecurity measures adopted by different stakeholders with the participation of 65 individual technicians' from 27 different shrimp hatcheries. The KAP result indicates significant attitudes and practices gap among the technicians'. But the knowledge and attitudes scores were good (78.1% & 76.4%) where the practice scores were fair 63.5%. The survey data highlighted that the previous experience, educational level etc. have direct effect on KAP scores. However, there is no standardized systems are implementing in case of microalgae culture in hatchery premises. Through identifying some forthwith gaps, this work will help to identify all common problems and taking proper mitigation measures.

Keywords: KAP survey, biosecurity, microalgae culture, shrimp hatchery, Bangladesh

1. Introduction
Over the past decades shrimp production patterns have shown tremendous changes in context of Bangladesh. The production is expanding, and the reliance to hatchery industry for post larvae (PL) is growing day by day. Microalgae, an important food source and feed additive in the commercial rearing of penaeid shrimp larvae. The importance of this live food source is not surprising at all in context of the aquaculture industry (Islam *et al*., 2022) [10]. Shrimp hatcheries production is impossible without the usage of microalgae. Hygienic production and use of microalgae is important to get healthy PL production. For that biosecurity measures in shrimp hatchery and microalgae production unit is crucial.
The use of the biosecurity concept in shrimp hatcheries microalgae farming has become important in the control of a variety of diseases that could have a negative impact on farm productivity and output. The concept of biosecurity can also assist the industry by increasing the health and quality of grown animals or plants (Rodgers *et al*., 2019; Campbell *et al*., 2020) [16, 4]. Introducing the biosecurity idea at this level, along with a proper surveillance and traceability system, could improve product acceptability in both domestic and international trade (FAO, 2020) [9]. The biosecurity idea has been widely recognized as a vital practice in the aquatic animal culture system (Bondad-Reantaso *et al*., 2021) [3]. Importantly, Bangladesh has been practicing biosecurity and traceability in the shrimp industry for over a year.
Since 1970s, the *Penaeus monodon* (Giant tiger shrimp/Black tiger shrimp) has been popularized and favored globally. Bangladesh is currently a substantial contributor to aquaculture production for both domestic and worldwide markets with *Penaeus monodon* as a key contributor. Bangladesh gained nearly 348 million US dollars from shrimp exports in the 2019-20 fiscal year (Hossan, 2021) [14].

The major markets for shrimp exports are the United States of America (USA), Japan, the European Union (EU), and Canada (DoF, 2016) [7]. Microalgae have long been used in shrimp hatcheries. Environmental and food safety issues have arisen as a result of the industry's rapid growth and increasing demand. This concern has led many customers to ask for product guarantee. In addition, good product certification from hatcheries also ensures product safety for aquaculture. All this concern has influenced the demand of certification of biosecurity (Srisopaporn *et al*., 2015) [18].

Analysis of the status of biosecurity measures requires some quantitative approach. The TPB (theory of planned behavior) has been widely applied in social science, including food handlers' food safety knowledge, attitude, and practices (KAP) (Rezaei *et al*., 2018) [15]. This provides a generalized and systematic information's by defining relations among variables. There is currently no information available on the biosecurity measures at microalgae cultivation premises in a shrimp hatchery in aspects of Bangladesh.

Understanding how biosecurity policies are communicated to farmers, how biosecurity measures are implemented at the farm level, and how policies meant to enhance farmers' behavior and awareness are affected is important (Emerenciano *et al*., 2022) [8]. In Bangladesh, most of the technicians' have followed biosecurity measures in microalgae culture unit of a shrimp hatchery. Still there is contamination and diseases occurrence in microalgae culture unit has been observed. The KAP survey method was approached to evaluate the current effectiveness of biosecurity measures in microalgae culture premises of different shrimp hatchery of Bangladesh. This method has previously been used to measure the situation of medical (Al-Maskari *et al*., 2013) [1] to aquaculture (Jia *et al*., 2017) [11]. This study will identify the current situation, practice pattern and knowledge gaps of the technicians' in microalgae culture practice.

In Bangladesh, the main government agency responsible for aquaculture standards is Department of Fisheries (DoF) under the Ministry of Fisheries and Livestock (MoFL). Shrimp production systems and products are certified in accordance with EU guidelines to support the DoF policy of enhancing aquaculture capabilities. There is still pollution and disease occurrence in the microalgae culture unit. The lack of technicians' knowledge and awareness towards adoption in hatchery premises during microalgae cultivation could be one reason. None of the investigation has yet been conducted regarding Knowledge, Attitude and Practices of the technicians' in microalgae culture premises of shrimp hatchery. This research thus aims to investigate the technicians' perceptions on the maintenance of proper biosecurity measures in microalgae culture premises of shrimp hatchery. Findings of the research will help to find out the reasons of different contamination encountered during microalgae mass culture at hatchery premises. It will also help the policy makers to execute different policy on basis of the prevailing problems.

2. Materials and Methods

2.1 Sampling site

The survey was conducted at different shrimp hatchery of Cox's Bazar, Bangladesh. A total 65 individual technicians' were interviewed from 27 different shrimp hatcheries (Figure 1). All the respondents were selected from the hatchery workers who are directly involved with microalgae culture in hatchery operation. The survey was performed from February 2022 to April 2022.

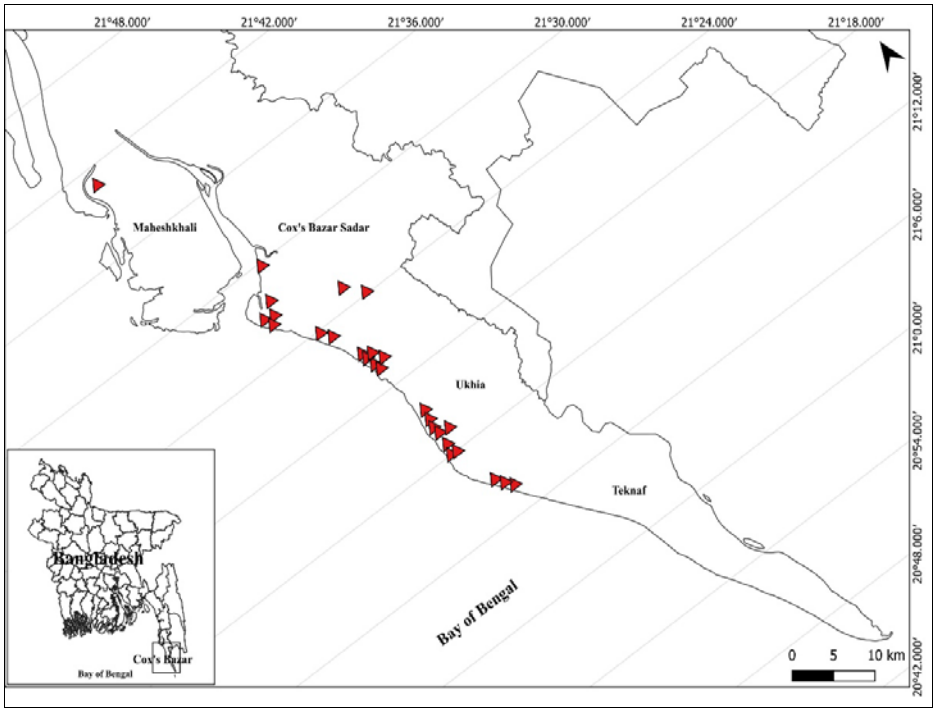

Fig 1: Sampling sites (KAP surveyed area)

2.2 Questionnaire design

The questionnaire was originally written in English and then translated into Bangla (The local language) for ease of comprehension by the interviewers. A set of general questions were initially asked to cover the demographic information of the respondents including some basic question about the microalgae culture in hatchery. The knowledge, attitude, and practices (KAP) questions were modified from the survey questionnaire by Jia *et al*. (2017) [11] and Kambey *et al*. (2021) [13]. The second and third part of the questionnaire was

designed with KAP and biosecurity questions respectively. Questions with similar patterns were distributed randomly to avoid biasness of the respondents.

In knowledge section, the questions were designed to know the basic idea about micro algal contamination and its reason in hatchery's algae culture premises. Each response was given a binary score of 1 for correct and 0 for incorrect and unsure answers (Andrade *et al*., 2020) [2]. The questions in the attitude part were arranged to learn about external or internal biosecurity systems and their control processes. The responses score were ranked as 5 for very useful, 3 for useful, 1 for not useful and 0 for unknown/ not sure. The questions in the practice part focused on the behaviors and management that had been practiced to address various compliances. The responses were graded as follows: 0 for yes/frequently, 1 for not always, rare, and 2 for never/not sure (Jia *et al*., 2017) [11].

2.3 Research design

The methodology was designed to achieve the research primary goal. The survey data was used to assess the database of the respondents using a quantitative technique. Simultaneously, the technical information was collected to evaluate and measure the knowledge, attitude and practice status in the survey. This study was mainly designed to determine the present status of biosecurity implementation policy in microalgae culture premises of different shrimp hatchery.

2.4 Data collection and entry

The questionnaire and its language were first validated by conducting some random interview. When it found okay, the formal interviews were conducted. The majority of the data were collected from different two training sessions on microalgae in Cox's Bazar, Bangladesh with the participations of different shrimp hatchery technicians'. Some data was collected through direct visit in various shrimp hatchery of Cox's Bazar, Bangladesh. The confidentiality and purpose of the survey were clearly explained to the respondents before taking their interview. The asking pattern was arranged according to Swann *et al*. (1982) [19] to avoid respondents' biasness. The original data was entered into Microsoft Excel (2016) with each respondent's unique identifier. All of the no-answer data was left blank.

2.5 KAP index: The technicians' KAP scores were based on each component question, and categories. The demographic information of the technicians' summarized proportionally.

$$\text{Score for each question} = \frac{\text{Sum of the respondents score}}{\text{Total number of respondents}}$$

$$\text{KAP index} = \frac{\text{Average score of respondents}}{\text{highest score of the correct answers}} \times 100$$

2.6 Statistical analysis

All the data were analyzed statistically using Microsoft Excel (2016) and IBM SPSS (V. 26.0) software.

3. Results

3.1 Demographic status: The demographic information of the respondents is summarized in Table 1. The majority (85%) of the respondents were aged between 25 to 50 years where 15% of the respondents were found aged under 25 years. Males were found to be the majority (100%) of those who responded. The majority of the respondents were educated up to higher secondary level (40%). In addition, 30% of the respondents had bachelor degree and 10% had master's degree. Approximately half of the population (45%) had more than ten years of experience, while the remaining 55% had one to ten years of experience regarding microalgae. About 52.5% of the respondents had no training on microalgae. Majority of the respondents (77.5%) are aware about the species they cultured where 72.5% used microalgae as an only feed source. Outdoor mass culture is the only technique they followed for culturing their species where 52.5% had experienced with early harvest due to the disturbance of weather. To mitigate various emerging problems 57.5% totally had changed the culture where the rest 42.5% followed water treatment protocol (37.5%) and white polythene sheet covered protocol (5%).

Table 1: Demographic information of the respondents

No.	Variables		Response (%)
1	**Age**		
		< 25	15
		25-50	85
		> 50	0
2	**Gender**		
		Male	100
		Female	0
3	**Education**		
		Primary	0
		Secondary	20
		Higher secondary	40
		Bachelor	30
		Masters	10
4	**Experience in microalgae culture**		
		< 1 year	0
		1-10 year	55
		> 10 year	45
5	Training on microalgae		47.5
	Microalgae as only feed source		
		Yes	72.5
		No	
6	**Know the species**		
		Yes	77.5
		No	22.5
7	Culture techniques followed		
		Outdoor mass culture	100
		Others (mentioned)	0
8	**Early harvest**		
		yes	52.5
		no	47.5
9	**Weather disturbance**		
		Yes	100
		No	0
10	**Mitigation measures**		
		Change the culture	57.5
		Treatment of water	37.5
		Cover with white polythene	5

3.2 Knowledge, Attitude and Practice (KAP) evaluation

3.2.1 Knowledge: In aspects of knowledge on various diseases/problems, majority of the technicians' were found acquainted with all mentioned common problems (Figure 2). Most of the technicians' were aware of bacterial contamination and protozoan attack. They also agreed that the presence of these problems as biosecurity risk at their hatchery with an average score 0.775 in both the cases. In addition, deteriorate water quality (0.525) and sudden rain (0.375) also causes various problems and ultimately created culture lose. Moreover, majorities are not aware about the reasons of culture contamination or lose.

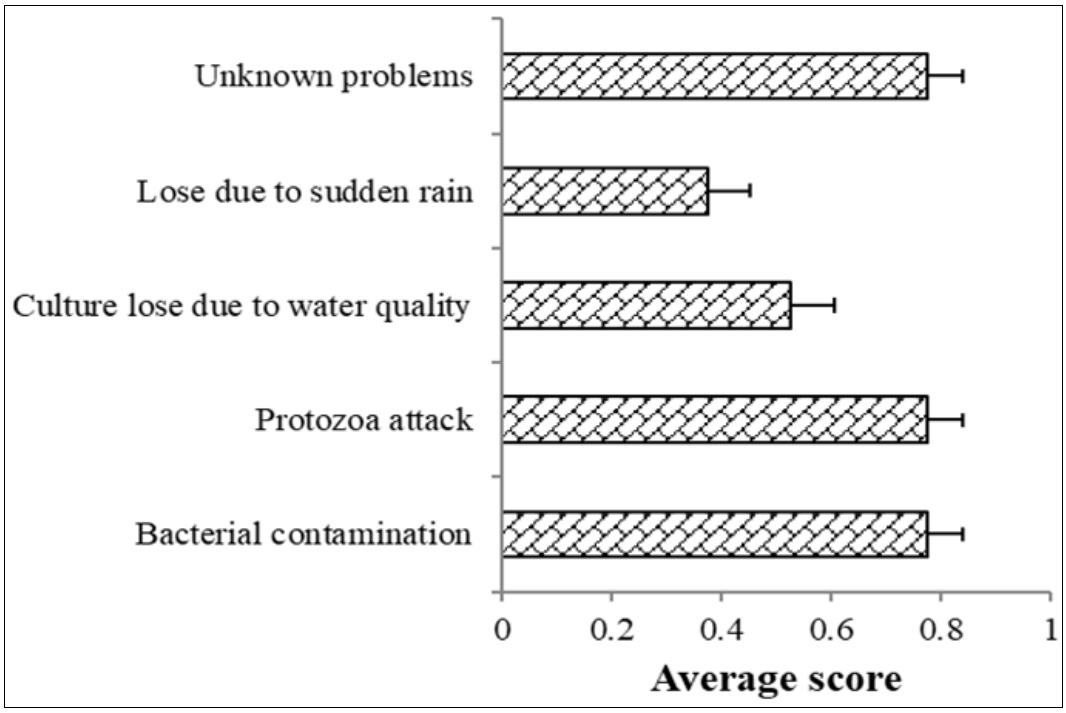

Fig 2: Biosecurity knowledge score on various diseases/problems in each given answer

In aspects of the knowledge on reason for introduction or spread of emerging disease (Figure 3), more than 70-80% technicians' were pointed out that the weather and environmental changes, use of contaminated stock and share of contaminated place were the main reason for spread of emerging diseases with an average score of 0.775, 0.7 and 0.7 respectively.

In addition, no separate area for culture, no idea about the algae stock and shared equipment with other hatcheries also reported as important causes for the introduction of various diseases with an average score of 0.625, 0.6 and 0.525. In contrast, longtime use of the same equipment also causes introduction but less considered by the technician' with an average score of 0.45.

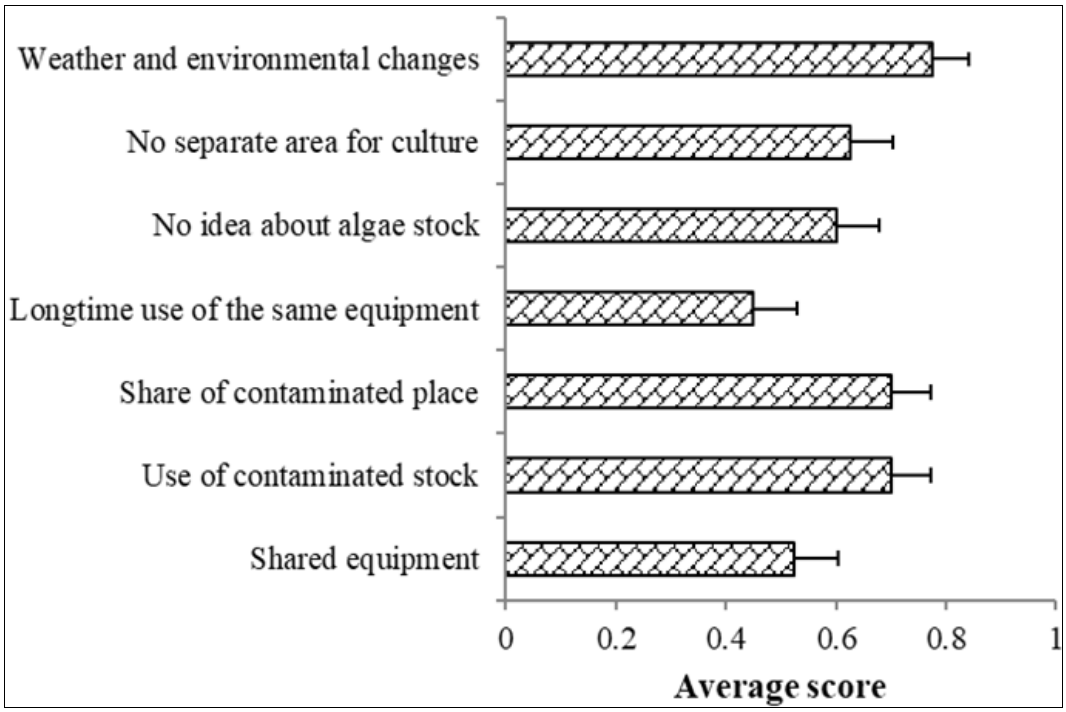

Fig 3: Biosecurity knowledge score on reason for introduction or spread of emerging disease in each given answer

3.2.2 Attitude

In aspects of attitude towards general management practices to maintain biosecurity, all the factors (early detection of diseases, prevention of contamination through biosecurity measures, disinfectant of hatchery equipment, stock management) were pointed as useful to very useful by the technicians' with an average score of 4.325 to 4.85 (Figure 4). However, early detection of contamination and disinfectant of the hatchery equipment were selected as the most important factors by the technicians'.

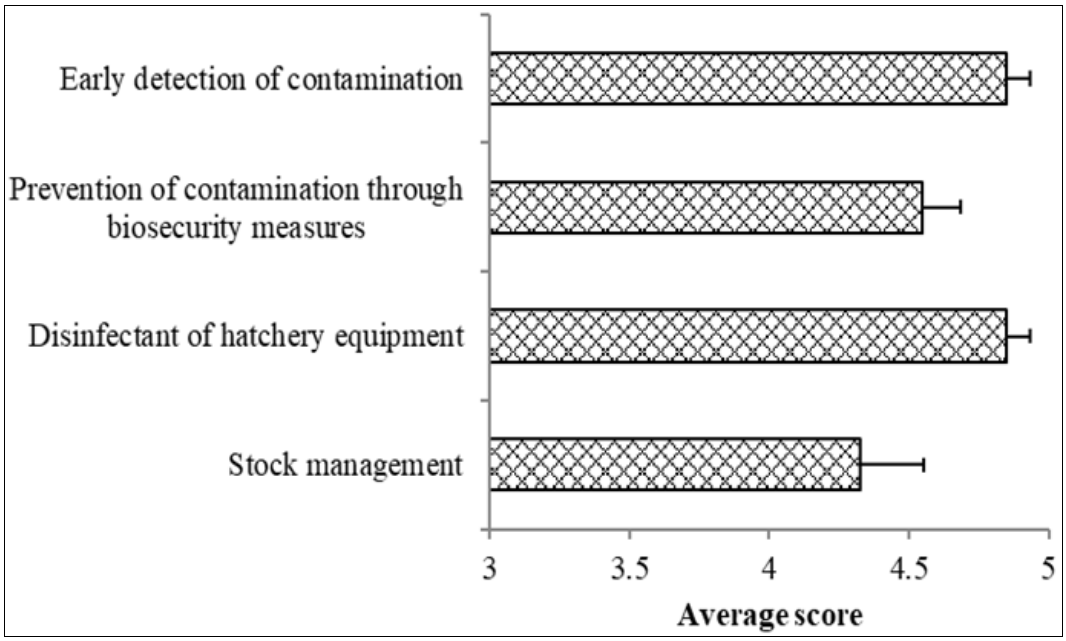

Fig 4: Biosecurity attitude score on general management practices in each given answer

In aspects of the attitude towards routine management, periodical cleaning and checking, not sharing equipment, removing contaminated stock etc. were pointed as very useful or useful by the technicians' (Figure 5). In additions, "remove the affected stock from the hatchery, remove the death cell from stock, learn to improve hatchery practices, check the stock health/growth regularly, changing hatchery management through experience, periodically clean and maintenance equipment" etc. were reported as very useful by the technicians' with an average score of 5. The lowest score in this category were monitored in case of isolation of new stock and monitor the changes with an average score of 3.15.

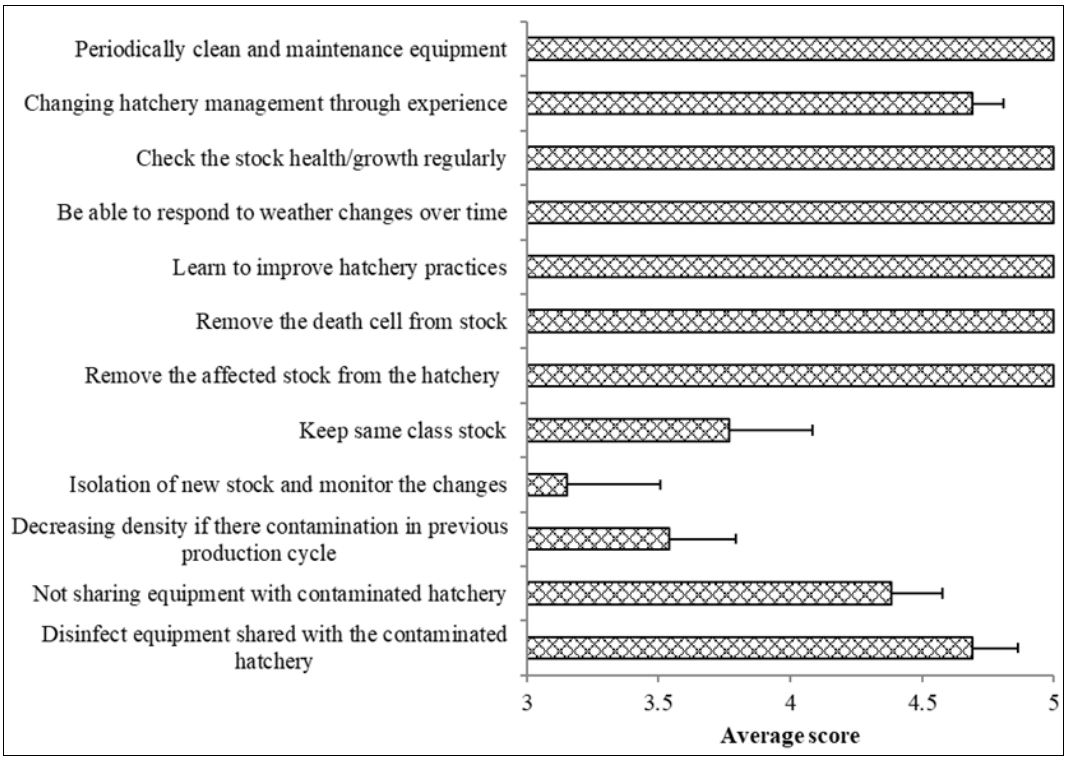

Fig 5: Biosecurity attitude score on routine management practices in each given answer

In aspects of the attitude towards biosecurity control processes "keeping records of the water conditions daily to detect problem earlier" was reported as the most important factor by the technicians' with an average score of 5 (Figure 6). In additions, keeping record of stock infections, disinfect hatchery equipment and quarantine of algae stock were reported as useful by the technicians' with an average score of 4.85-4.07. The lowest score in this category were reported in case of government controls over the quality of stock with an average score of 3.92.

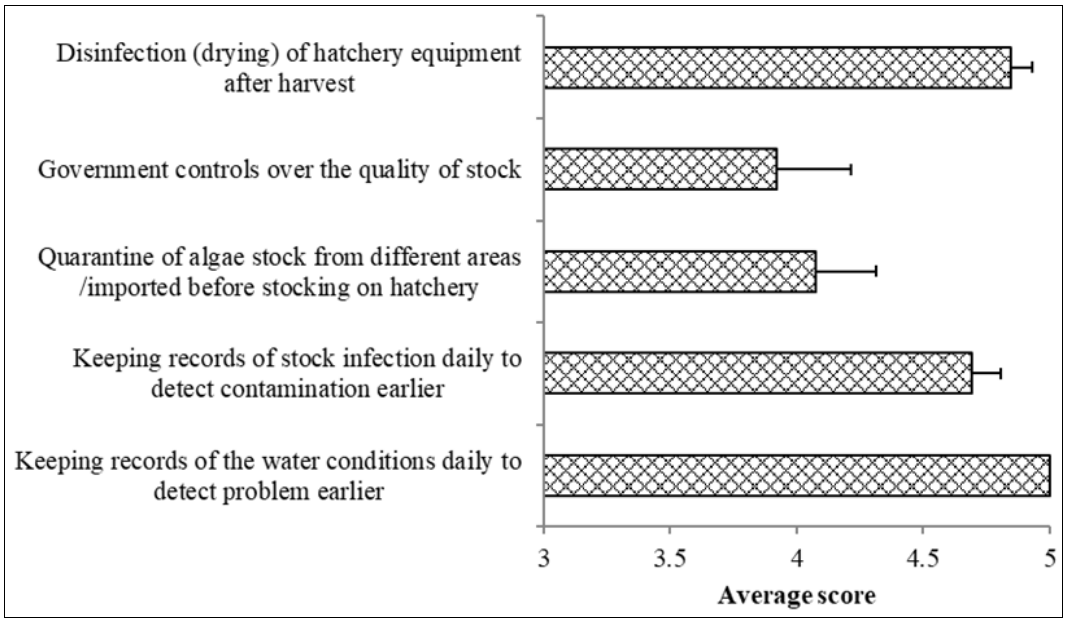

Fig 6: Biosecurity attitude score on biosecurity control processes in each given answer

3.3.3 Practices

In aspects of general management practices, 100% of the technicians' frequently practiced disinfection procedure for their growing equipment where 77.5% of the technicians' never share their equipment with other hatcheries with an average score of 1.3 (Figure 7). Moreover, most of the technicians' had rarely or often visited other hatchery, quarantine new stock, help other farmer during diseases outbreak, share equipment with other hatcheries with an average score 0.075 -1.

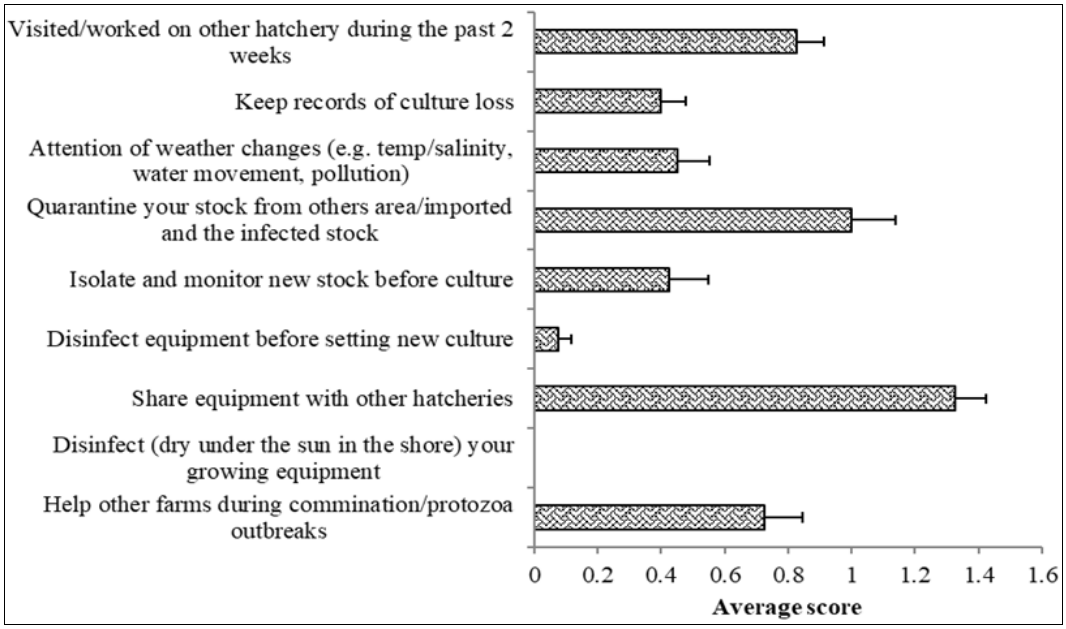

Fig 7: Biosecurity practices score on general management practices in each given answer

In aspects of practices towards routine management procedure, 100% of the technicians' never use the infected stock as initial stock for next cycle but often rely on their own experience for hatchery management, check the hatchery daily, pay attention on weather change, remove the contaminated stock, and avoid sharing contaminated stock (Figure 8). Many of the technicians' rarely practiced (change culture stock during contamination, periodical clean of used equipment, decrease culture density during culture lose, disinfect shared equipment etc.) with an average score of 0.075-1.55.

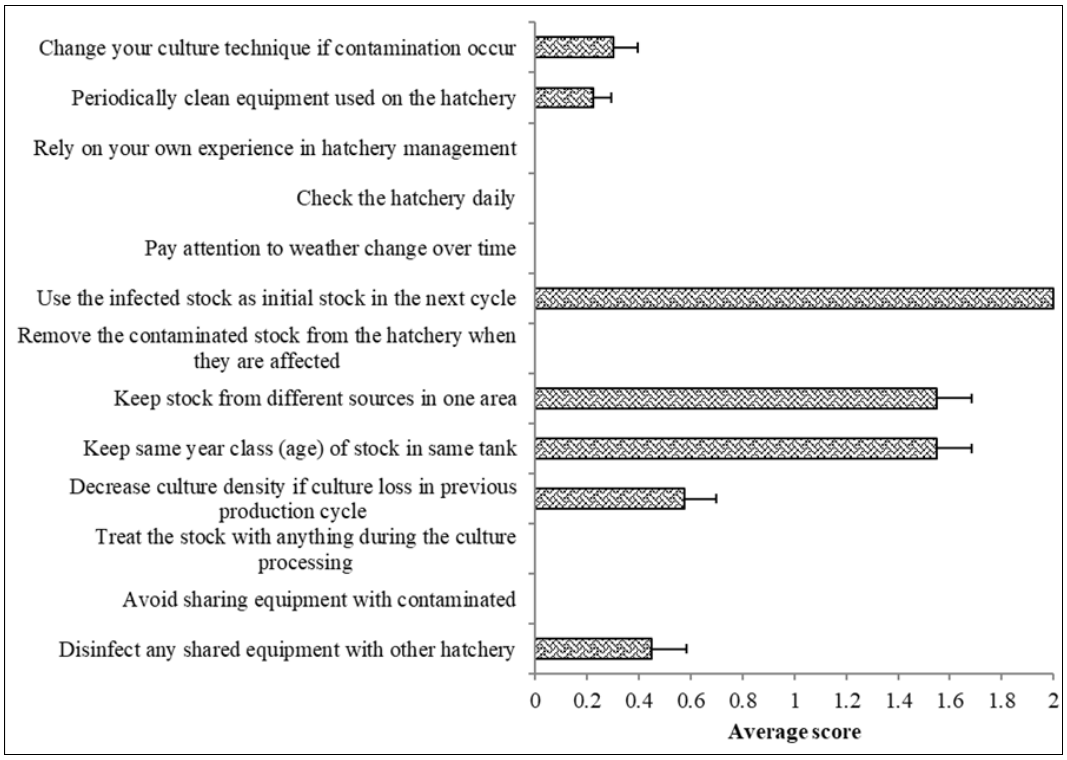

Fig 8: Biosecurity practices score on routine management practices in each given answer

In aspect of practices during diseases outbreak no one practiced controlling access to the hatchery by visitors. But 100% of the technicians' never suggest to stock new crops where diseases outbreaks (Table 2). Most of the technicians' rarely visited other hatchery during diseases outbreaks with an average score of 1.1 (Figure 9).

Table 2: Comparison of biosecurity attitudes versus practices for farmers

Components	Attitude (%)				Practices (%)		
	VU	MU	NU	NS	Often	Rare	Never
Disinfect equipment	77.5	15	7.5	0	7.5	52.5	40
Not sharing equipment	92.5	7.5	0	0	77.5	0	22.5
Quarantine stock	70	15	15	0	22.5	0	77.5
Environment control	100	0	0	0	100	0	0
Detection problem	70.5	20.5	9	0	52.5	38.5	9
Prevention	80	15	5	0	45	38	17

*VU = very useful; MU = moderate useful; NU = not useful; NS = not sure

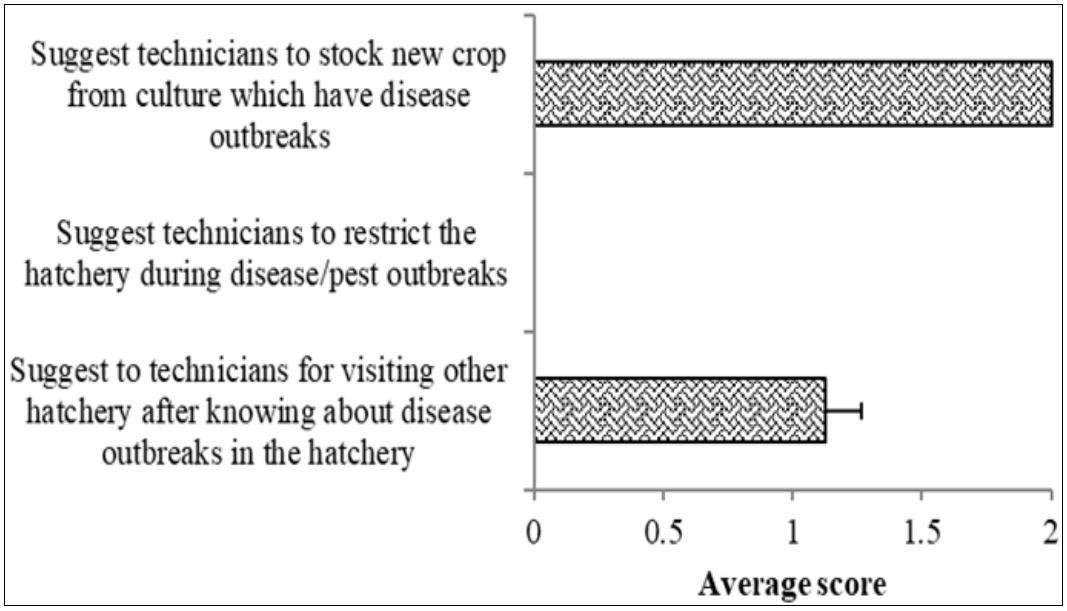

Fig 9: Biosecurity practices score in case of diseases outbreak in each given answer

3.4 Additional biosecurity practices

In case of additional farm biosecurity practices, the majority of technicians' are conscious of their reliance on various sources for stock. During contamination 50% of the technicians' through the contaminated stock outside of their individual hatchery where only 12.5% follow a definite treatment procedure. In addition, 37.5% of the technicians' followed new stock management after contamination where 32.5% leaved the hatchery empty for a short duration before stocking new stock. Average 65% technicians' assessed the stock health in a daily basis where rest of them assessed weekly.

Table 3: Summary of the additional hatchery biosecurity practices responses by the technicians'

Practices	Percentage (%)
Know the source of stock	Government (25); Local seller (27.5), Research centre (15), Non Govt. Organization (12.5), Others (20)
Culture removing system during contamination	Heat treatment and dispose (12.5), Throw away outside all hatchery (12.5),Throw away outside Individual hatchery (50), Throw away within hatchery (25)
Practices with new crops after contamination	Keep growing the old stock (12.5), New stock without removing the entire stock (0), Culture only new stock (37.5), Replace the equipment before culture new stock (17.5), Leave the hatchery empty for some time before culture new stock (32.5)
Frequency of stock health assessment	Daily (65), Weekly (10), When problem appears (10), When water condition change (0), When the neighbors have culture problems (15), Never (0)

3.5 KAP index

The technicians' of microalgae culture premises in different shrimp hatcheries of Cox's Bazar, Bangladesh scored good in case of knowledge and attitudes biosecurity measures with scores 78.1% and 76.4% respectively. But the practices were observed fair in the practical environment with an average of 63.5%.

4. Discussion

The knowledge, attitude and practice (KAP) survey tool was used in this study to investigate the biosecurity concept and its practices in microalgae culture premises at different shrimp hatcheries in Bangladesh. The findings from this survey have identified the present scenario of biosecurity measures in microalgae culture premises at different shrimp hatcheries in Bangladesh. It also identified where specific biosecurity measures have had limited implementations considering the knowledge, attitudes and practices gaps. The hatchery technicians are the initial implementers of biosecurity measures in hatchery environment. Based on their capability, they are essential in managing production and risks associated with the introduction and spread of infections (Jia *et al*., 2017) [11]. In this case, an identical knowledge and attitudes gaps were observed from the survey where the authority should take necessary steps to unify these knowledge gaps.

This survey indicates that the biosecurity knowledge of the technicians' is moderate. They have small understanding on pathogen transmission (Bacterial contamination, protozoa attack, untargeted species attacks, shared equipment, weather events) routes in the hatchery. Whatever it is, these types transmission are common in aquaculture systems (Tsiresy *et al*., 2016; Kambey *et al*. 2020) [20, 12]. The lack of understandings by the technicians' in different cases are implies the reason of contaminations in several cases. Proper knowledge on algal stock culture maintenance area, and equipment sterilization etc. can influenced on the contamination rates.

This survey results indicated that general management practices to maintain biosecurity, early detection of diseases, prevention of contamination through biosecurity measures, disinfectant of hatchery equipment, stock management etc. are very useful to reduce contamination. In additions, "remove the affected stock from the hatchery, remove the death cell from stock, learn to improve hatchery practices, check the stock health/growth regularly, changing hatchery management through experience, periodically clean and maintenance equipment" etc. were also reported as very useful. Although the consciousness was reported positive but the controls over the system reported moderate from the technicians'. Therefore, attitudes gaps must have to reduce to decrease the contamination risks.

Most of the surveyed technicians' frequently/rarely practiced disinfections procedure and never shared their equipment with other hatcheries. These results suggest a conscious attitude and management practices among the technicians' which is essential for proper biosecurity management. Quarantine of stocks from other area were moderately practiced by the technicians' which should practice more to reduce contamination. It indicates a formulated national policy is required for quarantine and new stock management for the species which are imported. However, the technicians' supported co-operative hatchery management discussing with the experience one and directly disagreed with the use of contaminated equipment or stock. The survey indicated access restrictions followed by the hatchery technicians' and no share of stock during diseases outbreak. These indicates a good practice of biosecurity measures.

The survey indicated that most of the technicians' are aware about disinfect equipment, not sharing equipment, quarantine stock, environment control, detection problem, and prevention but rarely practiced which indicated lack of regulations and monitoring in hatchery premises. The attitude and practice gap among the technicians' which must have to reduce to ensure proper biosecurity measures.

In the case of this survey, the technicians' participated were directly dependent on microalgae for the production and there was a direct financial relationship. So following biosecurity measures was considered important for target productions. Whatever it is, in Bangladesh it is difficult to implement biosecurity measures especially by the farmers. Therefore, incentive approach by the national authority could be good strategy for successful feedback (Cottier-Cook *et al*., 2016) [6]. Additionally, increasing the hatchery technicians'' community's awareness and understanding of biosecurity has been shown to be essential for altering people's behavior and may be used to improve the adoption of biosecurity techniques. (Kambey *et al*., 2021; Shannon *et al*. 2020) [12, 17]. In this situation, improved training for technicians' on disease and biosecurity issues could increase understanding among these groups of stakeholders which is a crucial step in passing science-based evidence to the industry (Campbell *et al*., 2020) [4].

However, this survey had shown that the policy and practices in Bangladesh is still need to improve in case of biosecurity

components especially in hatchery management. The following three issues identified in this survey. Firstly, the ambiguity in understanding about the biosecurity measures among the technicians'. Secondly, no strict or clarified national policy for such management. The attitude and practices gap among the technicians'. Finally, there exists some evidence base support to improve the biosecurity measures that we must have to followed to ensure proper biosecurity.

5. Conclusion and Recommendations

Microalgae culture management in hatchery premises requires some change in technicians' behavior especially in practices to prevent unintentional problem in the hatchery environment. The results of this study can guide future studies on the microalgae culture management aspects and provide information to those who want to develop more effective regulations into this field. This study precise many point more clearly and in detail about the attitude and practice gaps in management regarding biosecurity measures in hatchery environment. Additionally, the study's findings showed certain management strategies that are emphasized below for overcoming the difficulties in managing Bangladesh's hatchery business.

- Support technicians' by providing training on managing microalgae culture risks and introduction of pathogen
- Establish quarantine procedures at the national policy level for new stock as part of a comprehensive pathogen management strategy to reduce incoming risk for the industry
- Conduct experiments that provide evidence of the effectiveness of biosecurity controls in minimizing biosecurity hazards
- Documentation and certification programs for biosecurity measures in hatchery level for both infrastructure and technicians'

Finally, this KAP survey is an illustration of a useful tool in the development of hatchery management on a nationwide scale. The findings of this study could be useful for the policy makers to take target initiatives especially in culture management.

6. Funding

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7. Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

8. Acknowledgement

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9 References

1. Al-Maskari F, El-Sadig M, Al-Kaabi JM, Afandi B, Nagelkerke N, Yeatts KB. Knowledge, attitude and practices of diabetic patients in the United Arab Emirates, PLoS One. 2013;8:1-8. https://doi.org/10.1371/journal.pone.0052857
2. Andrade C, Menon V, Ameen S, Kumar Praharaj S. Designing and conducting knowledge, attitude, and practice surveys in psychiatry: practical guidance. Indian J. Psychol. Med. 2020;42:478-481. https://doi.org/10.1177/
3. Bondad-Reantaso MG, Fejzic N, MacKinnon B, Huchzermeyer B, SericHaracic S, Mardones FO, *et al*. A 12-point checklist for surveillance of diseases of aquatic organisms: a novel approach to assist multidisciplinary teams in developing countries, Rev. Aquacult; c2021. p. 1-19. https://doi.org/10.1111/raq.12530
4. Campbell I, Kambey CSB, Mateo JP, Rusekwa SB, Hurtado AQ, Msuya FE, *et al*. Biosecurity policy and legislation for the global seaweed aquaculture industry. J. Appl. Phycol. 2020;32:2133-2146. https://doi.org/10.1007/s10811-019-02010-5
5. Cicilia SB, Kambey, Iona Campbell, Elizabeth J, Cottier-Cook, Adibi RM, *et al*. Evaluating biosecurity policy implementation in the seaweed aquaculture industry of Malaysia, using the quantitative knowledge, attitude, and practices (KAP) survey technique. Marine Policy; c2021, 134. 10.1016/j.marpol.2021.104800
6. Cottier-Cook EJ, Nagabhatla N, Badis Y, Campbell ML, Chopin T, Dai W, *et al*. Safeguarding the future of the seaweed aquaculture industry, U. N. Univ. Inst. Water Environ. Heal. Scott. Assoc. Mar. Sci; c2016, 12. https://inweh.unu.edu/sa feguarding-the-future-of-the-global-seaweed-aquaculture-industry/.
7. DoF. National fish week, compendium (In Bengali). Department of Fisheries, Ministry of Fisheries and Livestock, Government of Bangladesh, Dhaka; c2016.
8. Emerenciano MGC, Rombenso AN, Vieira FdN, Martins MA, Coman GJ, Truong HH, *et al*. Intensification of Penaeid Shrimp Culture: An Applied Review of Advances in Production Systems, Nutrition and Breeding. Animals. 2022;12(3):236. MDPI AG. http://dx.doi.org/10.3390/ani12030236
9. FAO. The State of World Fisheries and Aquaculture. Sustainability in Action, FAO, Rome; c2020. https://doi.org/10.4060/ca9229en
10. Islam Z, Khatoon H, Rahman MR, Barman SK, Hossain S, Usha SZ, *et al*. Growth, productivity and proximate profiling of indigenous marine microalgae from southern coast of Bangladesh as potential feedstuff for animal feed. Bioresource Technology Reports. 2022;18:101025. https://doi.org/10.1016/j.biteb.2022.101025
11. Jia B, St-Hilaire S, Singh K, Gardner IA. Biosecurity knowledge, attitudes and practices of farmers culturing yellow catfish (*Pelteobagrus fulvidraco*) in Guangdong and Zhejiang provinces, China, Aquaculture. 2017;471:146-156. https://doi.org/10.1016/j.aquaculture.2017.01.016
12. Kambey CSB, Sondak CFA, Chung IK. Potential growth and nutrient removal of *Kappaphycus alvarezii* in a fish floating-net cage system in Sekotong Bay, Lombok, Indonesia, J World Aquacult. Soc. 2020;51:944-959. https://doi.org/ 10.1111/jwas.12683
13. Kambey CSB, Campbell I, Cottier-Cook EJ, Nor ARM, Kassim A, Sade A, *et al*. Seaweed aquaculture: A preliminary assessment of biosecurity measures for controlling the ice-ice syndrome and pest outbreaks of a Kappaphycus farm, J Appl. Phycol; c2021. https://doi.org/10.1007/s10811-021-02530-z
14. Hossan S. Shrimp Farming in Bangladesh: Why Shrimp Sector is Lagging Behind? Business Inspection; c2021. https://businessinspection.com.bd/why-the-shrimp-

sector-of-bangladesh-is-lagging-behind/
15. Rezaei R, Mianaji S, Ganjloo A. Factors affecting farmers' intention to engage in on-farm food safety practices in Iran: Extending the theory of planned behavior. J Rural. Stud. 2018;60:152-166.
16. Rodgers C, Arzul N, Carrasco N, Furones Nozal D. A literature review as an aid to identify strategies for mitigating Ostreid herpesvirus 1 in *Crassostrea gigas* hatchery and nursery systems. Rev. Aquacult. 2019;11:565-585. https://doi.org/10.1111/ raq.12246
17. Shannon C, Stebbing PD, Dunn AM, Quinn CH. Getting on board with biosecurity: evaluating the effectiveness of marine invasive alien species biosecurity policy for England and Wales, Mar. Policy. 2020;122:104275. https:// doi.org/10.1016/j.marpol.2020.104275
18. Srisopaporn S, Jourdain D, Perret SR, Shivakoti G. Adoption and continued participation in a public Good Agricultural Practices program: The case of rice farmers in the Central Plains of Thailand. Technol. Forecast. Soc. Chang. 2015;96:242-253.
19. Swann WB, Giuliano T, Wegner DM. Where leading questions can lead: the power of conjecture in social interaction. Journal of Personality and Social Psychology. 1982;42(6):1025-1035.
20. Tsiresy G, Preux J, Lavitra T, Dubois P, Lepoint G, Eeckhaut I. Phenology of farmed seaweed Kappaphycus alvarezii infestation by the parasitic epiphyte Polysiphonia sp. in Madagascar. Journal of Applied Phycology. 2016 Oct;28:2903-14.