Journal of
Dairy & Veterinary Sciences
ISSN: 2573-2196

Research Article
Volume 17 Issue 5 - September 2025
DOI: 10.19080/JDVS.2025.17.555974

Dairy and Vet Sci J

Mini Review on Seahorse Diseases During Captive Rearing and Farming Activities

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Submission: August 16, 2025, **Published:** September 04, 2025

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Abstract

Seahorse captive breeding in indoor and outdoor system is a new topic for emerging species for aquaculture industry. Since diseases are part of aquaculture programs, research on infectious diseases in the controlled conditions have resulted in massive, acute mortalities, yet there are undoubtedly many infectious diseases which may not have been documented and might have gone unrecorded. Dietary requirement and its nutritional needs are important for a species which depend Soley on the live feeds. This is an area where seahorse culture differs from other species which are part of the aquaculture system. Hence exposure to disease is inevitable since during certain period wild collection of live feed is undertaken to fulfil the rearing requirement which require increased attention and improvised filtration and biosecurity measures.

Keywords: Seahorse disease; captive rearing; farming; bottlenecks

Introduction

Seahorses are fascinating marine creature, primarily utilized for community usage by the fishermen as a traditional medicine for addressing health issues [1]. However, established trade for the wild caught seahorse commenced due to the demand for its use in Traditional Chinese Medicine (TCM) and its derivatives increased in the market. Small quantity of seahorses was sold as dried curiosities in coastal based tourist destinations along with molluscan shells [2,3]. Being a popular display specimen, its demand for live ornamental exhibit in public aquarium/ oceanariums and marine home aquariums, gained popularity because of its biological characteristics and appearances [4]. Farming of seahorse was undertaken to fulfil the requirement for the TCM in China way back in 1954 [5], since the aquaculture venture could not be able to full fill the requirement, collection of seahorses from the wild through the traditional fishing practices adopted by the marginalized fishermen community and exported through legal systems of the source country [2], however after the strict implementation of the international ban on seahorse trade, clandestine trade route was mainstreamed by traders and supporting the TCM industry requirement in the present scenario. Indiscriminate fishing has led to research development for captive breeding and rearing trials. Even though research studies have proved that seahorse is a candidate species for aquaculture, which has resulted in the indoor culture units in many countries by adopting the CITES requirement, but these raised seahorses are traded for marine aquarium trade [6], to full fill the TCM require there is a long way to go specially in the area of broodstock, rearing techniques, live feed production and disease management.

Literature reveals that around 48 valid species recorded, 27 of which are represented in the international aquarium trade [6], it is quite a huge number of species involved in the fulfilment of live aquarium trade, which also suggest the technological advancement in seahorse captive breeding programs on global perspective. Earlier a decade back commercial breeding and grow-out of approximately 13 seahorse species are conducted to supply the ornamental market [7], which suggest that continuous effort has been made to standardize the breeding and rearing program especially to reduce the fishing pressure in the wild. The sound technology has led to the research on farming of seahorse along with other species in the Multitrophic Aquaculture System (Littopenaeus vannamei, Crassostrea brasiliana) [8], rearing in shrimp ponds and sea cages [9], cage culture in mangrove estuaries [10], culturing along with seaweeds like Gracilaria lichevoides [11], net cages [12], illuminated cages [13], such initiative needs to be seen as an effort to conserve the wild population, however policy decision, aquaculture guidelines and other tools are involved to

carry forward the seahorse aquaculture for commercial purposes.

Diseases are generally classified into infectious and non-infectious diseases. Infectious diseases on fish have been caused by pathogens like viruses, bacteria, parasites, or fungi, non-infectious diseases or abnormalities can be the outcome of environmental stress, contaminants, or nutritional deficiencies [14]. Under captive conditions it has been reported that seahorse is infected with various diseases resulting in mass mortalities and hinder in the aquaculture operations. During seahorse indoor culture and outdoor farming activities has clearly suggested that seahorses are very much prone to diseases infected with bacterial, fungal, viral, parasitic, and non-infectious diseases [15,16]. Hence, the need for proper water quality maintenance, adopting the effective filtration system, effective handling of the species, streamline the feeding regimes, health monitoring are extremely important in the way forward to seahorse aquaculture.

Knowledge on diseases for seahorse under aquaculture/ captive condition is very crucial. The outbreak of disease would hamper the operation and leads to financial distress. Variety of seahorse diseases have been reported to cause mass mortalities and damage to the aquaculture operations [16]. Seahorse being a species with low fecundity, low mobility and a having a crucial pelagic phase as part of its life cycle needs disease control measures to sustain in the captive breeding and farming entrepreneurship. Disease management plays a crucial role since the captive breed/farmed seahorse should not spread any disease into the wild populations since aquaculture has been considered as a tool for conservation related programs. Hence knowledge on disease is of utmost importance for future conservation program as well as for the commercial aquaculture programs which need greater insights.

Broodstock Maintenance

Mostly under captive rearing system the pregnant males are caught from the wild for juvenile rearing activity, hence proper quarantine and disease diagnosis for the pregnant males needs to be examined without enforcing any stress to the animal. Healthy broodstock is a key parameter for the successful and continuous operation of a seahorse hatchery. For achieving good animal husbandry measures adequate nutritional requirement plays a major role along with disease management programs. Likewise, an important factor in the rearing system is the maintenance of water quality to provide conditions that support and benefit the seahorse broodstock [17]. Variety of feeds were given to seahorse broodstock in captivity which include adult Artemia, mysid shrimp, amphipods and shrimps which might be both culture and wild caught [18,19], and frozen foods [15,20,21] for gonadal development. During the broodstock management some of the diseases which has been encountered might be from the live feeds and frozen food items which are provided to the seahorse. In general diseases which has observed in the brood stock includes, skin lesion, tail rot, muscular ulcer especially in the brood pouch, protozoan infection and gas bubble diseases [22].

Pelagic Juvenile rearing

The juveniles which are released from the male seahorse lacks yolk sac which makes them search for the suitable prey immediately after its release from the brood pouch [23]. Vulnerability of young seahorses to diseases has been well documented [24]. During this phase ingestion of gas bubble due to unsuccessful feed strike led to ingestion of air bubble into its digestive system leading to Point of No return stage. The trapped air inside their bodies will, make them unable to move down the water column and causes them to lose the buoyancy [24]. The juveniles ingested with air bubbles inflate their swim bladders and exhibit irregular swimming pattern, lose their balance and are unable to capture prey, due to their erratic swimming behavior during this period they also disturb the feeding strike of juvenile seahorse in the system, float passively at the water surface subsequently leading to starvation and ultimately to death [22]. This situation resulted in low survival rates during the first two weeks of rearing [25]. Researchers have observed high mortality of juvenile seahorses due to air bubble disease resulting in low survivorship of juveniles is still a bottleneck problem in seahorse aquaculture [26].

Air-bubble disease has the potential to affect the survivorship in seahorse immediately after birth. Since, pelagic juvenile immediately starts the feeding behavior and the ingestion of air into the intestine is based on physical movement of the snout involved during prey capture [25,24]. Even though researchers have undertaken studies on the impact of illumination on air-bubble disease of seahorses [26], the issue needs to be approached on a multidisciplinary approach involving various parameters with are vital during the early juvenile stages. However, pelagic juvenile being visual feeder [27] research into aspects like illumination & temperature requirement, feed ration & density and stocking density can facilitate successful prey capture and avoid air bubble injection to a greater extent.

Settled Juvenile

The occurrence or outbreak of disease happens when the rearing fish species is exposed to a stressful condition resulting in infection from any pathogens which is present in the system. Fungi are generally considered to be opportunistic, relatively weak pathogens that are problematic only when hosts are exposed to some stressful conditions or otherwise have reduced defenses. Once the seahorse exhibits the settlement stage (holding to any structure provided as holdfast) they start exhibiting low mobility behavior. During these stages they are affected with fungal diseases, gas bubble formation in the tail region, protozoan accumulation in the gill, external parasite and bacterial infection.

Seahorse with its peak growth phase of its life cycle, the settled juveniles need nutritious feed for its somatic development. High mortalities in F1 juveniles from days 40-50 could be related with suboptimal nutritional status [28]. Even some disease problems with unknown origin have been faced in juveniles. The juvenile seahorses are prone to protozoan ciliate disease (white spot disease) caused by Cryptocaryon irritants; the outbreak of this

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disease will lead to mass mortality and need complete sanitation of the hatchery system [22]. The protozoans mostly attack the branchiostegal gills exhibiting pinhead-sized whitish nodules, mucus hyper production and skin discoloration, anorexia and respiratory distress. Due to the infection seahorse exhibit low food intake, lethargic and stressing behavior includes regular shaking of the head and pumping of water through the silt like gill opening forcibly. The infection of ciliate parasites has been documented in various seahorse species H.kuda [22,29], H.abdominalis [30], H.hippocampus [28]. Information on diseases infected on gill need more emphasis in seahorse since they have a closed gill (Lophobranchiate gills), which hinders visual examination disease.

Fungal infections are easily recognized by mold-like growths [31]. Fungal infections may result in rearing tanks that are poorly filtered, maintained with poor water Motion and water exchange not properly undertaken. These infections are indicated by hairy filaments covering the seahorse body and associated holdfasts. During the early juvenile period seahorse has the tendency to develop skin filaments in its body hence careful examination is needed for the infection of the fungus. Observation of branching septate fungal hyphae on the skin and infection of fungus (Fusarium solani) species complex to the internal organs has been observed in H.erectus [32]. Hydrogen peroxide has the potential to be used as immersion treatment (bath) for H. reidi to treat fungal issues [33].

Viral diseases in the aquaculture system have been a great concern for marine species till date. Studies on viral diseases on seahorses are very much limited and recently in juvenile H.abdominalis with symptoms like spiral swim pattern, abdominal distension and high lethality in farmed seahorses in Fujian, China was observed and further investigation revealed viral infection leading to the isolation and identification new strain of Nervous Necrosis Virus, mainly destructing the brain and eye and causes vacuolation of the brain and retina [34]. Studies on viral disease are very much limited and the scope for such study might emerge once seahorse aquaculture potential is implemented at the grow out level in polyculture and integrated system.

Matured Seahorse

Bacteria become pathogenic when the host/environment balance is changed by raised stocking density, inadequate nutrition, deteriorated water quality, or other stress factors [35]. Seahorse being a lethargic fish species exhibiting low mobility needs to be maintained in the aquaculture system for more than 150 days for obtaining the Minimum Legal Size of 10 cm (HT). During this phase any nutritional deficiency, deterioration in the water quality will enforces the bacterial load leading to occurrence of diseases like cutaneous lesion, ulceration in brood pouch and pope eye. Among the bacterial species Vibrio spp. has been the common encountered species causing various bacterial disease symptoms to the seahorses [36], the species includes Vibrio alginolyticus, V. harveyi, V.splendidus, V.vulnificus, V.parahaemolyticus and V.neptunius, V. rotiferianus, V. tubiashii, V. fortis [37,16,38, 39,40,41,42,43,44]. However other bacterial disease agents have ben also recorded during seahorse husbandry practices like Enterobacter aerogenes, Klebsiella pneumoniae, Mycobacterium chelonae, M. fortuitum, M. marinum, Nocardia nova [36,45,46]. Likewise, genus like Bacillus and Photobacterium were isolated from the lesion of ulcer formed in the brood pouch [22]. Antibiotic treatments have been widely used against bacterial illnesses in aquaculture for several years [47] and which is considered as the treating medium for addressing these diseases.

Gas bubble disease may be caused due to bacterial infection as well a due to UV-light intensity and supersaturation of oxygen [48]. Epidermal blisters may appear, usually originating in the tail region. In some cases, the bubbles appear on the snout, head and in the mouth region [22]. Gas super saturation occurs when the total pressure of gases dissolved in water is higher than the atmospheric pressure. Vibrio bacteria have been found in association with all affected areas. Submerging them in deeper display tanks (6 to 8 feet) in a bait bucket, till the bubbles diminishes [49].

Presence of microsporidian and parasitic infections has been recorded in the matured seahorses under captive breeding trials. The presence of Microsporidians, Glugea heraldi was notice in the seahorse rearing system [50,51], raised by researchers, hobbyist and during farming practices. Parasites, such as Uronema spp.; and marine leeches have been encountered in the seahorse rearing systems [52,53]. Outbreak of Amyloodiniosis (Amyloodinium ocellatum) in Dwarf Seahorses (H.zosterae) in aquarium setup [54]. This parasitological disease has a strong economic impact on aquaculture events, represents one of the most important bottlenecks for aquaculture and, with the predictable expansion to the area of influence [55].

Tumors (or neoplasia) are masses of abnormal tissue growing in or on the body that resemble the tissue from which they arise. Additionally, other less frequent diseases have been also reported such as tumoral neoplasia in H. kuda [56] and H. erectus [57] and nephrolithiasis in H. reidi [58]. Under aquarium conditions seahorses with brood pouch fibrosarcoma has been diagnosed [54]. Morphological abnormalities in seahorses especially with tail deformities, bicephalic head has been observed in captive breeding programs [3,59].

Conclusion

Seahorses are one among the marine trade commodities that has been utilized as ornamental fish when it is alive and raw material for traditional medicines when found dead [2], hence based on its demand and requirement seahorse have been collected from the wild. Due to the continuous collection of seahorses through incidental catches has led to the population decline of seahorses globally and researchers coupled with policy makers are on the thought process of utilizing the aquaculture technique for stock enhancement/sea ranching programmes to conserve the species with new framework or guidelines.

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Earlier research on seahorse rearing has been undertaken in indoor system whereas sound technology in rearing method led to the rearing of seahorse in outdoor system [8], this type of technical advancement clearly suggests its capabilities for commercial productions [9]. Research till date has intimated that seahorse is a potential species for aquaculture in different systems like mariculture, IMTA system, pond culture, integrated culture, polyculture, indoor system (RAS and flow through) which clearly suggest a brighter scope for this species under aquaculture diversification. Hence knowledge on disease diagnosis, prevention methods and treatment are very much needed for supporting the aquaculture activities, since disease limits productivity.

Captive breeding and rearing of many species of syngnathids remains a challenge due to disease from various pathogens, inappropriate nutrition and environmental conditions [56]. Bacterial infection causes mass mortalities and severe damage to seahorse aquaculture despite antibiotic treatment [60,61], and which has been seen in various farming species. Even though, farming of seahorse has little environmental footprint as they do not require artificial (formulated) feed at any stage of its life cycle. Knowledge on diseases in seahorse is a new topic to the field of seahorse farming for entrepreneurs since being a candidate species for aquaculture in the near future. To full fill the marine aquarium demand as of now captive breeding programs and scope for farming activities has been explored and suggestions has been made out to promote seahorse farming activities. As of now seahorse species which are mostly preferred in the live aquarium trade (H.erectus, H.ingens, H.kuda, H.abdominalis, H.guttulatus) has been identified with disease problems, whereas most of the infrastructure would be of indoor types. Presently, researchers have been proposing for seahorse culture in various ways like cage culture, along with shrimp culture, IMTA systems [62,63,64], which are mostly of outdoor type system hence studies on disease management plays a significant role for the successful aquaculture ventures in the near future.

Globally, many countries have been involved in the establishment seahorse captive breeding and rearing infrastructure for native and non-native seahorse species [64]. These activities are undertaken as per the protocol outline in the CITES Appendix II, such activities are driven mainly due to fulfil the demand in the marine aquarium industry, where seahorse is considered as a pet animal by the hobbyist. The main challenge for obtaining a good survival rate under the aquaculture system is directly linked to technical problems, such as rearing protocol and disease control measures (). During the rearing period animal welfare issues needs to be properly adhered if those measures are not properly implemented in the farming system, seahorses will be under stress leading to their susceptibility to infection and diseases. From a technical aspect, much more information on seahorse diets and diseases is needed since both are closely linked [65]. Considering the growing recommendations for seahorse farming and captive breeding centers, greater knowledge on bacterial disease needs to be established (Xie et al., 2020), despite advancement in water treatment/filtration techniques and best management practices are adopted. Further research into potential drugs and the development of disease resistance in seahorses [6], biosecurity measures, and adopting to emerging technological innovations for seahorse farming need more emphasis for future prospective.

Acknowledgement

Author is thankful to the members of the Crab Meat Processors Association for the financial support during the preparation of this manuscript.

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DOI:10.19080/JDVS.2025.17.555974

How to cite this article: Arumugam M. Mini Review on Seahorse Diseases During Captive Rearing and Farming Activities. Dairy and Vet Sci J. 2025; 17(5): 555974. DOI:10.19080/JDVS.2025.17.555974