Feasibility study providing a software model to predict incidence of White Spot Syndrome Virus in shrimp ponds contributed with physical and chemical factors in Iran

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Abstract

The objective of this survey was to provide a software ecological model to predict the incidence of WSSV in *Litopenaeus vannamei* ponds of Gwater area located in southeastern of Iran. The coding and grouping of effective factors, which were involved in the occurrence of White Spot Syndrome Virus (WSSV) including temperature, salinity, oxygen, pH, ammonia, silica, pond preparation and management and water phytoplankton with the critical-to-optimal ranges had being applied. The data were originated from a national research plan named epidemiological study of the effect of environmental and management factors affecting the incidence of WSSV of *Fenneropenaeus indicus* and *L. vannamei*. The type and quality of processes in the emergence of the effect of each exposure in the appearance of the outcome of WSSV were designed. In this design, meaningful effective factors directly contributed to the development of the process, and other factors merely assumed as complementary form of disease prognosis. It is concluded that the ecological model can shows the role of the physicochemical and management factors in incidence of WSSV in the area where the disease was already encountered with.

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Introduction

The adverse water quality affecting shrimp make them more susceptible to diseases outbreaks. Since 1993, in South Korea, heavy losses have been reported among the shrimp *Penaeus orientalis* caused by WSSV with similar sequence of isolates from Taiwan, Thailand and China (Moon, Do, Cha, Yoon, Kim, Ko M.S., Park, Kim, Sohn, Lee & Park 2003). Shrimp culture has been initiated in the southern of Iran in 1992-1993 although its infrastructure return to years before that (Kakoolaki, Soltani, Ebrahimzadeh Mousavi, Sharifpour, Mirzargar, Afsharnasab & Motalebi 2011). In the first decade of the shrimp culture, almost the shrimp farmers were suffering from the bacterial diseases in particular Vibriosis and within the second decade they were encountered with WSSV (Soltani, Kakoolaki & Keisami 1998, SamCookiyaei, Afsharnasab, Razavilar, Motalebi, Kakoolaki, Asadpor & Yahyazade 2012). The occurrence of five types of diseases: tail necrosis, shell disease, red disease, loose shell syndrome (LSS) and white gut disease (WGD) is contributed with *Vibrio* spp. In a research conducted in Gwater area of Iran (Khodami, Attaran-Fariman, Ghasemzadeh & Mortazavi 2011), temperature was shown as one of the most uncontrollable factors that had sometimes been "out of range." Salinity, suspended particles, and water transparency of the pools were largely inadequate, which made them to be of particular importance. Rapid changes and sudden decrease in water temperature of shrimp ponds in Khuzestan province in 2002 presented temperature as a risk factor of WSSV incidence and frequently reported at the same area in 2004, 2007 and 2009 (Kakoolaki, Sharifpour, Afsharnasab, Sepahdari, Mehrabi, Ghaednia & Nezamabadi 2014, Kakoolaki, Afsharnasab & Sharifpour 2015). In addition, the outbreak of WSSV was confirmed from the Bushehr and Sistan and Baluchestan provinces in 2006 and 2009, respectively which inflicted many damage to the shrimp industry in Iran (Afsharnasab, Kakoolaki & Afazli 2014). Ultra fluctuation from optimum of salinity degree (35 ºC) showed more susceptible to WSSV disease (Kakoolaki et al. 2011). They confirmed that the lethal conditions due to the WSSV were more provided in group of 30 and 50 ppt (lower and greater value than the normal condition) than the salinity of 40 ppt. The thoughtful of the role of the ecological parameters occurring in shrimp pond assist us resolve some of the shrimp disease questions faced by shrimp culture farmers (Ferreira, Bonetti & Seiffert 2011). One of the most important issues concerning the virus that causes the disease is wide range of its hosts. This virus not only causes infection in a large number of shrimp, but also in many crayfish and other crustaceans (Withyachumnarnkul, Boonsaeng, Chomsoong, Flegel, Muangsin & Nash 2003).

The objective of this survey was to provide a software ecological model to predict the incidence of WSSV in *Litopenaeus vannamei* ponds of Gwater area located in southeastern of Iran.

Materials and Methods

Farms and ponds

This essay is based on a retrospective study based on a national plan " An epidemiological study of the effect of environmental and management factors affecting the incidence of WSSV of *Fenneropenaeus indicus* and *Litopenaeus vannamei* ". The study of the above national plan indicated a correlation between the incidence of WSSV and some physico-chemical parameters of water. So that the factors of temperature, salinity, oxygen, pH, ammonia, silica and the amount of water phytoplankton in the pools of the Goater Shrimp Complex located in Sistan and alouchestan province, which were previously measured and recorded in the national plan were used in this study.

The retrospective study was carried out on the implementation of the West Bahu-Kalat Shrimp Breeding Center in Gwater of Sistan and Balouchestan Province with an area of 4000 hectares and a useful land area of 2500 hectares (Iran's Deputy Director of Planning and Exploitation of Fisheries, 1995). During the years of the plan implementation (89-90), a total of 12 farms (6 fields per year) were studied (Fig. 1).

Figure 1. Gwater shrimp complex shows the farms (Cs) were deployed in this study in southern phase of the complex.

Water & PCR sampling schedule

To investigate the physic-chemical factors, water samples of ponds had been taken once every two weeks. It should be noted that samples of water pools were taken on the same day for shrimp samples for PCR testing. The factors studied included silica, temperature, pH, dissolved oxygen (DO), ammonia, nitrite, nitrate, temperature and salinity. After water sampling was done from the ponds, samples from C1, C2 and C3 (from the beginning and the end of the canals) were also sampled (before sunrise at 4-5 am) and in the afternoon (from 16 to 18 pm).

Table 1. The identification of the farms were deployed in this study in 2011

Farms	Ponds
P7&P10	C2-5
P7&P9	C2-2
P8&P10	C2-31
P3&P5	C3-7
P11&P12	C3-8
P5&P10	C1-10

Table 2. The identification of the farms were deployed in this study in 2012

Farms	Ponds
P7&P10	C2-5
P7&P9	C2-2
P8&P10	C2-31
P3&P5	C3-7
P11&P12	C3-8
P5&P10	C1-10

Coding the factors

The condition of the phytoplankton was considered as template was given in table 3.

Table 3 codes of phytoplankton status and its condition in the pond water

Transparency of Phytoplankton (cm)	Point	condition
25-35	3-4	good
36-50	2	moderate
51-60	1	worse

For running the model, the data of silica were entered for 4 sampling times at 14, 50, 70 and 90-100 days while the stocking density as up to 10 (order 1), 11-20 (order 2), 21-30 (order 3) and 31 or more shrimp / m^2 (order 4) previously entered. Management criteria with 2 optional responses was one of the most crucial factor including sub- criteria e.g. black bottom soil removing, liming and ultimately ploughing the bottom before water entering to the pond.

Temperature was designed as 27 ºC and lower (order 1), 27-28 ºC (order 2), 29-30 ºC (order 3) and 31 ºC and going on (order 4).

Engineering the software

The infrastructure of this software was based on the features and nature of the hardware, and on the other hand due to the users and their expectations. The software was dynamic in nature and can adapt itself to the new needs and expectations of users all the time. It was also fully compliant with the Flexibility Principle, and is based on the N_Layer structure, consisting of various logical and physical and interleaved layers. It has been developed in the Windows Application Software Platform in the context of the architecture they followed in the Presentation Layer. In the design and production of this system, there were always three principals were intended.

1- Software user were simplicity and friendly
2- Software speeds were fast and easy to handle.
3- Have a high standard

In addition to aforementioned principles, rules and guidelines for using system utilities were considered in the Business Logic Layer. the Data Access Layer (DAL) is defined to be associated with the data source in the data access layer. For each identified entity in the system, this class layer is created that works with the source of the data through it. The functions of this layer are called through the BLL and UI layers. Ultimately, Microsoft SQL Server CE was used as default database (Table 4).

Table 4 the technologies were used in the software

NET Framework v4.0	APPLICATION PLATFORM
C# 4.0	DEVELOPMENT LANGUAGE
SQL Server CE	DATE BASE
Stimul	REPORTING
agile	METHODOLOGY

Results and Discussion

The results of the actions resulted in software production, was finally approved by the Iranian Fisheries Organization as a contractor of the Iranian Fisheries Research Institute in the production and promotion of software on the Gwater shrimp farm complex. In the software login section, the new and previous tests could be processed. If the test was new, the farm at the Gwater site, the name and characteristics of the farms and the ponds could be inserted in the list of experiments, and the previous experiments considered.

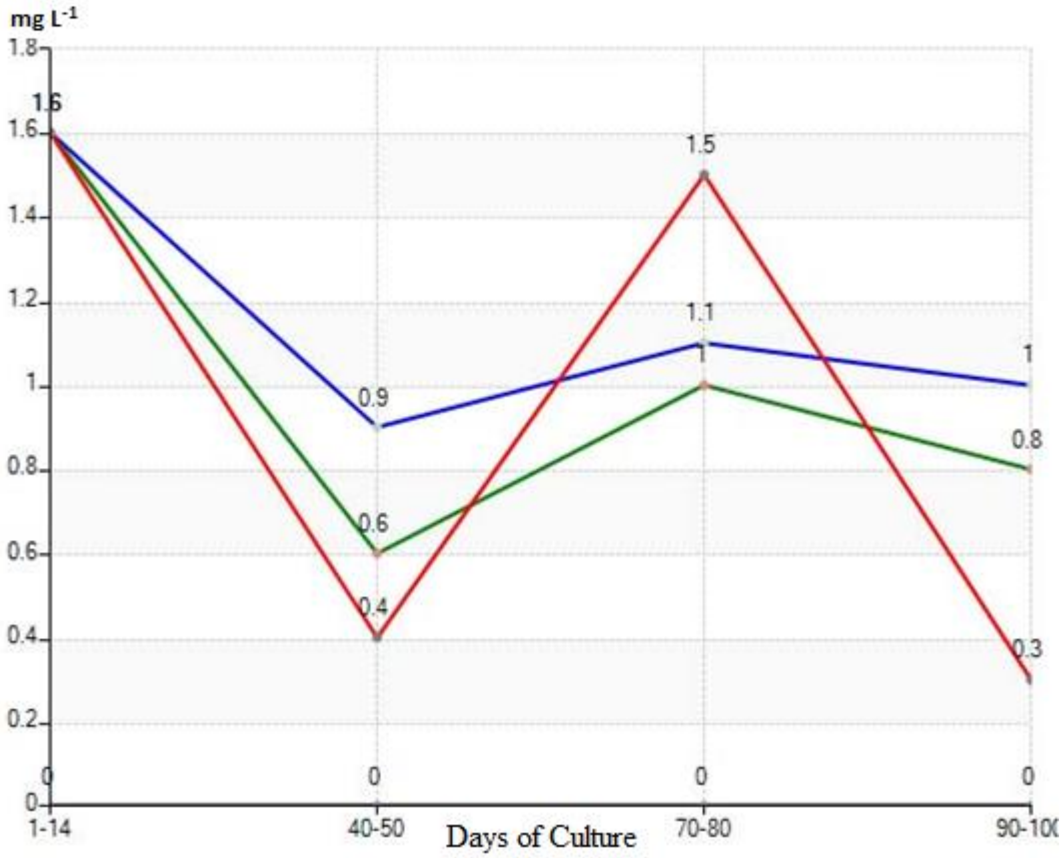

Figure 2. The probable status of the silica existed in the waters of ponds.

Based on the results and the raw data were given in Table 3, the phytoplankton graph (default) was determined presented in figure 2. The blue and green lines respectively show the optimum and appropriate conditions of the silica. Because of un-use of zooplankton in early stage of shrimp culture, the amount of phytoplankton showed high but it was gradually decreased within the experiment. In the ponds without WSSV occurrence the value of silica ranged between 0.6-1.0 mg/l but in the WSSV occurring ponds the value was accompanied with remarkable fluctuation (Fig2). The black line, which appeared after entering the data, was result of our data entered in the model not including in this figure. The blue line could be a standard condition with lower stocking of shrimp (orders 1- 2 stocking) and green line was also standard one but with higher density of shrimp stocked in the ponds (order 3 stocking). Red line indicated non-standard condition of the water pond e.g. in high stocking density of shrimp (order 4).

With the onset of phytoplankton bloom, diatom population decrease and other algae, including dinoflagellates and cyanobacteria get dominant (Yusoff & McNabb 1997). This could be caused by silica reduction. On the other hand, when the phytoplankton concentration increased, total food consumption of shrimp decreased and FCR increased in particular, when the predominant were dinoflagellates, resulted in inappropriate shrimp growth and yield decreased (Teeyaporn, Kimiko, Putth & Pensri 2012). Therefore, the higher temperature and more turbidity of the water with long water retention time in shrimp ponds (>100 days) must raise the probability of cyanobacteria blooms with silica depletion as well as our result showed with higher stocking density condition resulted in worse water quality, increase of waste feed and decrease of transparency indicated on eutrophic condition. Our results showed that each pond-water of the study with higher temperature more than 30 ºC along with a low or without fluctuation within 24 h of a day could not be resulted in WSSV occurrence. Other studies confirmed that water temperature of shrimp ponds more than 29 ºC could make the shrimp to resist against WSSV and decrease the mortality, ultimately (Kakoolaki et al. 2015).

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References

Afsharnasab, M., Kakoolaki, S. & Afazli, F. (2014) The Status of white spot syndrome virus (WSSV) in Islamic Republic of Iran. *Iranian Journal of Fisheries Sciences* 13(4), 1021-1055.

Ferreira, N., Bonetti, C. & Seiffert, W. (2011) Hydrological and water quality indices as management tools in marine shrimp culture. *Aquaculture* 318(3), 425-433.

Kakoolaki, S., Afsharnasab, M. & Sharifpour, I. (2015) The relation between temperature and salinity with WSSV occurrence in shrimp farms in Iran: An article review. *Journal of Survey in Fisheries Sciences* 2(1), 31-41.

Kakoolaki, S., Sharifpour, I., Afsharnasab, M., Sepahdari, A., Mehrabi, M.R., Ghaednia, B. & Nezamabadi, H. (2014) Effects of temperature on hematological and histopathological changes and survival rate of juvenile *Litopenaeus vannamei* experimentally challenged to White Spot Virus. *Iranian Journal of Fisheries Sciences* 13(1), 91-102.

Kakoolaki, S., Soltani, M., Ebrahimzadeh Mousavi, H.A., Sharifpour, I., Mirzargar, S., Afsharnasab, M. & Motalebi, A.A. (2011) The effect of different salinities on mortality and histopathological changes of SPF imported Litopenaeus vannamei, experimentally exposed to White Spot Virus and a new differential hemocyte staining method. *Iranian Journal of Fisheries Sciences* 10(3), 447-460.

Khodami, S., Attaran-Fariman, G., Ghasemzadeh, J. & Mortazavi, M. (2011) Comparison of different nitrogen compounds in three different environments of the Gwatar shrimp farms complex in the Gwatar Gulf region (Baluchestan-Iran). *Iranian Journal of Fisheries Sciences* 10(4), 663-677.

Moon, C.H., Do, J.W., Cha, S.J., Yoon, W.J., Kim, S.B., Ko M.S., Park, M.A., Kim, J.W., Sohn, S.K., Lee, J.H. & Park, J.W. (2003) Highly conserved sequences of three major virion proteins of a Korean isolate of white spot syndrome virus (WSSV). *Diseases of Aquatic Organisms* 53, 11-13.

SamCookiyaei, A., Afsharnasab, M., Razavilar, V., Motalebi, A., Kakoolaki, S., Asadpor, Y. & Yahyazade, M. (2012) Experimentally pathogenesis of Aeromonas hydrophila in freshwater Crayfish (Astacus leptodactylus) in iran. *Iranian journal of fisheries sciences* 11(3), 644-656.

Soltani, M., Kakoolaki, S. & Keisami, M. (1998) Isolation and identification of dominant Vibrio species in farmed prawn of health station,Bushehr. *Journal of Veterinary Research* 55(2), 28-32.

Teeyaporn, K., Kimiko, F., Putth, S. & Pensri, M. (2012) Nutrient, phytoplankton and harmful algal blooms in the shrimp culture ponds in Thailand.

Withyachumnarnkul, B., Boonsaeng, V., Chomsoong, R., Flegel, T.W., Muangsin, S. & Nash, G.L. (2003) Seasonal variation in white spot syndrome virus-positive samples in broodstock and post-larvae of *Penaeus monodon* in Thailand. *Diseases of Aquatic Organisms* 53, 167-171.

Yusoff, F. & McNabb, C. (1997) The effects of phosphorus and nitrogen on phytoplankton dominance in tropical fish ponds. *Aquaculture Research* 28(8), 591-597.

امکان سنجی ارائه مدل نرم افزاری عوامل مؤثر فیزیکوشیمیائی در بروز بیماری لکه سفید میگو

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چکیده

هدف از این بررسی، ارائه یک مدل اکولوژیکی نرم افزاری برای پیش بینی میزان بروز بیماری لکه سفید میگو در استخرهای پرورشی میگوی پا سفید *Litopenaeus vannamei* در منطقه گواتر واقع در جنوب شرقی ایران است. برنامه‌ریزی و گروه بندی عوامل مؤثر که شامل وقوع ویروس لکه سفید میگو (WSSV) شامل درجه حرارت، شوری، اکسیژن، pH، آمونیاک، سیلیس، آماده سازی استخر و مدیریت فیتوپلانکتون آب با محدوده های حیاتی و مطلوب در این تحقیق بکار رفت. داده های این بررسی از یک طرح تحقیقاتی ملی به نام بررسی اپیدمیولوژیک تأثیر عوامل محیطی و مدیریتی بر بروز بیماری لکه سفید در میگوهای سفید هندی و پا سفید به وجود آمده است. نوع و کیفیت فرآیندهای در ظهور اثر هر یک از بیماریها با توجه به عوامل تأثیرگذار بر بیماری لکه سفید میگو طراحی شده است. در این طرح، عوامل مؤثر معنی‌دار به طور مستقیم به توسعه فرایند کمک کرده و عوامل دیگر صرفاً به عنوان یک نوع مکمل پیش آگهی بیماری پیش‌بینی شده اند. به این نتیجه می‌رسیم که مدل نرم افزاری اکولوژیکی می‌تواند نقش عوامل فیزیکی و شیمیایی در بروز بیماری لکه سفید میگو را در منطقه‌ای که قبلاً با آن مواجه بوده است، نشان دهد.

کلمات کلیدی: میگوی پا سفید، بیماری لکه سفید میگو، نرم افزار، مدل اکولوژیکی

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