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Research Article

Coronavirus disease (COVID-19) pandemic: Lockdown and diseases' effects on different parts of Iran shrimp industry, Bushehr Province

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Abstract

This study aimed to evaluate the effects of Coronavirus disease (COVID-19) on different parts of the shrimp industry in Bushehr Province in Iran. This disease has threatened both human health and many industries around the world. Data were collected via an online web-based questionnaire about each of the effective indicators in shrimp hatcheries, farms, and processing centers. The data were categorized into five categories: without effect, low effect, medium effect, effective, and high effect. The results showed that the greatest effect of COVID-19 on shrimp hatchery centers was related to a section of services such as supplying air tickets for foreign experts and delays in importing larval feed and equipment into the country, which led to a decrease in shrimp larval production in the early period. In farms, despite the lack of post-larvae at the beginning of the rearing period, the most significant effect of COVID-19 on this section was the delay in investment return due to the lack of crop sales. The most important factors influencing the processing sector were an increase in the costs and prevention of packaging contamination with Coronavirus, non-sale of products, and a decrease in shrimp prices. As a result of an increase in infection among shrimp industry activists, contamination of shrimp packages with Coronavirus, a loss of customers on the global market, and a decrease in foreign exchange income, the shrimp industry may face bankruptcy if COVID-19 is not controlled in the country. To prevent bankruptcy in the industry, the governmental authorities must take protective actions after the public has been vaccinated.

Keyword: Iran, COVID-19, Shrimp industry, Pandemic, Lockdown, Bushehr Province

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Introduction

The Coronavirus disease outbreak (COVID-19) was first reported in December 2019 from Wuhan, China, spreading rapidly throughout the world (Wang *et al*., 2020). More than 685 million people worldwide have been infected with the disease so far, and by April 11, 2023, more than 6.8 million people worldwide have died. The first report of Coronavirus disease in Iran was on December 18, 2019, and so far, more than 6.8 million people in Iran have been infected with the virus, of which, by April 2023, more than 145,391 people have died (Worldometers, 2023). This disease in the country has endangered both human health and the bankruptcy or stagnation of many industries. COVID-19 has slowed international trade dramatically and affected the world's major economies, including China and the United States (UN, 2019). One of the major industries in the country is the shrimp farming industry, which was greatly affected by the Coronavirus disease. The shrimp industry is one of the most important economic industries in Bushehr Province. This Province has been able to play a significant role in creating employment in the country, employing 6,000 direct and indirect jobs (IFO, 2019; Kakoolaki *et al*., 2020). The global shrimp market value is estimated to be around $25 billion by 2026 (CISION, 2020). Shrimp production in 2019 exceeded 4.5 million tons in the world, which represents a relative increase in shrimp production compared to the same period in previous years (FAO, 2020). At the beginning of the outbreak in the country, due to the lack of quarantine and the fear of the epidemic, spontaneous groups blocked the entrances of cities. They imposed road restrictions to prevent people and travelers from traveling between cities. At the same time, many international flights to Iran or vice versa were blocked. The application of these restrictions in the country, especially in Bushehr Province, reduced the prevalence of the disease to a large extent. Further, its implementation led to disorder and disruption in all economic and social activities throughout the country. Following this incident, the National Coronavirus Headquarters (NCH) in the country decided to prevent the resulting disorder, and they decided that the control of the entrances of the cities should be handed over to the military forces. But these restrictions were accompanied by the one-month closure of many local businesses, causing dissatisfaction among many companies in Bushehr and its subordinate cities. It is noteworthy that the limitations of Coronavirus disease have caused an asymmetrical, heterogeneous shock to global and national food systems, from raw material supply to processing, export, trade, and national and international logistics systems (Schmidhuber and Pound, 2020; FAO, 2021a; FAO, 2021b). Unemployment was also due to the closure of many production units and economic activities, especially the cessation of the

production and service sectors. Due to social and movement constraints, the labor shortage in primary food production systems led to an economic recession (Swinnen and Vos, 2021). The impact of COVID-19 on recreational fishing in Western Australia was reported by Ryan *et al*. (2021). According to their results, the impacts of social distancing were greater for avid fishermen who were only permitted to fish with their families. During the early phases of COVID-19, metropolitan-based fishers were unable to travel to regional centers due to travel restrictions imposed by the state government. In another study, COVID-19 negatively affected Bangladesh's shrimp industry, and shrimp prices fell (Bashar *et al*., 2021).

In Iran, according to a report from the Ministry of Cooperatives Labor and Social Welfare (MCLSW), by April 2023, people had registered in the comprehensive labor relations system more than 10.6 million (MCLSW, 2023). The outbreak of the Coronavirus disease has affected various industries, including the shrimp industry in Iran. The Coronavirus outbreak coincided with the start of shrimp hatchery centers in the country. However, many of the items needed for the shrimp industry had to be sourced from outside the Province or country. The application of these restrictions and the closure of many borders, commercial centers, local markets, and even government agencies in the early stages of the Coronavirus disease led to severe disruptions in the activities of this industry. The aim of this study was to investigate the intensity and impact of each of the different factors on the activity of shrimp industry-related sectors in Bushehr Province, including hatchery centers, farms, and processing centers.

Materials and methods

Data collection

This study's data collection was performed by designing an online questionnaire via Google Form (www.docs.google.com). The question links were shared through social apps such as WhatsApp and Telegram in fisheries and shrimp industry-related groups. The Face and content validity of the developed questions was verified by shrimp industry experts. To complete the questionnaire, they had to examine the overall structure, understand the questions, and take the time to answer them. After gathering their opinions, the questions were sent to participants related to the shrimp industry. Cronbach's alpha was used to determine the reliability of the questionnaires after respondents completed them. Based on the answers, a reliability coefficient of less than 0.50 was interpreted as low, 0.50-0.80 was considered moderate, and greater than 0.80 was interpreted as high.

Design questions

The questions consisted of two parts; the first part included inquiries related to the identity information of the respondents, and the second part had a set of different questions regarding the

type of their participation in the shrimp industry: I) Shrimp hatchery centers, II) Shrimp farms, and III) Shrimp processing centers. In the second part, the questions were designed using five sets of supply requirements, costs, limitations, benefits, and services. These questions were included in all three parts of different sections, such as managers, labor, skilled technicians (domestic and foreign experts), broodstock, fresh materials, supply of inputs and equipment needed, price of purchased feed concentrate, marketing, and selling fees for shrimp, transportation, and transactions. In all of these sections, the responses were designed in the form of five options: without effect, low effect, medium effect, effective, and high effect, with numbers from 1 to 5, respectively (Arthur *et al*., 2018). To better understand the impact of the disease epidemic on the shrimp industry over three weeks, a survey was performed of 154 people, including hatcheries (15.63%), farmers (75.23%), and managers of processing centers and shrimp exporters (9.14%).

Statistical analysis

To investigate the intensity of each of the effective indicators on different sectors of the shrimp industry in Bushehr Province, the data collected IBM using SPSS (version Statistics 26) was and determined via frequencies and Friedman Tests. Finally, the effects of each indicator were displayed in the form of graphs using Microsoft Excel 2016.

Results

Shrimp hatchery centers

The study results of each of the studied indicators in the hatchery centers of Bushehr Province indicated that the supply of equipment and food to the larvae purchased from abroad, especially in Southeast Asia, and their transfer inside the country, had the most significant impact on the supply requirements part. In the part of costs, the increase in current expenses had the most significant impact. Road and quarantine restrictions had little effect on the activities of these centers. Despite the high demand for post-larval payment by breeders and return on investment, it significantly impacted the activities of hatchery centers. In contrast, the import of larval food and ticketing of reproduction experts had the most significant impact of the outbreak of Coronavirus disease on the service sector. The least impact was related to the supply of breeders in breeding centers (Fig. 1).

According to the Chi-square test and Friedman test, it was observed that in all sections, the effect of each of the above indicators on the activity of reproduction centers was significant ($p<0.05$), but no statistically significant difference was observed in the limitations section ($p>0.05$) (Table 1).

Based on the ranking made by the Friedman test, the services and restrictions had the significantly highest and lowest impact due to the Coronavirus disease, respectively ($p<0.05$) (Table 2).

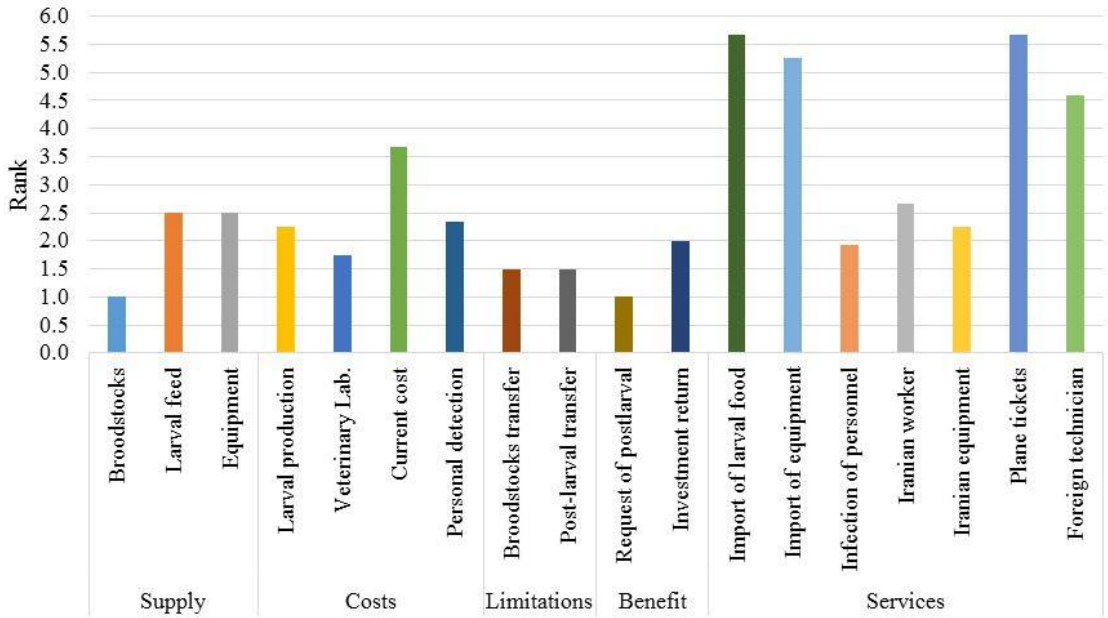

Figure 1: Ranking of effective indicators in shrimp hatchery centers.

Table 1: Chi-square coefficient and P-*value* of effective indicators in *L. vannamei* shrimp hatchery centers, farms, and processing centers in Bushehr, Iran.

	Supply	Costs	Limitations	Benefit	Services
Shrimp hatchery centers					
chi-square	10.800	8.878	0.000	6.000	25.133
df	2	3	1	1	6
P value	0.005	0.031	1.000	0.014	0.000
Shrimp farms					
chi-square	10.058	9.308	2.977	13.471	17.835
df	3	1	2	2	3
P value	0.018	0.002	0.226	0.001	0.000
Shrimp processing centers					
chi-square	0.500	20.170	0.000	5.375	8.069
df	1	4	1	2	2
P value	0.480	0.000	1.000	0.068	0.018

Shrimp farms

The results showed that Coronavirus disease had the most significant impact on post-larval and staff food supply in the supply sector. In terms of costs, the increase in current expenses had the largest impact. The prevalence of Coronavirus disease had little effect on road transport restrictions. While the reduction of prices and non-return of capital due to the lack of customers was the most important factor influencing the benefits sector. In the service sector, Coronavirus disease caused a deficit of shrimp harvesting labor and disrupted shrimp delivery in processing centers (Fig. 2).

Based on the Chi-square and Friedman tests, all the results of the effects of Coronavirus disease on different parts of shrimp farming were significant. The rankings based on the

Friedman test showed that the benefits and limitations sections had the significantly highest and lowest Coronavirus disease effects, respectively (p<0.05) (Table 1).

Table 2: Ranking of effective factors in *L. vannamei* shrimp hatchery centers, farms, and processing centers in Bushehr, Iran along with P-*value*.

	Supply	Costs	Limitations	Benefit	Services
Shrimp hatchery centers					
Rank	2.83	3.08	1.08	3.42	4.58
chi-square			18.586		
df			4		
P value			0.001		
Shrimp farms					
Rank	2.97	2.79	1.62	4.82	2.79
chi-square			43.786		
df			4		
P value			0.000		
Shrimp processing centers					
Rank	2.00	3.78	2.89	4.56	1.78
chi-square			22.541		
df			4		
P value			0.000		

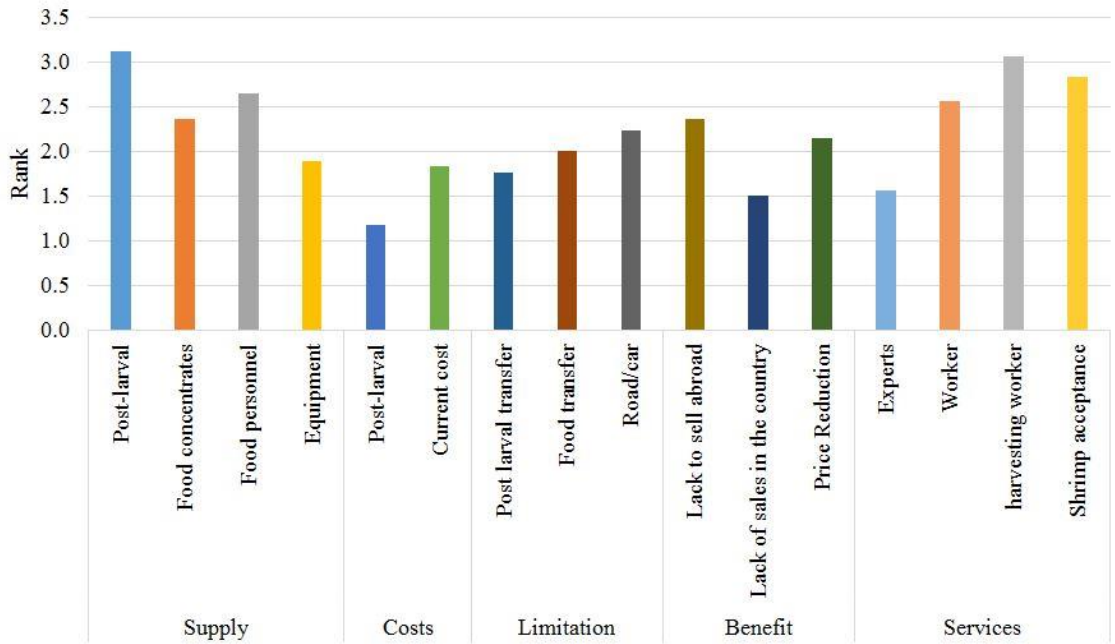

Figure 2: Ranking of effective indicators in shrimp farms.

Shrimp processing centers

The study results of the impact of Coronavirus disease on processing centers showed that there was little impact on equipment supply. In contrast, the sensitivity of shrimp packaging to Coronavirus disease had the most significant effect on increasing the cost of processing centers. Additionally, road restrictions and

exports due to the outbreak had little impact on the activity of shrimp processing centers. However, the decrease in shrimp prices and the lack of customers had a significant effect on the revenue generation of these centers. Labor shortages and increased personnel infections in the service sector due to Coronavirus disease had the most significant impact (Fig. 3).

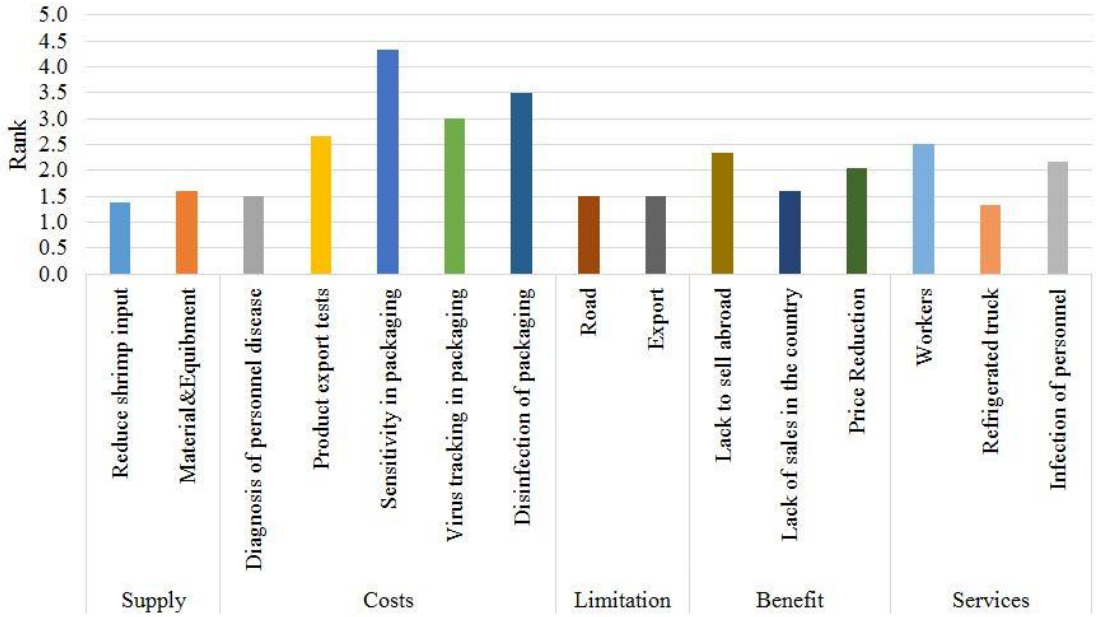

Figure 3: Ranking of effective indicators in shrimp processing centers.

According to the Chi-square and Friedman tests, except for the limitations section all sections were statistically significant (p<0.05) (Table 1).

A summary of the various influential sectors in the processing centers showed that, according to the ranking made by the Friedman test, the highest and lowest sector had the effects of Coronavirus disease benefits and services outbreaks, respectively (p<0.05) (Table 2).

Discussion

Litopenaeus vannamei has been cultivated as the first shrimp farmed species in Iran. The origin of imports of this species was Molokai, Kana Bay, and the Oceanic Institute of Hawaii Pacific University (OI) regions. Due to the issue of fluctuations in the price of the dollar and the devaluation of the national currency, as well as international sanctions, the last shipment of specific pathogen-free (SPF) L.vannamei broodstock to the country in 2016 was from the Molokai Broodstock Company (MBC). During this period, cooperation of relevant organizations such as the Iranian Veterinary Organization (IVO), Iranian Fisheries Science Research Institute (IFSRI), and Iran Fisheries Organization with the localization of farmed shrimp to broodstocks of this species in the country eliminated their dependence on imported broodstock

(Pazir *et al*., 2021). Therefore, during the outbreak of Coronavirus disease in the country, hatchery centers did not have any problems supplying L.vannamei broodstocks from reputable international centers and importing them. Hence, each of the hatchery centers met their needs by producing broodstocks, so the transfer of producers between the hatchery centers was rare. While border closures in India hampered the SPF broodstock imports from the United States, Madagascar, and Mexico (Kumaran *et al*., 2021), the beginning of the Coronavirus disease outbreak coincided with the start of the shrimp industry in Bushehr. Initially, due to traffic restrictions and the fear of individuals and private drivers contracting the disease, inter-provincial and inter-city transfers were challenging to carry out. However, there were no restrictions on public transportation.

However, in the early days of the global crisis, most airlines ceased operations, the reducing cargo capacity of agricultural goods significantly and disrupting the global food supply chain (Ivanov, 2020). Experts from Southeast Asian countries, particularly Thailand and Philippines, have produced post-larvae of shrimp in hatchery centers in Iran for many years. They were unable to travel to Iran due to the spread of Coronavirus and the closure of air and land borders. Although two months have passed since the beginning of the breeding season in the country, some hatchery centers in the Province did not have a breeding expert, but during this period, Iranian experts based on their work experience began to produce post-larvae shrimp. Due to the lack of shrimp larval feed factories in Iran, most shrimp hatchery activists have to purchase their equipment and food from unreliable shops and factories in Southeast Asia. These products are illegal in Iran.

Therefore, the coincidence of these transfers with the outbreak of Coronavirus disease and the closure of Thai Airlines on the one hand, and the lack of licenses for cargo ships to the UAE causing the imports of these materials and equipment to be delayed by three months from the beginning of the breeding season, along with other managerial factors, led to a reduction in the production of post-larvae shrimp in the hatchery centers of the Province, which was accompanied by an increase in the demand for post-larvae shrimp by shrimp farmers. Other issues and problems of the industry included currency fluctuations accompanying the devaluation of the national currency and international sanctions, which, in addition to imposing high costs on the industry, made it difficult to transfer money and goods internationally. Disrupted international transfer of money and goods was one of the industry's main problems (Blau, 2017). Simultaneously with the outbreak of Coronavirus disease, there was a severe disruption in meeting the daily needs of staff working in hatchery centers and shrimp farms, food for including broodstock such as squids, sea worms, and *Artemia* biomass. According to the

managers of these centers, the cost of providing these items had increased several times compared to the year before the outbreak of Coronavirus disease. On the other hand, due to the dependence of aquatic disease diagnostic laboratories on imported diagnostic kits, the increase in the cost of foreign exchange and international sanctions, and the closure of the country's land and air borders, the cost of testing for diseases reported by the IVO in broodstock and post-larval populations had risen sharply. Hence, all these factors led to an increase in the price of post-larval and production costs.

Despite the current economic problems and high unemployment rate in the country due to the outbreak of Coronavirus disease and restrictions on the movement of people from different areas, fortunately, there was no particular problem in the employment of labor in hatchery centers and farms. Due to the isolation of hatchery the lack of entry and exit of miscellaneous and people, contact of personnel working in these centers with other people, and most importantly, observing health issues from the beginning to the end of the breeding season, there were no reports of deaths of people working in these centers. The shrimp farming season in most parts of the lasts country once a year from May to December (Pazir *et al*., 2020), but due to the limited shrimp farming period, in delays larval production due to problems caused by the outbreak of Coronavirus disease in hatchery centers, centers had disrupted the supply and demand of post-larvae shrimp, especially at the beginning of the breeding season in Iran. Also, the coincidence of the outbreak of Coronavirus disease in Iran with the start of shrimp farms in Bushehr Province and the traffic restrictions created made it difficult to prepare the farms.

On the other hand, the main labor force working in shrimp farms in Iran consists of indigenous people and migrant workers from neighboring Provinces (Sistan and Baluchestan) and neighboring countries, especially Afghanistan. Despite the increasing prevalence of Coronavirus disease in the country and the rising incidence and daily casualties due to the condition in the Province, no particular problem was observed regarding the employment of labor in farms. As Iranian shrimp farms are located in farming complexes, there is no social distancing between the workers. Therefore, as asymptomatic people moved between different farms without wearing protective equipment such as masks, the disease spread among them, resulting in severe disruptions to rearing due to the removal of workers. There has been an increase in the prevalence of Delta-Coronavirus disease among workers and even farm managers this month. Other problems during the rearing period were the increase in the price of shrimp feed and the running costs of hatchery centers and shrimp farms; which main reasons for this event were the closure of borders and the reduction

of imports of raw materials for shrimp feed mills and other food needs. The devaluation of the national currency and the increase in economic inflation coincided with the prevalence of Coronavirus disease led to a marked increase in the production cost. Hence, in 2020, following the outbreak of Coronavirus disease, the cost of production increased by 57.22% compared to 2019, but with the continuing prevalence of the disease in 2021, this rate was again accompanied by a 45.19% increase compared to 2020 (APTUI, 2021). Kumaran *et al*. (2021) found that the Covid-19 outbreak in India caused shrimp hatcheries, farms, processors, retailers, and exporters to lose an estimated 30 to 40 percent of their business worth $1.50 billion in the wake of India's lockdown. Although aquaculture products are very expensive for domestic consumers, dealers buy these products from farmers at very low prices. Therefore, if the disease is not controlled and it spreads again due to the continuation of the created restrictions, it may cause a lot of economic damage in the next cropping season (Hasan *et al*., 2021).

Due to the outbreak of shrimp white spot virus disease and issues related to the seizure of shrimp shipments from Ecuador and Saudi Arabia in China last year due to contamination of product packaging with the Coronavirus disease (Seaman, 2020), shrimp processing centers and related organizations have considered special planning. Therefore, before starting the work of these centers, a series of preventive instructions were incorporated, including the use of masks and gloves and not using infected people in shrimp processing centers, as well as disinfection of equipment and tools. These measures were associated with increased product processing costs. Regarding labor employment in processing centers, the results showed that there was no disruption in this area. However, due to the outbreak of shrimp white spot virus disease at the end of the culturing season in 2020 and the increasing tendency of breeders to harvest shrimp early due to fears of increased white spot syndrome disease losses, many shrimp processing centers faced large quantities of harvested shipments, which was sometimes caused by labor shortages due to the employment of workers in two or three 8-hour shifts per day. On the other hand, despite the prevalence of Coronavirus disease in the country and the increase in cases and mortality, studies conducted during the shrimp harvest season showed that the prevalence of this disease had little effect on shrimp harvest, its transfer from farms to processing centers and from these centers to export ports (Kakoolaki *et al*., 2020).

In Iran, during the shrimp farming period, no antibiotics or additives are used, which is why most Iranian shrimps are exported. Many exporters bought shrimp in excess of their ordinary capacity, despite the decrease in demand for shrimp in global markets due to the outbreak of Coronavirus disease. They did so in the hope that

customers, mainly Chinese traders, would purchase the product. Similar findings were observed in related demand of aquaculture animal products including finfish in Bangladesh, Myanmar, India, Egypt, Nigeria, and Malaysia (Waiho *et al*., 2020; Belton *et al*., 2021; Hasan *et al*., 2021; Sunny *et al*., 2021), shrimp in India (Kumaran *et al*., 2021), and in seafood trade worldwide (Coll *et al*., 2021; Love *et al*., 2021). Despite the closure of global markets, tourist centers, and restaurants following the outbreak of Coronavirus disease (Hoque *et al*., 2020), as well as international sanctions and problems due to the movement and transfer of products to global markets, shrimp buyers, due to fear of the heavy fines in the international community, have little interest in the Iranian shrimp market.

However, due to such conditions, most of Iran's shrimp exports are sold to world markets through illegal sources and sometimes under the name of another country's product, causing many shrimp buyers to be aware of the country's economic situation and intervene in shrimp pricing, buying the product at lower prices than expected. Consequently, during the last two years, the prevalence of Coronavirus disease in the country, despite the increase in shrimp production costs, led to estimates of a 65% decrease in the global purchase price of shrimp last year (Bashar *et al*., 2021; Kumaran *et al*., 2021). Simultaneously with the reduction in the price of shrimp and the lack of export of the product, less than 35% of the harvested shrimp was exported by January 2021, with most of the harvested shrimps stored in cold storage processing centers. All of these factors led to the imposition of additional costs on various segments of the shrimp industry. By March 2021, following the implementation of the global vaccination plan and the lifting of some restrictions in the world, and the reopening of restaurants and tourist centers, most of the product was exported at lower prices than last year.

Due to the sudden increase in the price of foreign currencies in the country, especially the dollar, the decrease in the price of purchasing the product was accompanied by an increase in the income of industry activists. Consequently, this year, with the multiplication of production most of this production, despite the revenue was spent costs. Furthermore, on restarting due to the prevalence strains of several of Coronavirus disease in the country in recent months, the such strain, as delta and the infection of many people in the Province, especially shrimp farmers, and approaching shrimp harvest season, it is possible that some countries may impose new restrictions on imports of products such as shrimp to prevent the introduction of new strains of Coronavirus disease into their country. In such a situation, the possibility of not selling the product this year or a sharp price drop remains strong. This industry is usually considered one of the most lucrative and employment-generating industries in the country, but if such a situation continues, industry activists will suffer severe losses.

In conclusion, all chains of the shrimp production industry in Iran, from hatchery centers to shrimp farms, processing centers, and feed factories, are highly interdependent; however, in the event of any disruption in one sector, the other parts will also be affected. Overall, it can be concluded that the Coronavirus disease has had a major impact on the shrimp industry in Bushehr, Iran. Firstly, the Coronavirus increased the number of infected people who engaged in the shrimp industry and caused contamination of shrimp packages, which resulted in not selling shrimp products and ultimately led to a drop in the price. Secondly, the decrease in income from shrimp export can jeopardize job security and reduce job creation. Subsequently, this can lead to the bankruptcy of the industry. In order to prevent the industry from going bankrupt, the governmental authorities must take serious actions after the public has been vaccinated.

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