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Water quality in culture ponds of pacific white shrimp, *Litopenaeus vannamei* (Boone, 1931) at selected locations in Rajasthan and Punjab

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Abstract
The greatest economic increase has been seen in the world's prawn output. India is one of the biggest exporters of prawns due to substantial developments in brackish water aquaculture. Shrimp farming has been growing dramatically in inland saltwater. The current study was conducted at three designated aquaculture shrimp farms in the locations of Partappura (Sri Ganganagar), Taranagar (Churu) in Rajasthan and Shamkhera (Muktsar Shahib) in Punjab. Two ponds were randomly chosen from each of the locations. From March to July 2022, all of these chosen shrimp farm locations were visited once every fifteen days to gather water samples. Among the water quality parameters, Air temperature was recorded between 30.6°-46.2 °C, Water temperature 24.4°-33.1 °C, Transparency 40.1-45.2 cm, pH 7.8-8.6, Salinity 16.7-25.7 ppt, Electrical conductivity 8.99-9.87 mS/cm, Total dissolved solids 3965-6978 mg/l, Dissolved oxygen 5.87-6.34 mg/l, Ammonia 0.21-1.21 mg/l, Nitrate 0.07-2.53 mg/l, Sodium 1169-1793 mg/l, Potassium 71.09-126.3 mg/l, Magnesium 817-1136 mg/l and Ortho-phosphate 0.19-0.67 mg/l. Collected water parameters were used to established a combined correlation between all the recorded parameters.

Keywords: Shrimp, water quality, *Litopeneaus vannamei*, culture practice

Introduction
Global fish production is estimated to have reached about 178 million tonnes in 2020, of which 87.5 million tonnes, valued at USD 264.8 billion, came from aquaculture production. Of the overall, total 157 million tonnes were used for human consumption, equivalent to an estimated annual supply of 20.2 kg per capita. Aquaculture accounted for 49.2 percent of the total production of aquatic animal. The species with the highest amount of production in 2020 at the species level was the white leg shrimp (*Penaeus vannamei*), with 5.8 million tonnes. (FAO, SOFIA, 2022). Global economic growth in the prawn farming industry has been the fastest. In nations with tropical and subtropical environments, this activity is gradually increasing. In India's fisheries industry, production of shrimp culture plays a key role. Despite producing significant quantities of different carp species, India's seafood export industry mostly depends on the production of shrimp. When it comes to all the sea foods that are exported internationally, shrimp make up 17% of exports. Over the past ten years, frozen shrimp has been the most valuable and significant export. During 2019–20, India exported 6.52 lakh MT of frozen shrimp for US$4889.12 million. Frozen shrimp account for 50.58% of all sales and 73.21% of total USD revenue. The single highest contribution to seafood exports is farmed *L. vannamei* shrimp, with 5.12 lakh MT. (MPEDA, 2022) [2].

A major ecological issue, soil salinization has a detrimental influence on more than 100 nations' agricultural productivity and to varied degrees on the financial well-being of their farming populations. The world's largest inland saline lands are located in dry, semi-arid, low-lying, and poorly drained regions, where soils with high salt concentrations accumulate. It has been shown that salt affects more than 1,300 million hectares worldwide, which has a negative influence on their agricultural productivity and the rural economies of many developing nations, including India. There are 6.74 million hectares of salt-affected land in India, including coastal saline soils. Of that total, 1.20 million hectares are in the northern, non-coastal Indo-Gangetic plains, which span seven states and include Punjab (1.51 lakh ha), Haryana (2.32 lakh ha), Bihar (1.53 lakh ha), Uttar Pradesh (1.37 lakh ha), Madhya Pradesh (1.39 lakh ha), Jammu and Kashmir (0.17 lakh ha) and maximum in Rajasthan (3.75 lakh ha).

(Ansal and Singh, 2019) [3].

Due to the higher revenues than traditional farming or fishing, inland saline shrimp farming has been expanding quickly. It has had a significant impact on the socioeconomic growth of Haryana, Punjab, Uttar Pradesh, Rajasthan, and Maharashtra. New production systems have been created as a result of rising demand for aquaculture. A number of nations, including Israel, the USA, India, and Australia, engage in inland saline water shrimp farming, which is defined here as land-based aquaculture using saline groundwater. One of the most popular aquaculture species is the Pacific white leg prawn (*Litopenaeus vannamei*), which is the world's most widely cultivated shrimp. It is liked by many people because of its excellent flesh quality, delectable flavour, and nutritional benefits, as well as how simple it is to produce. *L. vannamei* is a salinity-tolerant shrimp species that may be grown at high densities in a variety of salinities. To fulfil the rising demand for seafood, expand aquaculture productivity, motivate farmers to engage in *L. vannamei* farming, and improve socioeconomic position of the population, inland saline shrimp farming must be implemented. (Rao *et al.*, 2022) [4]. Thus, the current study was conducted to record the water quality parameters of *L. vannamei* culture ponds, used to establish correlation between all the recorded water quality parameters utilising underground inland saline water.

Materials and Methods

Surface water samples from each of the chosen ponds were taken throughout the study period using plastic buckets every two weeks. Water samples were kept in one-liter laboratory-grade plastic bottles with airtight lids so that specific quality standards for water could be analysed in a lab.

Analysis of collected samples

Various physical and chemical characteristics of water samples were examined in accordance with APHA (2005) [5]. Using a standard digital meter (035, Erma), pH, electrical conductivity, and TDS were examined. A hand refractometer (Brix Refractometer with ATC) was used to test the salinity of all the experimental ponds. An ammonia test kit (Salifert Ammonia test kit) was used to measure the amount of ammonia. A flame photometer was used to examine the components of sodium, potassium, and magnesium.

For a meaningful conclusion of correlation of water quality parameters SPSS 16.0 was used.

Results and Discussion

The biological activity in the culture pond and weather conditions have an impact on the water quality (Milstein, 1993) [6]. An essential primary factor in the current study was the air temperature range, which was discovered to be between 30.6-46.2 °C from March to July 2022. Among the water quality parameters, water temperature is a major factor ranges between 24.4°-33.1 °C which is similar to the 29°-34 °C founded optimum (Junda, 2008) [7] for *L. vannamei* culture. One of the most significant pond water characteristics that is affected by various kinds of factors is pH. According to the current study, the pH of the water was between 7.8 and 8.6 in all of the experimental ponds, which is equivalent to 6.95 to 8.38, which is advantageous for *L. vannamei*, as reported by Ganesh *et al.* (2016) [8]. The salinity in all the experimental ponds ranged between 16.7-25.7 ppt which is correspondence to 13-22 ppt was reported by Junda (2018) [7] for *L. vannamei* culture in inland saline water. The range of EC was 8.99-9.87 mS/cm which is found in between the range of 2.08-14.35 mS/cm suggested by Poonkodi *et al.* (2017) [9] and was favourable for *L. vannamei* cultutre. DO level was recorded between 5.87-6.34 mg/l which is similar to DO level between 4.4-8.6 mg/l (Ganesh *et al.*, 2016) [8] in shrimp culture ponds. Ammonia in the culture ponds was between 0.21-1.21mg/l similar to 0.02-1.07 mg/l is reported favourable for shrimp culture by Ganesh *et al.* (2016) [8]. The nitrate was ranged between 0.07-2.53 mg/l and found optimum for *L. vannamei* culture according to Ganesh *et al.* (2016) [8] reported nitrate range between 0.01-6.40 mg/l is favourable for *L. vannamei* culture. The magnesium values were recorded in present study between 817-1136 mg/l similar to 998-1032 mg/l (Venkateswarlu *et al.*, 2019) [10] reported magnesium ranges favourable in culture ponds of shrimp.

Correlation

Any relationship between two variables is known as correlation. When an increase or decrease in the value of one parameter is accompanied by an equivalent increase or decrease in the value of the other, this is referred to as a direct correlation. When one parameter increases and the other increases as well, the correlation is said to be positive. Conversely, when one parameter increases and the other parameter decreases as well, the correlation is said to be negative. The value of the correlation coefficient (r) ranges from +1 to -1. The water temperature has shown a significant positive relationship with air temperature, salinity, EC, TDS, sodium, potassium, magnesium and Ortho-phosphate however, a significant negative relationship was recorded with nitrate. The EC has shown a significant positive relationship with TDS similar to Shroff *et al.* (2015) [11]. The transparency has shown a significant negative relationship with TDS similar to Alam *et al.* (2015) [12]. The pH has shown a negative relationship with Temperature which is similar to Alam *et al.* (2015) [12]. Similarly, correlation of different water quality parameters can be seen in the Table 2.

Table 1: Range of Water Quality Parameters at all the Locations.

	Pratappura (Sri Ganganagar)		Taranagar (Churu)		Shamkhera (Muktsar Shahib)	
Parameters	**P-1**	**P-2**	**P-1**	**P-2**	**P-1**	**P-2**
Air Temp. (°C)	30.6-41.3	30.6-41.3	31.2-46.1	31.2-46.1	31.9-41.8	31.9-41.8
Water Temp. (°C)	24.6-32.1	24.4-32.3	25.3-33.1	25.6-32.8	26.5-30.3	26.3-30.1
Transparency (cm)	42.8-45.2	41.5-44.1	40.1-42.6	40.7-43.6	41.3-44.3	40.1-44.9
pH	8.1-8.6	7.9-8.5	8-8.6	7.9-8.6	7.9-8.6	7.8-8.6
Salinity (ppt)	17.1-18.7	17.2-18.8	23.4-25.3	23.2-25.7	16.8-17.8	16.7-17.9
EC (mS/cm)	8.99-9.7	9-9.73	9.13-9.87	9.09-9.7	9.06-9.26	9.09-9.28
TDS (mg/l)	3965-4287	3978-4219	6239-6978	6109-6710	4359-4469	4378-4476
DO (mg/l)	5.9-6.22	5.87-6.2	5.87-6.27	5.97-6.32	6-6.34	6.12-6.33

Ammonia (mg/l)	0.32-1.07	0.36-1.17	0.42-1.21	0.39-1.17	0.21-1.03	0.24-0.98
Nitrate (mg/l)	1.89-2.42	1.98-2.31	0.09-0.61	0.07-0.68	2.12-2.53	2.09-2.49
Sodium (mg/l)	1196-1287	1169-1296	1693-1789	1694-1793	1180-1232	1199-1243
Potassium (mg/l)	71.09-77.63	72.72-79.31	108.9-124.7	110.6-126.3	75.41-78.29	75.59-79.34
Magnesium (mg/l)	827-917	817-918	1037-1136	997-1135	847-929	834-917
Ortho-phosphate (mg/l)	0.2-0.29	0.19-0.3	0.51-0.61	0.49-0.67	0.25-0.36	0.21-0.35

Table 2: Correlation of water quality parameters in *Litopenaeus vannamei* ponds at all Locations

Parameters		**Air Temperature**	**Water Temperature**	**Transparency**	**pH**	**Salinity**	**EC**	**TDS**	**DO**	**Ammonia**	**Nitrate**	**Sodium**	**Potassium**	**Magnesium**	**Ortho-phosphate**
Air Temperature	Pearson Correlation	1													
Water Temperature	Pearson Correlation	.853**	1												
Transparency	Pearson Correlation	-.040	-.009	1											
pH	Pearson Correlation	-.119	-.049	.000	1										
Salinity	Pearson Correlation	.547**	.502**	-.463**	-.251	1									
EC	Pearson Correlation	.430**	.410**	-.213	-.134	.522**	1								
TDS	Pearson Correlation	.503**	.403**	-.511**	-.336*	.967**	.448**	1							
DO	Pearson Correlation	-.055	-.138	-.320*	-.055	-.105	-.287*	-.001	1						
Ammonia	Pearson Correlation	-.150	-.252	-.142	-.167	.316*	.169	.320*	-.254	1					
Nitrate	Pearson Correlation	-.493**	-.493**	.497**	.255	-.975**	-.435**	-.956**	.040	-.207	1				
Sodium	Pearson Correlation	.452**	.392**	-.495**	-.266	.979**	.441**	.977**	-.050	.373**	-.973**	1			
Potassium	Pearson Correlation	.483**	.388**	-.503**	-.295*	.978**	.454**	.989**	-.047	.371**	-.955**	.982**	1		
Magnesium	Pearson Correlation	.495**	.392**	-.496**	-.235	.939**	.426**	.949**	-.016	.398**	-.912**	.947**	.959**	1	
Ortho-phosphate	Pearson Correlation	.458**	.401**	-.548**	-.303*	.938**	.414**	.946**	.045	.288*	-.940**	.935**	.938**	.908**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Conclusion

In conclusion the outcome of the present study indicates that, the water quality parameters at the selected locations are favourable for *L. vannamei* culture using inland saline water. Using this study futures studies can conduct to understand about water quality parameters for *L. vannamei.*

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