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Vikas Mali
College of Fisheries, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

BK Sharma
College of Fisheries, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

SK Sharma
College of Fisheries, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

B Upadhyay
College of Fisheries, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Corresponding Author:
Vikas Mali
College of Fisheries, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Analytical study of the effect of salinity on growth and survival of *Artemia nauplii* in inland saline water of Didwana Lake, Rajasthan

Vikas Mali, BK Sharma, SK Sharma and B Upadhyay

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Abstract
The brine shrimp *Artemia* (Crustacea, Branchiopoda) lives in hypersaline lakes distributed all around the world. It is widely used as live prey in larviculture for many advantages, especially easy operation, adequate size and nutritional quality. Many sites have been exploited for its cysts, and demand from aquaculturists remains increasing. The population of *Artemia salina* was reared at 5 different salinities (80, 100, 120, 140 and 160 ppt) using fermented feed made with baker's yeast, rice floor and ground nut oil cake used as food. Larval development, population growth and survival were studied. At the highest salinity tested (160 ppt), growth was slower and lower survival due to natural mortality was observed possibly this was due to oviparous type of reproduction in which the number of offspring is generally lower or may not present. The increment of number of *nauplii* of Artemia at lower salinities 80, 100, 120, 140 ppt was due to the ovoviviparous kind of reproduction in lower salinity regimes, pre-adult stage was longest, reproductive traits were relatively rapid, with a precocious sexual maturity and a highest total offspring were observed in treatment with salinity 100 ppt.

Keywords: *Artemia nauplii*, salinity, growth, survival, inland saline water

Introduction

Aquaculture accounts for 85% of total fish output in India. It has enormous potential to feed not just the growing human population, but also as a feed component in the diets of many domesticated animals with great economic value. Because of the vast resources available in coastal and oceanic waters, including rivers, wetlands, mangroves, and inland saline water bodies, India has enormous potential for aquaculture development, which will lead to an increase in fish production, resulting in increased youth employment, GDP, and nation growth. In acknowledgement of the sector's expansion, the Indian government created various fisheries-related research institutes (Silas, 2003) [18]. Until the early 1970s, these initiatives were mostly focused on finfish production, although enormous expansion in shrimp aquaculture was also achieved during this time period. Previously, these systems were completely reliant on wild fish or shrimp seed collected from riverine or estuary resources to furnish seed stock, which became one of the limiting issues impeding developments in culturing systems. With the introduction of controlled breeding of carp in bundhs and shrimp with eyestalk ablation, the constraint was removed.

Central Marine Fisheries Research Institute of ICAR achieved effective shrimp seed production at Narakkal, Kerala (Silas, 2003) [18]. The Marine Products Export Development Authority then constructed commercial shrimp hatcheries (MPEDA). The MPEDA has exhibited semi-intensive culture technique on a trial size initiative (Muralidharan, 2010) [14]. These methods, together with more farmer experimentation, were effective, resulting in large-scale growth of this industry as shrimp aquaculture took root in India. The overall farming area dedicated to shrimp farming expanding day by day, this offered work possibilities in isolated coastal settlements, ensuring financial stability for the impoverished and bringing significant foreign cash into the country. The species of shrimp usually used in the early period of aquaculture in India are *P. monodon* and *F. indicus* were initially the most popular. Currently, alternative species *L. vannamei* is widely used. *L. vannamei* has a number of desired features such as higher growth rates, a broad range of salinity tolerance, higher level stocking densities and lower requirements for dietary protein. Substantial variations have already occurred in the shrimp culture industry in India from the 1990's to the present.

The apparent diversification in this sector is vast due to the diversity of prevailing aquatic species (Duarte *et al*., 2007) [9], but the bottleneck of high larval mortalities threatens the realization of this potential. As the demand for seafood has increased, technology has made it possible to produce food in coastal marine waters and in the open ocean, this expansion requires fish seed and for the successful culture operations of fin fishes and shellfishes, feeding the larval, juvenile and adult stages with appropriate, nutritionally balanced, non-polluting, economically viable and readily acceptable feed to obtain the optimum growth and survival, is considered as one of the major requirements in aquaculture practices the world over it can only be met by the live feed source so called *Artemia*.

Artemia cyst consumption increased to several hundred tons annually as a result of worldwide expansion of the commercial larviculture of marine fish, shrimp and prawn. Although the present commercial cyst supply doesn't meet the demand and became the major bottleneck in the expansion of seed and larval production of marine fish, ornamental fish, prawn, shrimp. *Artemia* has high nutritive value that helps in good immunity and health status with higher survival in larval stages of fish and shrimp in hatchery or nursery ponds so-called by us as super-capsule.

It is a non-selective phagotophic filter feeder that may be fed a variety of living and inert foods (Provasoli and Shriashi, 1959) [15]. It has ability to tolerate high level of temperature and salinity also called magic powder in the aquaculture industry (Wright, 2017) [23], high conversion efficiency, short generation time, high fecundity rate and considerable long-life span. Diverse micro flora of pond water enhances the overall productivity in water thus this tiny creature also helps in obtaining improved salt quality. All the life stages of *Artemia*, i.e., cysts (after decapsulation), *nauplii*, juveniles, sub adults and adults are used as feed in aquaculture operations according to the feed size requirement of the predator (Kumar and Babu, 2015) [13]. As the temperature and salinity significantly affect survival, with the effect of temperature more pronounced (Vanhaecke *et al*., 1984) [22]. More than 85% of marine organisms which are bred in aqua hatcheries world over today are fed with *Artemia nauplii* as a sole diet or in combination with other live or inert food item. It became more widespread due to its nutritional value for larval organism. The dormant cyst of Artemia can be stored for long in cans. As it can be utilized as of the shelf food requires only 24 hr. of incubation.

Local production of Artemia cysts and Artemia biomass in solar salt ponds may be dynamic for the development of the local and national aquaculture sector. In solar salt unit, active management to enhance productivity may be minimal, but the highest productivity is reached when intensive management procedures are applied (Baert *et al*. 1997) [5]. However, in spite of its relative success, peer-reviewed literature on Artemia in pond production system is limited. A limited number of literature sources report on the specific scientific experiments conducted in pond conditions, aiming to positive enhancement of Artemia production (De los Santos *et al*., 1980; Anh *et al*., 2010; Gao *et al*., 2017) [8, 2, 11]. Differences in form of body of Artemia under the influence of the salinity of the external medium were reported by many workers (Schmankewitsch, 1875, 1877; Bateson, 1894; Anikin, 1898) [17, 6, 3].

A vast area in western Rajasthan is under salt production and these solar salt pans offer excellent scope for carrying out Artemia culture. Most of the infrastructure required for production is already available with associated areas and Artemia forms a valuable byproduct to salt farmers.

Materials and Methods

The present research has been carried out in August, 2022 to investigate the relation of salinity on growth and survival of *Artemia salina*, to assessing the brine shrimp production potential of Didwana Lake situated in Nagaur District of central Rajasthan. The experiment was conducted in indoor conditions.

Eggs of *Artemia salina* were used for this experiment. Stock cultures of Artemia were maintained in five salinities (80, 100, 120, 140, 160ppt) for its culture. In all experiments on growth and form the animals were reared under constant culture conditions with controlled feeding. As 1000-liter capacity cylindrical FRP tank were used for the rearing of *Artemia nauplii*. Before initiation of experiment hatching was done separately in all tanks. The initial stocking density was maintained at 100 nauplii/50ml in all salinities with respective tanks. Hatching rate was cross estimated by counting the number of *Artemia naupili* 50 per ml to avoid the errors and ommissions as the hatching rate of the available Artemia cyst was 80% and these were stocked at the rate of 2.5 g per 800 liter of water in FRP tanks those which are having 1000-liter capacity, out of this 2.5 g Artemia is having 5 lack number of cyst and 4 lack was hatched out with 80% hatching rate, so finally leading to the calculation of 100 nauplii/50ml.

The water exchange was performed every two days. Half of the raising water was dumped. At the same time, the same volume of freshly produced water was filled with different salinities as per treatment. Physical water quality factors such as DO, temperature, total alkalinity, nitrate and pH were measured once on biweekly basis. Survival in each rearing medium was determined at the conclusion of the culture period i.e., last day of experiment, and population growth was calculated on a weekly basis. Four replicates were maintained for each salinity.

A. Physiography and Climate of central Rajasthan

Nagaur is mainly part of arid climate with hot summer. Sand storms are common in summer. The climate of the district marked by extreme dryness, extreme temperature fluctuations and erratic rainfall patterns. The district's highest recorded temperature is 47.2 °C, while the lowest recorded temperature is 0 °C. The district's average temperature is 23.3 °C. The winter season lasts from mid-November to early March. The rainy season is only a few months long, lasting from mid-July to mid-September. 349.8mm of rain falls on average per year in the district.

B. Study area

The Lake Didwana, the district of Nagaur is situated in Rajasthan's middle. It is bordered in the north by the districts of Bikaner and Churu, in the east by the districts of Sikar and Jaipur, in the south by the districts of Pali and Ajmer, and on the western side by the district of Jodhpur. It has an area of 17,805.1 sq km and is located between 26° 24' 01.10" and 27° 42' 28.21" north latitude and 73° 04' 43.46" and 75° 22' 04.08" east longitude. Since a large portion of the district lacks a formal drainage system, the majority of the middle and northern region is included in the "Outside" Basin. Both the Sekhawati River and the Luni River drain into the Nagaur districts southwest and southeast, respectively.

C. Salient Features of Didwana Lake

Phytoplankton of Didwana was composed of only 9 genera including *Anabaena* and *Nodularia*. Didwana Lake once contained *Artemia*, is now totally devoid of them. Nutrient enrichment in the lakes was low.

D. Research analysis

1. Water quality analysis

Water quality parameters such as salinity, water temperature and pH, dissolved oxygen, total hardness, total alkalinity, nitrate were determined in laboratory, using standard methods of APHA (2017) [24].

2. Population growth

Population Growth was measured by Growth increment summation method as suggested by Rigler and Downing (1984) [16]. Straight line percent change method was used for determining the growth among different stages of experiment.

Growth rate = Final-Initial/Initial
Percent change = growth rate × 100

3. Survival of Artemia

The survival of the adult Artemia will be analyzed by counting the *nauplii* per 50 ml of water at 7th, 14th, 21st, 28th day. This amount of water is taken from all the treatments and replicates respectively after proper stirring of water for gentle or equal mixing of the Artemia, after this 50 ml of water is taken randomly and number of live Artemia was counted manually with patience.

Results

The results pertaining to the water quality parameters, growth and survival of Artemia in different experimental units during the study period i.e., August, 2022 are presented in tables 1 to 3. The data regarding water quality parameters, growth is depicted with fortnightly variations at different experimental tanks having different salinity whereas data for survival are taken at end of experimental period. Overall average values are also given with their means, minimum and maximum values. The statistical analysis with variables of stations and their interactions has also been attempted by establishing correlation between various parameters.

Water temperature

Water is a valuable resource that is essential to the survival of all living organisms. The average temperature of the water ranged from 26.02 to 26.2 °C. The highest average temperature was recorded in T_0 and the lowest in T_1 (Table 1).

pH

In all of the treatments, the pH of the experimental water was almost alkaline. The pH range of the water was determined between 8.4 and 9.9, the maximum value of water pH was recorded 8.5 in treatment T_0 and the minimum of 9.9 was recorded in T_4 (Table 1).

Dissolved Oxygen (DO)

The range of dissolved oxygen was 9.27 to 9.55 mg/l in T_1 indicated fluctuations in DO concentration. The lowest mean value of DO (9.38 mg/l) was found in T_0, T_1, T_2 while the highest mean value of DO (9.43 mg/l) was found in T_3, T_4 (Table 1).

Total Alkalinity

The total alkalinity of experimental water ranged between 112 to 209 mg/l in T_0 and T_4 respectively, the highest mean value of total alkalinity (208 mg/l) was recorded in T_4, whereas, the lowest mean value of alkalinity (114 mg/l) was recorded in T_1 (Table 2).

Hardness

The range of hardness in this study is 1515 to 2357 mg/l, with T_0 having the highest mean hardness value (1524 mg/l) and the lowest mean hardness value (2355 mg/l), observed in T_4 (Table 3).

Nitrate

The nitrate in experimental water ranged between 133 to 164 mg/l in T_0 and T_4 The highest mean value of nitrate (162 mg/l) was recorded in T_4, whereas, the lowest mean value of nitrate (135 mg/l) was recorded in T_0 (Table 1-3).

Table 1: Water quality parameters for 1st day during experimental period with different treatments

		pH	Hardness	Temperature	Dissolved oxygen	alkalinity	Nitrite
T0	R1	8.50	1500.00	26.80	9.30	110	130
	R2	8.40	1540.00	27.00	9.40	115	135
	R3	8.50	1520.00	26.80	9.30	113	133
	R4	8.40	1530.00	27.00	9.40	111	131
T1	R1	8.50	1885.00	26.90	9.40	128	140
	R2	8.70	1905.00	26.90	9.30	135	139
	R3	8.60	1890.00	27.10	9.20	137	137
	R4	8.60	1910.00	27.00	9.20	132	140
T2	R1	8.90	2250.00	26.90	9.40	188	141
	R2	9.00	2195.00	26.80	9.30	184	142
	R3	9.00	2225.00	27.00	9.40	195	139
	R4	8.90	2233.00	27.00	9.50	190	145
T3	R1	9.50	2300.00	26.90	9.30	195	149
	R2	9.50	2310.00	26.80	9.40	190	155
	R3	9.40	2310.00	27.00	9.30	198	153
	R4	9.50	2305.00	27.00	9.40	193	155
T4	R1	10.00	2350.00	27.00	9.40	200	160
	R2	9.80	2360.00	26.90	9.30	210	161
	R3	9.90	2350.00	26.90	9.30	205	155
	R4	10.00	2360.00	26.90	9.40	207	157

Table 2: Water quality parameters for 14th day during experimental period with different treatments

		pH	Hardness	Temperature	Dissolved oxygen	Alkalinity	Nitrite
T0	R1	8.50	1500.00	25.10	9.40	115.00	133.00
	R2	8.60	1520.00	26.10	9.40	110.00	135.00
	R3	8.50	1520.00	26.10	9.30	115.00	133.00
	R4	8.60	1520.00	25.10	9.30	112.00	132.00
T1	R1	8.60	1900.00	26.10	9.40	135.00	139.00
	R2	8.70	1910.00	26.20	9.30	138.00	140.00
	R3	8.60	1910.00	26.20	9.30	137.00	141.00
	R4	8.70	1900.00	26.10	9.20	135.00	140.00
T2	R1	8.90	2220.00	26.20	9.40	195.00	142.00
	R2	9.00	2230.00	26.20	9.40	190.00	141.00
	R3	8.90	2225.00	26.10	9.30	188.00	144.00
	R4	8.90	2220.00	26.10	9.30	195.00	144.00
T3	R1	9.30	2300.00	26.10	9.40	198.00	156.00
	R2	9.40	2310.00	26.20	9.50	195.00	155.00
	R3	9.40	2300.00	26.20	9.40	198.00	158.00
	R4	9.40	2310.00	26.20	9.50	198.00	159.00
T4	R1	10.00	2360.00	26.00	9.40	210.00	160.00
	R2	9.90	2360.00	26.10	9.30	200.00	164.00
	R3	9.90	2350.00	26.10	9.50	210.00	157.00
	R4	10.00	2350.00	26.10	9.50	210.00	160.00

Table 3: Water quality parameters for 28th day during experimental period with different treatments

		pH	Hardness	Temperature	Dissolved oxygen	Alkalinity	Nitrite
T0	R1	8.60	1540.00	25.50	9.40	115.00	135.00
	R2	8.70	1530.00	25.60	9.50	118.00	138.00
	R3	8.60	1530.00	25.50	9.40	114.00	139.00
	R4	8.70	1540.00	25.60	9.50	116.00	137.00
T1	R1	8.70	1890.00	25.50	9.60	138.00	140.00
	R2	8.70	1900.00	25.60	9.50	135.00	142.00
	R3	8.80	1890.00	25.50	9.60	136.00	142.00
	R4	8.60	1910.00	25.60	9.50	138.00	140.00
T2	R1	9.00	2240.00	25.50	9.50	190.00	142.00
	R2	9.00	2250.00	25.50	9.40	195.00	144.00
	R3	8.90	2240.00	25.60	9.30	198.00	142.00
	R4	9.10	2240.00	25.40	9.40	195.00	144.00
T3	R1	9.30	2300.00	25.40	9.40	198.00	155.00
	R2	9.40	2310.00	25.50	9.50	200.00	160.00
	R3	9.40	2310.00	25.50	9.40	200.00	160.00
	R4	9.30	2300.00	25.40	9.60	198.00	158.00
T4	R1	10.00	2360.00	25.50	9.50	210.00	160.00
	R2	10.00	2360.00	25.50	9.60	208.00	168.00
	R3	9.90	2350.00	25.60	9.50	208.00	164.00
	R4	10.00	2350.00	25.60	9.40	210.00	164.00

B. Population Growth

Growth of artemia population was analysed using the ANOVA it shows significant difference in various treatments the growth with respect to salanity shows major variation as well as the survivability also swings in the Artemia population. T_1 with salinity 100 ppt is showing maximum growth rate whereas T_4 with 160 ppt for the experimental period showing decline in the initial stocking population, this type of result is reflecting may be due to oviparous type of reproduction in which the number of offspring is generally lower or may not present.

The increment of number of *nauplii* of Artemia is seen at 80, 100, 120, 140 ppt was due to the ovoviviparous kind of reproduction in lower salinity regimes as female is producing new batch of eggs in every 5 days.

Table 4: Population growth and survivability of *Artemia* at various salinities

	C	T1	T2	T3	T4
	80 ppt	**100ppt**	**120ppt**	**140ppt**	**160ppt**
Day 7th	$96^a \pm 1.41$	$96.25^a \pm 1.5$	$97.25^a \pm 1.70$	$92.75^a \pm 0.95$	$91^a \pm 2.44$
Day 14th	$112.25^a \pm 3.5$	$109.25^a \pm 3.59$	$107.75^a \pm 3.86$	$96.5^a \pm 2.08$	$90.75^a \pm 2.21$
Day 21st	$128.5^b \pm 2.51$	$143.25^b \pm 1.70$	$135^b \pm 2.94$	$104.25^b \pm 1.89$	$87.75^a \pm 2.21$
Day 28th	$135^b \pm 1.63$	$166.5^c \pm 4.65$	$145.5^c \pm 2.08$	$111.75^b \pm 2.36$	$80^a \pm 3.55$

Overall growth on weekly basis with respect to the salinity of all treatments as shown in table 4. As it was clearly seen that in the first week in all treatments there is minimal adjustment in the number of populations with that of initially stocked population, this may be due to the natural mortality of the stock. The actual rise or decline will be seen after first week as the animal in various treatment starts reproduction upon maturation. So, the overall rise in stock number till 28th day was measured and recorded, this shows maximum increment of stock with 100 ppt salinity and it will be declining at the 160 ppt as showing in the graph given below.

Table 5: Mean population growth at various salinities

	C(T0)	T1	T2	T3	T4
Day	**80 ppt**	**100 ppt**	**120 ppt**	**140 ppt**	**160 ppt**
7th	96	96.25	97.25	92.75	91
14th	112.25	109.25	107.75	96.5	90.75
21st	128.5	143.25	135	104.25	87.75
28th	135	166.5	145.5	111.75	80
Mean	117.9375	128.8125	121.375	101.3125	87.375

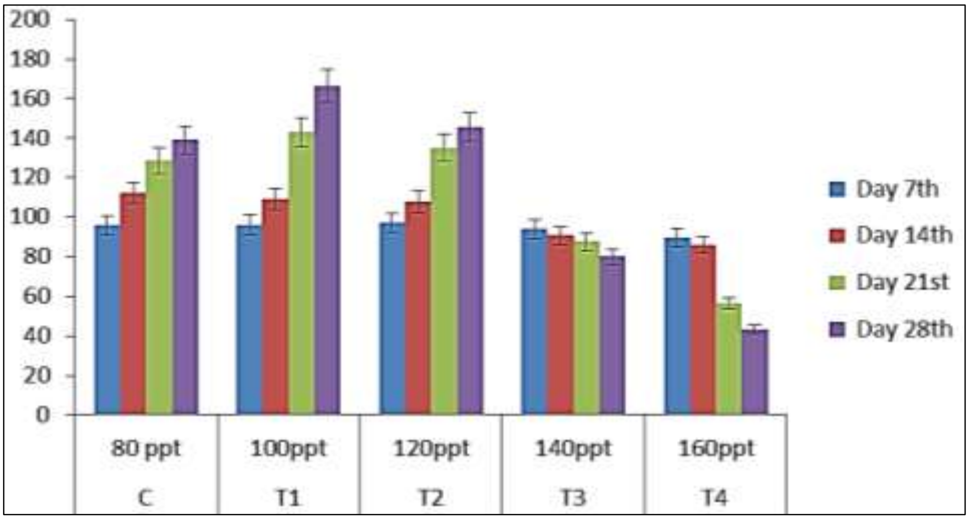

Fig 1: Bar graph depicting mean population growth among various salinities

Survival rate

The survival rate was calculated at end of experiment and mean values based on initial growth trends are as follows

Day wise Survival: As it was clearly seen that in the first week in all treatments there is minimal decline in the number of *Artemia nauplii* population with that of initially stocked population, this may be due to the natural mortality of the stock.

Day wise Survival % for Treatment: Little decline in the 1st week after this growth starts to increase with highest population at 4th week i.e. 135 at end of experiment at 80 ppt. Little decline in the 1st week after this growth starts to increase with highest population at 4th week i.e. 166.5 at end of experiment 100 ppt. Little decline in the 1st week after this growth starts to increase with highest population at 4th week i.e. 145.5 at end of experiment 120 ppt. Little decline in the 1st week to 2nd week after this growth starts to increase with highest population at 4th week i.e. 111.75 at end of experiment 140 ppt. Little decline in the 1st week after this the stock tends to decline till end of the experimental period i.e. 80 at end of experimental duration 160 ppt.

Table 6: Table showing day wise survival at various salinities

		T0		T1		T2		T3		T4	
Day	**Initial**	**Final**	**Result**	**Final**	**Result**	**Final**	**Result**	**Final**	**Result**	**Final**	**Result**
7th	100	96	-4	96.25	-3.75	97.25	-2.75	97.75	-2.25	91	-9
14th	100	112.25	12.25	109.25	9.25	107.75	7.75	96.5	-3.5	90.75	-9.25
21st	100	128.5	28.5	143.25	43.25	135	35	104.25	4.25	87.75	-12.25
28th	100	135	35	166.5	66.5	145.5	45.5	111.75	11.75	80	-20

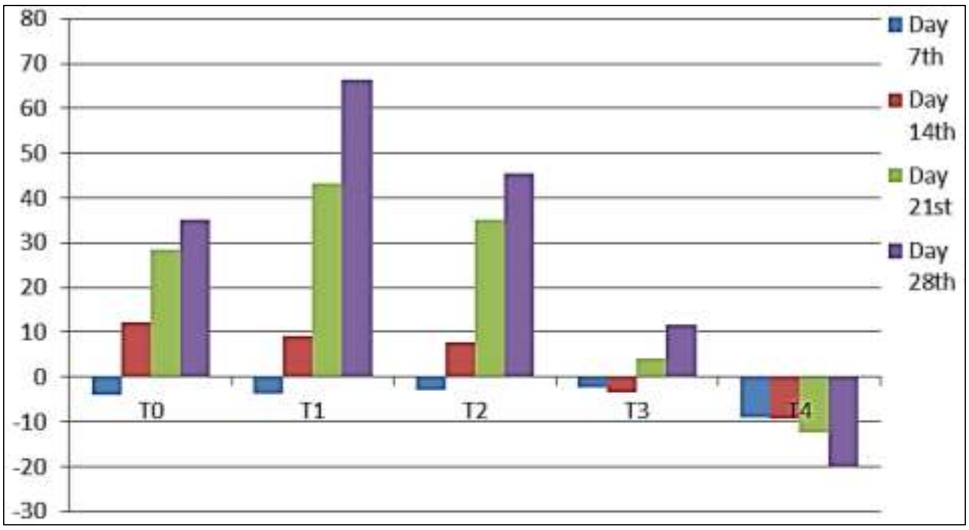

Fig 2: Graph showing day wise survival at various salinities

Groundwater is a natural gift to the population of this mother planet; it is a valuable and commonly utilised resource on the planet. This source, which resides under the earth surface, is critical for the existence of life. Groundwater resources in Rajasthan are limited due to severe hydrogeological and climatological conditions. Native production of Artemia in salt fields will have a socioeconomic dimension in certain regions of the world, particularly in countries where aquaculture is just getting started and taking off, because poor salt farmers will be able to produce another product while also having the opportunity to develop aquaculture with local artemia. Salt farmers who also cultivate artemia have approximately three times the household income.

Lower dissolved oxygen concentrations caused stress in aquatic organisms, which can be alleviated by aeration. This approach may also be effective in reducing the tension caused by thermal stratification (Johnson, 1966) [25].

Water temperature fluctuates fast in response to variations in air temperature. It is a critical quantity because of its influence on biological and chemical activity in water. A rise in water temperature accelerates chemical processes, lowers gas solubility, intensifies taste and odour, and increases organism metabolic activity. Temperature also has an impact on both the quality and quantity of plankton. The fluctuation in water temperature might be attributable to the impact of the season as well as differences in collecting schedules.

pH is defined as the negative logarithm of the hydrogen ion concentration (-log10 of H+). Water contains both H+ (Hydrogen) and OH- (Hydroxyl) ions. Water having more H+ ions than OH- ions it is considered acidic and if H+ ions are less than OH- ions it is basic or alkaline.

The Nitrate-nitrogen has indicated significant positive relationship with all parameters except bicarbonate alkalinity, total alkalinity, hardness and CRs. Nitrate concentration in groundwater ranges from 10 to 490 ppm was observed by Chaudhary, 2018 [7]. Same were observed during this study.

In pure waters, pH is controlled by the balance between dissolved CO_2, carbonates and bicarbonate ions. pH value of groundwater samples ranges from 7.26 (Madam) to 8.65 (Chhapari Kalan) (Chaudhary, 2018) [7]. Their total hardness of this region varies from 100 ppm (KHURI) to 1600 ppm (Singhana).

Artemia is naturally found in environments with salinities ranging from 10-300ppt (Sorgeloos, 1980) [20], but is seldom seen in waters with salinities less than 45ppt. Similarly, *Artemia* was cultivated in salinities ranging from 80 to 160 ppt in the current investigation. *Artemia* survival was shown to be highest when predators are absent, and because the current investigation was done in the laboratory, improved survival was seen. Because the experiment was carried out under controlled settings, no predator populations were encountered. When *Artemia* was cultivated in varied salinities, they reached their adult stage between 10 and 14 days. Even though *Artemia* is euryhaline, increased salinity is critical for this little creature's existence. The water was exchanged once in every two days and the culture was performed indoor.

Salinity is a critical factor affecting the production of biomass of *Artemia* (Arana, 1987) [4]. The *Artemia* reached adult stage in 20 ppt on 19th day and in 45ppt at 18th day (Soniraj, 2004) [19]. In the present observation, *Artemia* attained adult stage in our control group (80 ppt) on 9th day, T_1 (100ppt) on 9th day, T_2 (120ppt) on 11th day and T_3 (140 ppt) on 12th day, T_4 (160) on 14th day. “Brood size’ was better at salinity T_1 (100 ppt) as this result was concurrent with the study done by Soundarapandian and Saravanakumar, 2009 [21]. A significant drop in survival was observed at 120 g l^{-1} and upward by El-Bermawi (2004) [10] and similar decline in survival was observed in this current study.

Rearing *Artemia* at various salinities indicated that increasing salinity resulted in a reduction in brine shrimp body size, particularly the abdomen, as evidenced by the current study, which also shows a similar conclusion as Gilchrist (1960) [12] so small sized artemia population was seen in the higher salinity treatments as in T_4.

The result pertaining to a study is also supported by Abatzopoulos (2003) [1] who concluded from his experiment that the life span characteristics are also affected by salinity, higher salinities caused delay in development as similar results are seen in this study i.e., at T_4 (160 ppt) there was delay in broodstock development.

From the present study it could be confirmed that seawater salinity was highly suitable for the culture of Artemia as evidenced by higher survival and good growth rate.

Ability of Artemia change its appearance under the influence of salinity has been established by Gilchrist (1960) [12], rearing Artemia at different salinities concluded that salinity increase results in reduction of brine shrimp body size especially the abdomen. It is clear that variations in the body of Artemia with relation to salinity also depend on the locality. In the present study it has been clear that Artemia reared in lower concentration have longer body, small and thin abdomen and attain early sexual maturity in lower salinity regimes.

Conclusion

In this study, we tried to define the reproductive status in terms of population growth and life span in terms of survival characteristics of an Artemia with environmental component due to evaporation in outdoor conditions i.e., salinity. The growth and form of *Artemia salina* have been investigated under standard conditions in five concentrations of brine. But as the present study was conducted in indoor conditions the required salinity was obtained by the addition of salt which was easily available from solar salt pens. The variations in the population growth and survival in this study showed that different salinity gradients employed significant effects. In early stages, the size or growth rate, survival and maturation are directly related to the salinity of the medium but the size of the adult brine shrimp varies inversely with the salinity of the medium as population growth is higher in 100ppt salinity. But further studies are required in this direction to completely make this picture clear for the development of this sector.

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