INFLUENCE OF SALINITY ON GROWTH PERFORMANCE AND SURVIVAL OF *ARTEMIA* IN CONTROLLED CONDITIONS

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Abstract
***Artemia**, commonly known as brine shrimp, is an Anostracan aquatic organism widely used as live feed in aquaculture for fish, crustaceans, and other economically important species. It typically inhabits saline water bodies such as inland salt lakes, salt pans, and occasionally seawater. The present study aims to evaluate the response of Artemia to varying salinity levels under controlled laboratory conditions, with a focus on assessing its adaptability and identifying its optimal salinity range. Artemia's response to different salinity treatments was assessed through parameters such as length gain, dry weight, survival rate, mortality, and specific growth rate (SGR). Among the tested groups, the S2 treatment exhibited the highest growth (2.43 mm on day 14; 3.2 mm on day 28) and weight gain (5.2 µg on day 14; 12.2 µg on day 28), indicating optimal conditions for development and biomass production. Survival was highest in both the control (SC) and S2 groups (80.00% and 80.33% on day 14; 55.50% and 58.33% on day 28), which also showed the lowest mortality rates. Furthermore, the highest SGR was recorded in the S2 group (16.12% on day 14; 26.42% on day 28), confirming it as the most favourable salinity level for Artemia growth.*
Keywords*: *Aquaculture, Artemia, Anostraca, Dry weight, live feed.

Introduction

Artemia is an important organism in the aquaculture industry, widely used as live feed for the rearing of economically important aquatic species and ornamental aquarium fishes. Belonging to the order Anostraca, Artemia naturally inhabits saline aquatic environments and has been extensively studied to understand various aspects of its biology.

The habitats of Artemia are typically characterized by high salinity, an important abiotic factor that significantly influences their distribution. Salinity not only determines their habitat range but also plays a critical role in limiting predators, which generally thrive at lower to moderate salinity levels. Although there is no universally defined optimal salinity for Artemia, studies suggest that they perform best at the lower end of their salinity tolerance range, as this reduces the energy expended on osmoregulation. Salinity also directly affects cyst development, with hatching occurring only below a strain-specific salinity threshold (Lavens and Sorgeloos, 1987). Temporary reductions in salinity may result from freshwater inflows or rainfall events.

Hammer and Hurlbert (1992) demonstrated that A. franciscana survives well in salinity levels above 38 ppt, but its performance declines at lower concentrations. While Artemia have been recorded in hypersaline environments with salinities up to 340 ppt (Post and Youssef, 1977), such extreme conditions severely impair their physiological functions. Despite their physiological ability to tolerate seawater and brackish water, Artemia are rarely found in environments with salinity below 45 ppt (Persoone and Sorgeloos, 1980).

Soundarapandian and Saravanakumar (2009) reported that seawater salinity offers optimal conditions for Artemia survival, while a more recent study by Mali *et al.* (2023) on Artemia nauplii from the inland saline waters of Didwana Lake, Rajasthan, identified 100 ppt as the ideal salinity level for maximizing naupliar production.

The present study aims to examine the response of Artemia to varying salinity levels under controlled laboratory conditions. Parameters such as length gain, dry weight, survival, and mortality were recorded over a 14-day period to assess their adaptability and growth performance across different salinity treatments.

Materials and Method

Collection of Cyst

The cyst of *Artemia* was brought from branded reliable online platform for the present research work. Before the actual starting of experiment the 1 mg cyst were hatched in aquarium having controlled conditions such as 30 ppt salinity, 24°C, pH 8 for 24 hours. After hatching 1000 equal sized individuals were sorted and used for experimental purpose.

Preparation of brine (Artificial salt solution)

For the present investigation artificial salt solution was prepare as prescribed in (FAO Fisheries Technical Paper 1996), is depicted in following table 1

Table1: Ingredients of Artificial salt solution

NaCl	31.08 g
MgCl2	6.09 g
CaCl2	1.53 g
KCl	0.97 g
MgSO4	7.74 g
NaHCO3	1.80 g
Distilled Water	1 L

The experiments were carried out in 5-liter glass Aquariums equipped with necessary equipment's. the food used during the treatment is spirulina powder. To investigate the response of *Artemia* (brine shrimp) to varying salinity levels, an experiment was conducted using the following setup. Six salinity test solutions together with a control, were prepared at concentrations of 15, 30, 45, 60, 75, and 90 parts per thousand (ppt) using above mentioned constituents to obtain desired range of salinity.

1000 newly hatched *Artemia* nauplii, aged between 24 to 36 hours, were introduced into each culture aquarium containing the respective salinity solutions. The experiment was carried out in triplicate to ensure statistical reliability, with three separate culture aquariums prepared for each salinity level.

Throughout the experimental period, the other important conditions such as temperature (24 C), pH of (8), aeration by aquarium aerator and a light of 1000 lux. supply was maintained. The experimental culture was carried out for about 14 days.

Table 2: Salinity Test Solutions

	Salinity						
Group Code	SC	S1	S2	S3	S4	S5	S6
Salinity (PPT)	00	15	30	45	60	75	90

Artemia growth was assessed by measuring total length and dry weight at days 14 and 28. Total length (mm) was determined using the ocular-micrometer scale method, calibrated with a stage micrometer for accuracy. Measurements were taken from the base of the antennae to the telson for 10 randomly selected individuals. Dry weight (µg) was measured by weighing 10–20 individuals on an electronic balance (0.1 mg precision), drying them at 60°C for 24 hours, and reweighing to calculate dry weight using the formula,

DW (µg) = (Dried weight - Tare weight) / Number of individuals.

The Survival % of *Artemia* was recorded on above mentioned two intervals. The following formula was employed to calculate percentage survival,

Survival rate %= total number of survived individuals / total number of exposed *Artemia* x 100

Mortality percentage was calculated by using following formula,

Mortality Rate (%) = (Number of Dead *Artemia*/ Total Number of Artemia) x 100

Result and Discussion

The present investigation was carried out to report the response of *Artemia* to variable salinity level. *Artemia* were cultured in six different salinity solutions together with a control for about 14 days to assess the impact of salinity on growth and survival. the major findings of present study are as follows,

Length gain was highest in the S2 group, with mean length of 2.43 mm on day 14 while the lowest length gain was reported in S6. The length increases of *Artemia* exposed to various salinity levels showed significant differences, as indicated by the statistical results (F=40.07, p=0.0001185 for day 14). The weight increase of *Artemia* exposed to different salinity levels showed significant variations, as indicated by the statistical analysis (F=132.8, p=3.63E-06 for day 14). The highest weight gain was observed in S2, 5.2 µg on day 14, while the lowest weight gain was recorded under S6 treatment.

The survival rate of *Artemia* exposed to various salinity levels showed significant differences, as indicated by statistical analysis (F=54.32, p=4.481E-05 for day 14). The highest survival was observed in the control group (SC) and S2 (80.00% and 80.33% on day 14). In contrast, extreme salinity levels (S5 and S6) resulted in the lowest survival rates, with S6 showing the highest mortality (47.00% survival on day 14). The mortality percentage of *Artemia* exposed to different salinity levels showed significant variation, as indicated by statistical analysis (F=55.53, p=4.229E-05 for day 14).

Studies on *Artemia franciscana* growth under varying salinity conditions have shown consistent trends. Castro-Mejía *et. al.,* (2011) reported similar patterns of length gain across different salinity levels throughout their study**.** Lavens and Sorgeloos (2000) found that *Artemia franciscana* exhibited the highest growth performance in moderate saline environments, with extreme hypersaline or hyposaline conditions leading to stress-induced

metabolic suppression and lower dry weight accumulation. Research on various *Artemia* species and strains worldwide has also highlighted significant differences in salinity tolerance**.** Dhont and Lavens (1996) highlighted that *Artemia* exhibits optimal growth in salinity ranges between 10–35 ppt, with drastic reductions in survival and biomass accumulation outside this range.

Likewise, Soundrapandian and Saravanakumar (2009) explored the effects of salinity on *Artemia* growth and survival, concluding that seawater salinity supports optimal growth, with the highest length gain recorded under such conditions. Alal and Olendi (2014) had reported that salinity significantly influenced the survival of *A. salina* nauplii over a five-day culture period, with survival rates differing notably across the salinity treatments. These findings underscore the importance of maintaining an optimal salinity range to support *Artemia's* physiological functions and maximize growth potential.

Table 3: Length gain of *Artemia* under different salinity treatments

Groups		SC	S1	S2	S3	S4	S5	S6
Length increases 14th Day	Mean	1.80	1.03	2.43	2.16	1.77	1.00	0.7
	±SD	0.10	0.21	0.32	0.12	0.15	0.26	0.1
		F=40.07, df=6.14, p=0.0001185 / Significant at p<0.005						

Table 4: Dry weight of *Artemia* under different salinity treatments

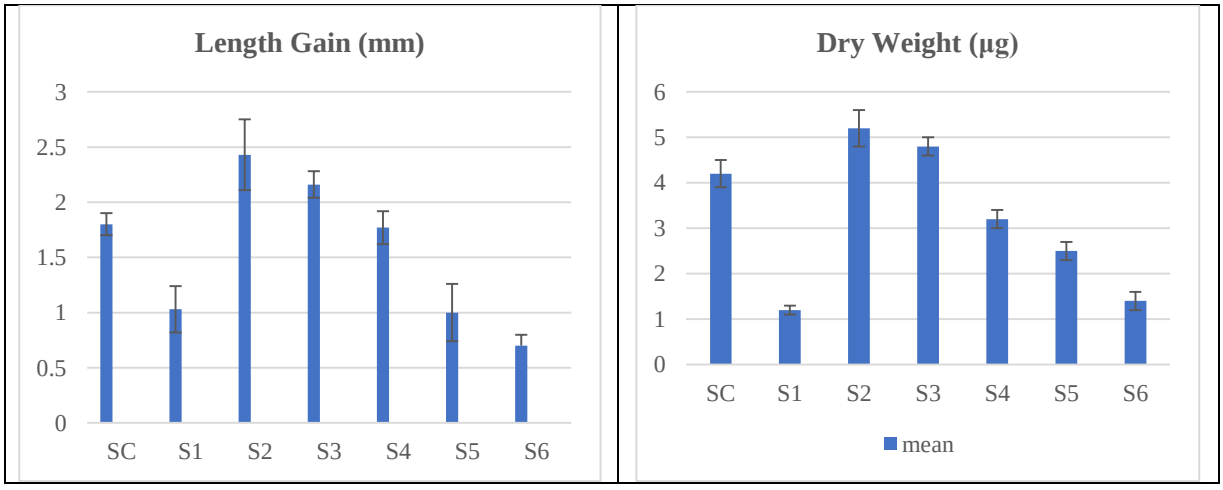
Groups		SC	S1	S2	S3	S4	S5	S6
Dry Weight 14th Day	**Mean**	4.2	1.2	5.2	4.8	3.2	2.5	1.4
	±SD	0.3	0.1	0.4	0.2	0.2	0.2	0.2
		F=132.8, df=6.074, p=3.63E-06 / Significant at p<0.005						

Table 5: Survival Percentage of *Artemia* under different salinity treatments

Groups		SC	S1	S2	S3	S4	S5	S6
Survival 14th Day	Mean	80.00	72.67	80.33	73.67	62.33	56.33	47.00
	±SD	3.43	2.08	2.52	3.06	3.06	3.06	2.00
		F=54.32, df=6.193, p=4.481E-05 / Significant at p<0.005						

Table 6: Mortality Percentage of *Artemia* under different salinity treatments

Groups		SC	S1	S2	S3	S4	S5	S6
14th Day	Mean	20.00	27.33	19.67	23.00	37.67	43.67	53.00
	±SD	3.2	2.08	2.52	4.00	3.06	3.06	2.00
		F=55.53, df=6.186, p=4.229E-05 / Significant at p<0.005						



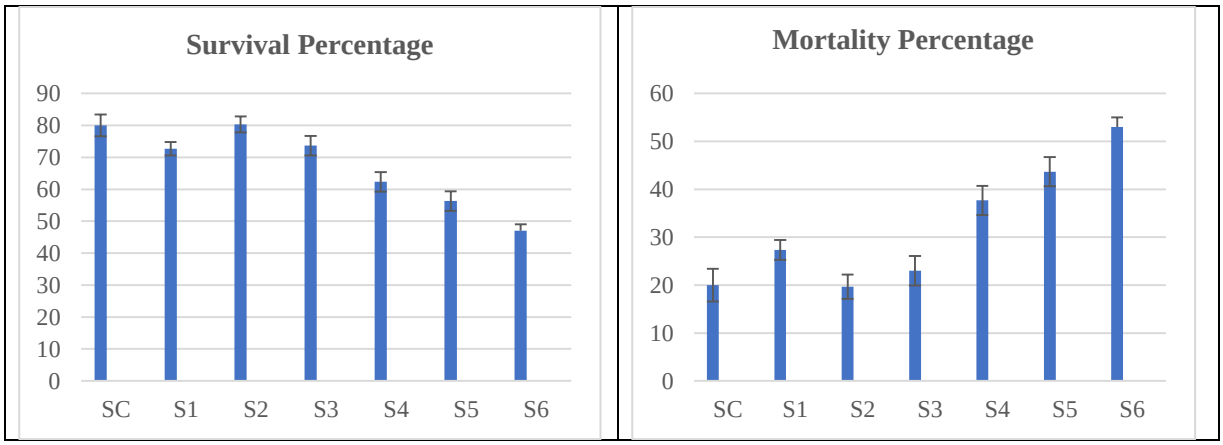


Figure 1: Responses by *Artemia* to different salinity treatments

Conclusion

Present research showed that the growth by means of length and weight gain in *Artemia* after 14 days is maximum under a range of S2 to S3 as compared to SC. The lowest mortality and highest survival were recorded over a period of 14 days showed that S2 salinity is most suitable in which the percentage of survival and mortality is almost like that of SC. However, there is a significant variation among the treatments, the artemia is adaptable to wide range of salinity. The S2, S3 and S4 treatments showed similar kind of trend in the growth under the laboratory condition which proves that *Artemia* could tolerate variation in salinity.

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