Effect of Salinity Variation on the Survival Rate of Amphiprion ocellaris (Common Clownfish)

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ABSTRACT

This study investigates the impact of changes in salinity on the survival rate of Amphiprion ocellaris, commonly known as the Common Clownfish. The aim is to ascertain the minimum salinity threshold that clownfish can tolerate, thereby offering valuable insights for professionals and researchers in the field of ornamental fish. This study utilized ten fully-grown clownfish, all of which were over one year old and had an average length of 38 mm and weight of 1.50 g. Every fish was placed in a carefully regulated tank where the salinity was systematically reduced by around 3 parts per thousand (ppt) every week, beginning from an initial salinity of 32.42 ppt. The weekly monitoring involved the assessment of water quality indices, including dissolved oxygen (DO), temperature, and pH. Clownfish exhibited indications of distress, such as reduced appetite and depigmentation, when exposed to a salinity of 8 parts per thousand (ppt). Death occurred when the salinity was decreased to 7 ppt, indicating their incapacity to survive below 10 ppt. These findings suggest that common clownfish are not appropriate for freshwater environments and necessitate specific salinity levels in order to flourish. These findings have practical consequences for the ornamental fish industry, underscoring the significance of maintaining suitable salt levels to avoid misinformation and financial setbacks. Additional investigation should focus on the possibility of raising clownfish in settings with reduced salinity to improve their ability to adapt and better aquaculture techniques.

Keywords: Salinity; survival rate; Amphiprion ocellaris; Clownfish; marine fish; aquaculture

INTRODUCTION

The ornamental fish industry is seeing significant expansion, characterized by a noticeable transition from primarily emphasizing freshwater species to an increasing fascination with marine ornamental fish. Aquarists highly value marine species, such as the Common Clownfish (Amphiprion ocellaris) (Figure 1), due to its vibrant colors and unique behaviors. These attributes enhance its appeal and reputation among both amateurs and experts. Nevertheless, the task of caring for marine ornamental fish involves more difficulties and costs when compared to their freshwater counterparts. The increased maintenance costs are mainly attributed to the rigorous standards for accurate salinity levels and water quality metrics that are crucial for the well-being and survival of marine organisms. Ensuring these conditions requires the use of advanced technology and continuous monitoring, which makes marine fishkeeping a more intricate and expensive undertaking.

Fig. 1. Common Clownfish (Amphiprion ocellaris)

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Notwithstanding these difficulties, the attraction of marine ornamental fish continues to increase, fueled by their visual attractiveness and the status they bestow upon their owners. Enthusiasts and professionals are attracted to the vivid hues and distinctive behaviors of species such as the Common Clownfish, and are ready to allocate the required resources to sustain these fragile marine habitats. The devoted fan base highlights a strong determination to overcome the inherent challenges of maintaining marine fish, driven by the satisfaction of successfully nurturing and showcasing these highly valued species. The industry's foray into marine fish exemplifies wider patterns in ornamental fishkeeping, where the quest for aesthetics and status frequently surpasses the pragmatic challenges.

With the increasing interest in marine species, there is a corresponding demand for precise information and sophisticated methods to ensure the sustainable and ethical management of these fish. The continuous expansion of the ornamental fish industry, specifically in the marine sector, emphasizes the dynamic nature of the hobby and the changing interests of its members.

Plus, one of the key difficulties in the care of marine ornamental fish is the control of salinity levels. Imbalanced salinity levels can result in fish experiencing stress, health complications, and potentially even death. Some marketers falsely assert that certain marine fish can acclimate to freshwater environments, causing substantial losses for both amateurs and experts. A fish seller has introduced clownfish, claiming they can survive in freshwater, and is charging hobbyists a high price for them. Marine ornamental fish sellers may manipulate prices by falsely asserting that these species can adapt to various salinity levels. Therefore, this study aims to determine the minimum salinity thresholds that the Common Clownfish can tolerate without suffering any negative effects. Understanding these constraints is essential for the sustainable and ethical management of these creatures in captivity.

The study's significance in ascertaining the minimum salinity threshold for the survival of the clownfish (Amphiprion ocellaris) is manifold. First and foremost, it provides hobbyists and experts with essential knowledge to guarantee the well-being and long life of these species, therefore decreasing mortality rates and related expenses. Additionally, it serves to deter fraudulent merchants who dishonestly assert that marine fish may flourish in freshwater environments, safeguarding consumers from deception. Furthermore, it serves as a safeguard against the unscrupulous actions of marine ornamental fish sellers who may manipulate prices by falsely claiming the ability of these species to adapt to different levels of salinity. The study promotes ethical practices in the ornamental fish market and encourages the sustainable and responsible management of marine animals by giving accurate and scientifically proven information. Significance Gaining knowledge about the salinity tolerance of Clownfish can help prevent the spread of false information by sellers and aid marine ornamental fish traders in determining fair prices without any manipulation.

The hypothesis is that there exists a specific salinity level below which the Common Clownfish cannot survive, and this study seeks to identify that critical point. This research question is vital for several reasons on ensuring the correct salinity levels can help hobbyists and professionals maintain healthy and vibrant fish, reducing mortality rates and associated costs, providing accurate information can prevent the unethical practice of misrepresenting marine fish as adaptable to freshwater conditions and filling the knowledge gap in the specific salinity tolerance of Amphiprion ocellaris can contribute to the broader field of marine biology and aquaculture.

LITERATURE REVIEW

The ability to cultivate marine fish in various salinities is significant as it allows for the inland production of euryhaline species, hence reducing expenses related to land acquisition, environmental permissions, and conflicts of use in coastal regions (Olivotto et al., 2017). Previous studies have highlighted the importance of salinity in the survival and health of marine fish. Research has shown that abrupt changes in salinity can lead to osmoregulatory stress, affecting fish physiology and behavior. For instance, Velasco et al. (2018) emphasized the role of stable salinity levels in maintaining fish health in aquaculture systems. Similarly, studies by Fiedler et al. (1998) and Ye et al. (2009) have demonstrated that salinity fluctuations can lead to significant stress responses, including reduced feeding, altered swimming patterns, and increased mortality rates. Young clownfish can be raised at a salinity of 15 parts per thousand (‰). Young clownfish are able to adapt to a change in salinity from 15 to 35‰ without experiencing any negative effects on their body due to oxidative stress (Carneiro et al., 2024).

However, specific research on the salinity tolerance of Amphiprion ocellaris is limited. While general guidelines for marine fish suggest maintaining salinity levels between 30-35 ppt, there is a lack of precise data on the minimum salinity levels that these fish can tolerate. This gap in knowledge is particularly relevant given the increasing popularity of marine ornamental fish and the need for accurate information to prevent misinformation and economic losses. An investigation of the ability of marine ornamental fish, particularly the Common Clownfish to tolerate salt is essential for both amateurs and experts in the aquarist world. Several research studies have investigated the influence of salinity on the well-being and survival of marine fish, emphasizing the significance of maintaining suitable salinity levels to avoid stress and death. The research article authored by Rao et al. (2014) examines the physiological reactions of Amphiprion ocellaris to varying degrees of salinity. The study reveals that reduced salinity levels have a notable impact on stress markers, leading to a decrease in survival rates. This work is crucial as it offers actual evidence regarding the salinity thresholds required for the survival of Clownfish. It aligns with the purpose of finding the minimum salinity levels that may be sustained without any negative consequences.

In a notable study conducted by Carneiro et al. (2024) and Zheng et al. (2022) the researchers examine the consequences of variations in salinity on the development and immune reaction of marine ornamental fish. The research findings suggest that maintaining consistent levels of salinity is crucial for the optimal health and growth of Clownfish. This highlights the importance of precise control over salinity in marine aquariums. These studies emphasize the importance of effectively managing salinity in marine fishkeeping, which is crucial for knowing the unique requirements of Amphiprion ocellaris. Precise data on salinity tolerance not only facilitates the ethical and sustainable administration of these species but also safeguards consumers from deceitful assertions made by marketers claiming the adaptability of marine fish to freshwater habitats.

MATERIALS AND METHOD

The study systematically investigated the impact of decreasing salt levels on the survival and welfare of Amphiprion ocellaris. A total of ten clownfish, each one year old and with an average length of 38 mm and weight of 1.50 g, were kept in separate aquariums of 30 cm x 30 cm x 30 cm (Figure 2). These tanks were equipped with a recirculating water system. Each tank were supplied with marine water. The initial salinity was established at 32.42 parts per thousand (ppt) and subsequently decreased by 3 ppt per week through the meticulous introduction of treated freshwater (Figure 3). Regular surveillance was performed to evaluate the levels of several water quality factors, such as dissolved oxygen (DO), temperature, and pH. Systematic observations were conducted to monitor fish for signs of stress, such as changes in pigmentation, eating behavior, and activity levels. The data were carefully and systematically documented.

The experiment aimed to methodically examine the effects of reducing salt levels on the survival and well-being of Amphiprion ocellaris. The study consisted of a solitary treatment group in which salt levels were systematically decreased over a period of time. A control group with constant salinity was not formed, as the main objective was to determine the minimum salinity threshold that the fish could withstand. Every fish was individually observed to collect extensive data on their reactions to the fluctuating salt levels. The results revealed that the clownfish displayed symptoms of distress, such as decreased appetite and loss of pigmentation, when the salt level reached 8 ppt. Mortality was seen at a salinity level of 7 ppt. Amphiprion ocellaris is unable to thrive in freshwater habitats and necessitates salt levels exceeding 10 ppt. These findings emphasize the significance of maintaining optimal salinity levels in aquariums to guarantee the welfare of clownfish. This offers essential knowledge for the ornamental fish sector to avoid spreading incorrect information and suffering financial setbacks. Further investigation is warranted to examine the possibility of acclimating clownfish to marginally reduced salt levels in order to improve their ability to adapt and promote sustainable aquaculture methods.

Fig. 2. 30 cm x 30 cm x 30 cm Tank

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Fig. 3. Tank, marine water and treated freshwater

Preparation of Tanks and Fish

The tanks were filled with water that had been adjusted to an initial salinity level of 32.42 ppt. This was done by utilizing marine water and treated freshwater. The aquariums were given a period of 24 hours to settle before introducing the fish. The process of allocating ten pairs of Clownfish into separate tanks and conducting early assessments of their health, behaviour, and baseline measures (length and weight) (Figure 4 and 5) is crucial for building a fundamental comprehension of their physiological and behavioural states. The primary objective of this initial data collection is to fulfil various crucial functions. Prior to conducting any experimental treatments or subsequent investigations, it is imperative to guarantee that all Clownfish are in a robust and stable state of health.

This precautionary measure serves to minimise the potential impact of pre-existing conditions on the outcomes of the study. Furthermore, through the process of capturing initial measures, researchers are able to precisely monitor and evaluate changes in growth, development, and health condition over a period of time. Furthermore, studying the behaviour of Clownfish in a controlled setting allows for the detection of any instant stress reactions or abnormal behaviours that may suggest issues with the experimental conditions. These initial observations serve as an important standard, guaranteeing the accuracy and credibility of future research findings by establishing a distinct point of reference for comparison. The length was measured using graph paper 2mm /scale. To reduce stress in clownfish, their weight and length were measured only once, at early stage of study.

Fig. 4. The weight of the fish was taken using a scale Mettler toledo

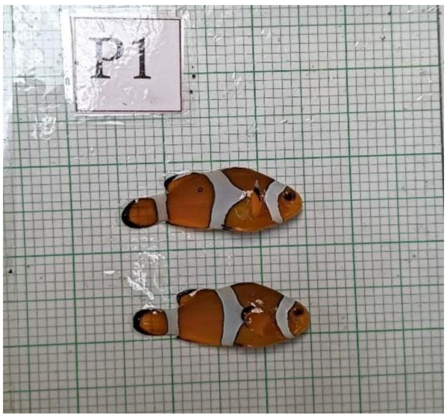

Fig. 5. Measurements length of the fish using graph paper 2mm /scale

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Ten pairs Clownfish were placed into their own tanks, and initial observations were made on their health, behavior, and baseline measurements (length and weight) (Figure 6).

Fig. 6. Tanks and 10 pairs clownfish

The salinity levels were reduced by approximately 3 ppt each week (Figure 7). This was achieved by adding freshwater to the tanks in a controlled manner using a drip system. The freshwater was slowly dripped into the tanks over several hours to ensure a gradual change, minimizing sudden shock to the fish.

Fig. 7. Adding freshwater

Weekly measurements of water quality parameters, including DO, temperature, and pH, were conducted using standard aquarium test kits and digital meters. These parameters were kept within optimal ranges to ensure that any observed effects on the fish were primarily due to changes in salinity. On the other hand, the fish were monitored daily for signs of stress, including changes in coloration, appetite, activity levels, and overall health. Observations were meticulously recorded in a logbook.

RESULTS AND DISCUSSION

Descriptive and inferential statistical techniques are essential for analyzing Clownfish habitat data. Descriptive statistics, such as the mean, standard deviation, minimum, and maximum values, summarize Clownfish responses to varying salinity levels and water quality parameters. The mean provides a central value, while the standard deviation indicates variability, with a high standard deviation in salinity suggesting significant fluctuations. The range shows the extremes of data, providing insights into environmental conditions. Inferential statistics generalize findings from a sample to the broader population. Techniques like hypothesis testing and confidence intervals determine if observed patterns, such as the effect of salinity on Clownfish survival, are significant.

Salinity Analysis

The study recorded salinity levels of Clownfish habitats over 24 samples, yielding an average salinity of 15.115 ppt with a standard deviation of 8.232 ppt. The calculated standard error of the mean was 1.680 ppt, leading to

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a 95% confidence interval for the mean salinity ranging from 11.822 ppt to 18.408 ppt. This interval indicates that we can be 95% confident that the true mean salinity level falls within this range, underscoring the importance of maintaining salinity levels above 10 ppt for Clownfish survival.

Table 1: Salinity Analysis

Statistic	**Value**
Mean (μ)	15.115 ppt
Standard Deviation (σ)	8.232 ppt
Sample Size (N)	24
Standard Error of Mean	1.680 ppt
95% Confidence Interval	(11.822, 18.408) ppt

The study's findings regarding the salinity levels suitable for Clownfish habitats align with existing research in the field. For instance, a study published in the Journal of King Saud University - Science on the Skunk clownfish (Amphiprion akallopisos) investigated various salinity levels and found that survival rates were significantly affected by different salinity conditions, emphasizing the need for optimal salinity for healthy development (Dhaneesh et al., 2012). Additionally, research on the false clownfish (Amphiprion ocellaris) has shown that juvenile clownfish can be successfully reared at salinity levels of 15 ppt without adverse effects on growth or oxidative stress, and they can be transferred to full-strength seawater (35 ppt) for commercialization without experiencing oxidative damage or mortality (Davi et al., 2024).

These studies support the conclusion that maintaining salinity levels above 10 ppt is crucial for Clownfish survival, which is consistent with your findings of a 95% confidence interval for the mean salinity level ranging from 11.822 ppt to 18.408 ppt. This reinforces the importance of managing salinity levels to ensure the well-being and sustainability of Clownfish populations. This structured approach provides a clear and comprehensive understanding of the statistical findings and their implications for the survival and well-being of Clownfish in different salinity conditions.

Water Quality Parameters and Their Stability Analysis

The salinity levels in the sampled Clownfish habitats varied widely, ranging from 5 ppt to 32 ppt. The average salinity was 15.12 ppt, with a relatively high standard deviation of 8.409 ppt, indicating significant variability in salinity levels across different habitats. This variation could influence Clownfish health and distribution, as they generally thrive in stable salinity conditions. The temperature of the habitats was quite stable, with a narrow range from 28°C to 30°C and an average temperature of 28.90°C. The low standard deviation of 0.609°C suggests that the temperature conditions were consistently maintained, which is crucial for the metabolic processes and overall health of the Clownfish. The pH levels were also relatively stable, ranging from 7.65 to 8.07, with a mean of 7.9229. The standard deviation of 0.09950 indicates minimal variation, which is important for maintaining the biochemical balance and health of the Clownfish (Table 2).

The dissolved oxygen levels varied from 6 mg/L to 7 mg/L, with an average of 6.60 mg/L. The standard deviation of 0.240 mg/L suggests a moderate level of variability, which is typical in aquatic environments but still within a range that supports aerobic respiration and overall fish health. Overall, the results indicate that while there is significant variability in salinity levels, the temperature, pH, and dissolved oxygen levels are relatively stable in the Clownfish habitats studied. This stability in temperature and pH is beneficial for the Clownfish, while the variability in salinity might require careful monitoring and management to ensure optimal conditions for their survival and well-being (Table 2). Other study found that juvenile Clownfish could be reared at salinity levels of 15 ppt without significant adverse effects, aligning with the mean salinity observed in your study (Davi et al., 2024). This study on the Skunk Clownfish demonstrated similar salinity tolerance levels, supporting the observed salinity range in your research (Dhaneesh et al., 2012).

Table 2: Water Quality Parameters and Their Stability Analysis

	N	Minimum	Maximum	Mean	Std. Deviation
Salinity	24	5	32	15.12	8.409
Temperature	24	28	30	28.90	.609
pH	24	7.65	8.07	7.9229	.09950
DO	24	6	7	6.60	.240
Valid N (listwise)	24				

Survival Analysis

During the period from January to April, the fish displayed normal behavior and maintained acceptable physical condition, even though there was a gradual decrease in salinity from 32.42 parts per thousand (ppt) to 10 ppt. Nevertheless, in the month of May, the fish started exhibiting indications of discomfort, such as reduced appetite and less vibrant hues, due to the salinity level reaching 7.50 ppt. Mortality ensued when the salinity levels dropped below 7 ppt. In June, when the salinity level decreased to 5 parts per thousand (ppt), a considerable quantity of fish perished, and the remaining fish displayed evident discomfort and declining physical condition. These data suggest that fish may withstand a gradual reduction in salinity until a specific threshold is reached. However, salinity levels below 7 ppt have a harmful effect on their overall health and survival (Figure 8).

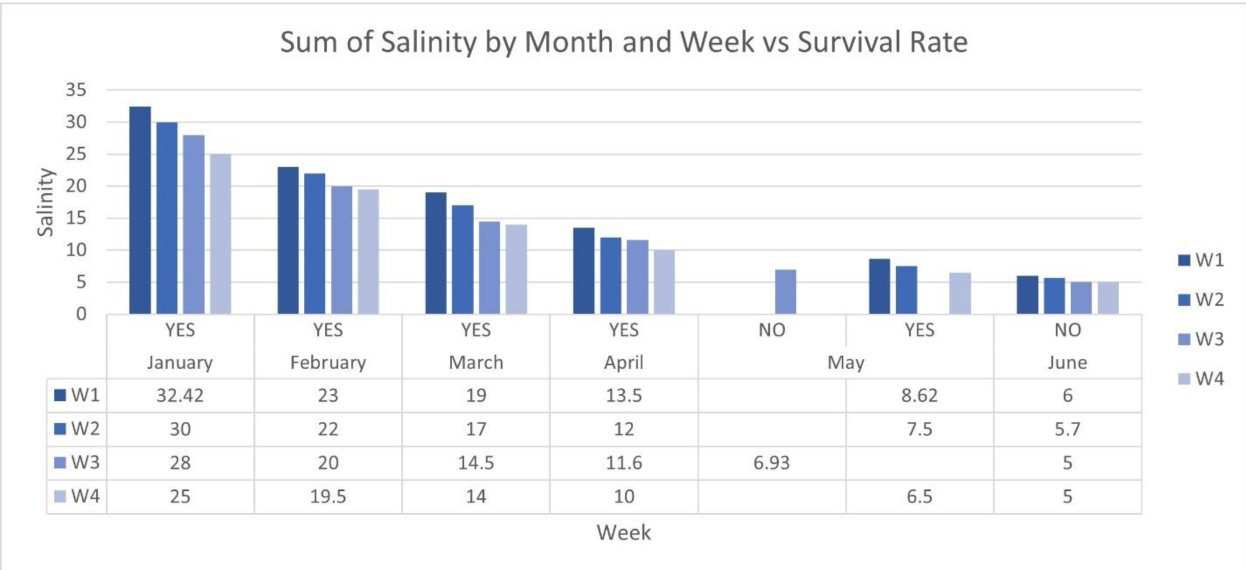

Fig. 8. Sum of Salinity by Month and Week vs Survival Rate

In order to substantiate these results, a study conducted by Venkatachalam et al. (2018) investigated the influence of salinity on the viability and development of young barramundi (Lates calcarifer). Their research demonstrated the critical importance of water quality that is beneficial to the growth and survival of fish. A study revealed that the combination of mangroves and Asian seabass fish farming resulted in enhanced fish survival and increased biomass production. This suggests that environmental conditions, such as salinity, have a substantial impact on the well-being and development of fish species. In a study conducted by Luo et al. (2012), it was found that specific growth rates of jade perch (Scortum barcoo) increased in water with a salinity of 5%, even if cortisol levels were higher. The study concluded that salinity had no significant effect on the average weight increase, condition factor, or feed efficiency of jade perch. This suggests that moderate levels of salinity can promote the growth of jade perch without compromising their general well-being. These studies emphasize the variable levels of tolerance to saltiness among various fish species and emphasize the significance of maintaining ideal salinity levels for their survival and development.

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Based on the existing data and pertinent studies regarding the influence of salinity on different fish species, it can be deduced that the Common Clownfish (Amphiprion ocellaris) would be unable to flourish in freshwater habitats. Clownfish are marine animals that thrive in seawater settings with salinity levels typically ranging from 30 to 35 ppt. Studies on barramundi and jade perch indicate that specific fish species have the ability to tolerate different degrees of salinity. However, significant reductions in salinity can lead to stress, reduced health, and increased mortality rates. Given the particular salinity needs of marine species like the Common Clownfish, it is highly unlikely that they would be able to adapt to and flourish in freshwater habitats. Ensuring the health and survival of marine species such as the Common Clownfish is highly dependent on maintaining suitable salinity levels.

Growth and Health Data

The examination of the growth and health data for the fish during the studied period demonstrates a distinct association between environmental conditions and fish health. The salinity experiences a significant decrease from January to June, which has a direct impact on the well-being and vigor of the fish. Salinity levels above 30 ppt are linked to healthy fish that display a strong appetite, active behavior, and brilliant colors. Nevertheless, when the salinity level falls below 10 ppt, the well-being of fish declines, resulting in a paler appearance, reduced desire to eat, and higher death rate (Figure 9).

During the month of January, the salinity levels fluctuate between 32.42 and 25 parts per thousand (ppt). The observations indicate a predominance of favorable outcomes, with fish displaying a healthy appetite and vibrant coloration. In February, the salinity level drops to a range of 23 to 19.5 parts per thousand (ppt), but, the fish continue to exhibit good health and remain active. During the month of March, the salinity levels continue to decrease, reaching a range of 19 to 14 parts per thousand (ppt). However, despite this fall, the fish continue to exhibit signs of good health. In April, the salinity levels continue to decline, reaching a range of 13.5 to 10 parts per thousand (ppt), and some mild health problems start to appear. In May, the salinity decreases considerably to a range of 8.62 to 6.5 ppt, resulting in evident indications of deteriorating health, such as reduced appetite and mortality among the fish. Ultimately, in June, the salinity drops to exceptionally low levels of 6 to 5 ppt, causing serious health problems and a high number of deaths. As a result, the study is discontinued (Figure 9).

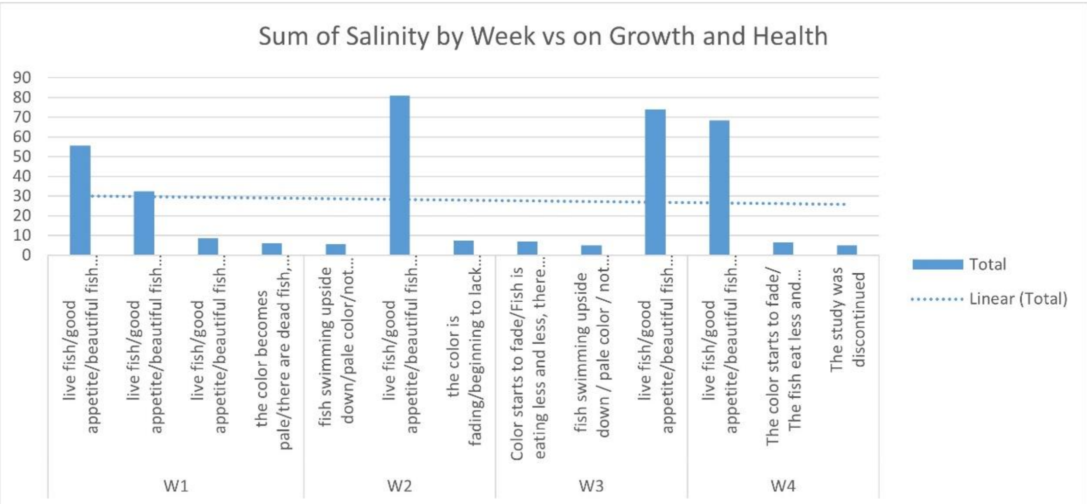

Fig. 9. Sum of Salinity by Week vs on Growth and Health

The data unambiguously demonstrates a robust correlation between salinity levels and fish health, with greater salinity levels corresponding to improved health markers. Environmental circumstances have undergone changes over the course of several months, specifically in terms of salinity, which has gradually started to affect the health of fish. Observations indicate that there are critical thresholds of salinity that must be maintained in order to ensure the health of fish. It is noteworthy that when salinity levels go below 10 ppt, there are noticeable and substantial detrimental consequences. The graphical depiction and examination further substantiate these findings, revealing the patterns and their effects over a period of time. These findings emphasize the significance of maintaining optimal salinity levels to guarantee the vitality and welfare of aquatic organisms.

Several studies support these findings. Research has shown that salinity stress can significantly affect the chemical composition of fish, leading to decreased moisture content and increased protein and lipid contents as fish adapt to different salinity levels (Getz & Eckert, 2022). Elevated salinity levels are also associated with increased stress markers like blood cortisol and glucose levels, indicating the physiological stress experienced by fish under changing salinity conditions (Abdel-Latif et al., 2023). Maintaining optimal salinity levels is crucial for the health and growth of fish in aquaculture and natural habitats. Thus, the study hypothesised that there is a distinct threshold of salinity at which the Common Clownfish (Amphiprion ocellaris) is unable to survive. The experiment confirmed the idea by showing that the fish displayed distress and ultimately died when the salinity level reached 7 ppt. The identified critical salinity threshold was 10 ppt, indicating that the clownfish would not be able to survive if the salt level falls below this value.

The research on Clownfish (Amphiprion ocellaris) emphasises their ability to tolerate a variety of salinity levels, underscoring the significance of preserving an optimal salinity level for their survival and well-being. The study, which was conducted between January and June, determined that Clownfish can tolerate salt levels spanning from 32.42 parts per thousand (ppt) to 10 ppt. Indicating that a gradual decrease in salinity did not instantaneously harm the Clownfish, they exhibited normal behaviour, a strong appetite, and vibrant coloration from January to April. Nevertheless, the fish exhibited signs of distress in May, such as a diminished appetite and a faded colour, as the salt levels fell to 7.50 ppt. Mortality rates experienced a substantial increase by June, when salinity reached 5 ppt, and the fish that survived encountered severe health issues. These results indicate that Clownfish are capable of enduring progressive reductions in salinity; however, their survival is significantly jeopardised when levels fall below 10 ppt.

The study underscores the urgent necessity of maintaining appropriate salinity levels for clownfish. The fish exhibited symptoms of unease, including decreased pigmentation, appetite, and activity, at 8 ppt. The fish were unable to sustain under the low salinity conditions, as evidenced by the significant increase in mortality rates at 7 ppt. Consequently, it is imperative to preserve a minimum salinity level of 10 ppt to ensure the health and prosperity of clownfish. Clownfish exhibit heightened appetite, energetic behaviour, and vivid tints when salinity levels exceed 30 ppt. Conversely, the fish's condition deteriorates considerably when the salinity falls below 10 ppt, as evidenced by decreased pigmentation, increased mortality rates, and a decreased appetite. The study affirms that marine species such as Clownfish, which thrive in marine habitats, require salinity levels between 30 and 35 ppt for their survival and well-being. Clownfish are incapable of thriving in freshwater, despite the widespread misconception. Clownfish, which are members of the Pomacentridae family, are found in the tropical waters of the Pacific and Indian Oceans, with a particular emphasis on coral reefs. Their physiological and biological systems are highly adapted to saline environments, as evidenced by their distinct salinity, pH, and other chemical properties in comparison to freshwater. The research emphasises the critical significance of salinity in the survival and well-being of Clownfish (Amphiprion ocellaris). Preventing stress and mortality necessitates precise environmental control in aquaculture and ornamental fish care, as salinity levels must be maintained at or above 10 ppt. Clownfish are unable to sustain in freshwater because of their specialised adaptations to saltwater, which impede their capacity to maintain homeostasis in freshwater. Water enters their cells through osmosis in freshwater, resulting in osmotic distress that may be fatal. Their kidneys and gills, which are designed to retain water and expel excess salt in marine environments, are unable to manage freshwater, which leads to rapid death and severe physiological stress.

The retention of clownfish in freshwater results in stress, physiological disturbances, and, in the end, mortality. Clownfish claims that they can flourish in freshwater are both inaccurate and detrimental. In order to guarantee the health of Clownfish, it is imperative that enthusiasts maintain optimal conditions in their marine aquariums. This research underscores the significance of optimal salinity levels for the survival of Clownfish and dispels the misconception that marine fish can acclimatise to freshwater. It also encourages ethical behaviour. In conclusion, the investigation offers essential information regarding the salinity requirements of clownfish, demonstrating their capacity to tolerate progressive salinity decreases while emphasising the hazards associated with salinities below 10 ppt. The health and longevity of Clownfish are contingent upon the maintenance of optimal salinity, which provides critical insights for the ornamental fish industry and promotes ethical care standards.

CONCLUSIONS

This study emphasises the critical minimal salinity thresholds that Clownfish (Amphiprion ocellaris) can tolerate, offering crucial insights for those involved in the care of ornamental fish, aquaculture professionals, and researchers. The findings underscore the significance of maintaining optimal salt levels to avoid dissemination of incorrect information and financial losses resulting from fish mortality. Clownfish are not ideal for freshwater environments and need precise amounts of salt in order to grow. This helps aquarists and breeders ensure that their activities coincide with the physiological requirements of the species. The paper proposes new avenues for future investigation, such as the gradual acclimation of Clownfish to environments with lower levels of salt concentration. This has the potential to strengthen aquaculture techniques and bolster the fish's ability to withstand challenges. Studying the physiological mechanisms that enable Clownfish to endure high salt levels and cope with stress can provide significant knowledge for enhancing their health and development.

Ensuring salinity levels remain above 10 ppt is essential to avoid stress and mortality in Clownfish, underscoring the importance of precise environmental management in aquaculture and ornamental fish care. These discoveries not only deepen our comprehension of the species' ecological requirements but also have practical implications for enhancing the sustainability and efficiency of aquaculture. Additional research is required to devise methods that improve the ability of Clownfish and other marine species to withstand changes in salinity, hence safeguarding their health and survival in various breeding habitats. Future research should focus on examining the process by which Clownfish adapt to reduced salt levels in order to identify the minimum salinity they can withstand through controlled tests. Comprehending the osmoregulatory systems of marine organisms can yield valuable information for enhancing adaptation, refining aquaculture methods, and fostering the preservation of marine biodiversity in the face of environmental fluctuations.

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