Biological Sciences and Pedagogy Journal (BioSPed)
Volume 2, Issue 1 (2026), 28-33
e-ISSN: 3110-3138
https://ejournal.edukhatulistiwa.com/index.php/biosped/index

Plasmolysis in *Rhoeo discolor* Leaf Epidermal Cells Exposed to a Hypertonic NaCl Solution

Muhammad Israr[1*], Rofiqotul Faizah[1]

[1]Natural Science Education Study Program, Faculty of Teacher Training and Education, University of Trunodjoyo Madura, Bangkalan, Indonesia

*Corresponding author: muhammadisrar7510@gmail.com

ARTICLE INFO

Article history
Received: 04 July 2026
Revised: 18 September 2026
Accepted: 26 September 2026

Keywords:
Hypertonic solution; Osmosis; Plant cells; Plasmolysis; Rhoeo discolor

A B S T R A C T

This study was conducted to observe the plasmolysis process in *Rhoeo discolor* (Adam Hawa) leaf epidermal cells after exposure to a hypertonic sodium chloride (NaCl) solution. The study also aimed to demonstrate osmosis and plasmolysis through direct microscopic observation as a practical laboratory learning activity. The experiment focused on identifying visible changes in cell structure caused by osmotic pressure differences between the inside and outside of the cell. A qualitative descriptive method was used through direct microscopic observation before and after treatment with a 10% NaCl solution. Observations were carried out using 4× and 10× objective magnifications, with sufficient time allowed for visible treatment-related changes to develop. Before treatment, the cells appeared turgid, with the plasma membrane remaining closely attached to the cell wall and the purple pigment evenly distributed. After adding the NaCl solution, clear plasmolysis was observed. The cytoplasm gradually shrank inward, and spaces formed between the plasma membrane and the cell wall due to water leaving the cell through osmosis. The observations show that hypertonic solutions can reduce turgor pressure and trigger plasmolysis in plant cells. This experiment also helped explain the concept of osmosis more clearly through direct visual observation. In addition, the study highlights the importance of osmotic balance in biological processes such as plant water regulation, wilting, and food preservation.

© 2026 Israr & Faizah. This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0) (https://creativecommons.org/licenses/by/4.0)

INTRODUCTION

Plasmolysis occurs when plant cells lose water after being placed in a hypertonic solution. Water moves out of the cell through osmosis, causing the cytoplasm to shrink and the plasma membrane to separate from the cell wall. This phenomenon illustrates the relationship between water movement, turgor pressure, and cell structure in plants (Campbell et al., 2020; Taiz et al., 2015). Osmotic stress can cause water loss from plant cells, resulting in reduced turgor pressure and changes in cell volume and membrane–cell wall interactions (Yu et al., 2024).

Osmosis refers to the movement of water molecules from an area of higher water potential to an area of lower water potential through a selectively permeable membrane. In

plant cells, osmosis is important for maintaining turgor pressure. When plant cells are exposed to a hypertonic solution such as concentrated NaCl, water moves out of the cells, reducing turgidity and potentially causing plasmolysis (Campbell et al., 2020; Taiz et al., 2015).

Rhoeo discolor (Adam Hawa) is commonly used for plasmolysis observations because its epidermal cells contain purple pigments that make cellular changes readily visible under a microscope. The cells allow structural changes before and after exposure to a hypertonic solution to be observed directly. In a recent study, Zikri et al. (2024) examined plasmolysis in *Rhoeo discolor* epidermal cells using sucrose solutions of different concentrations and found that plasmolysis varied with solution concentration.

Direct microscopic observation can also make the abstract process of osmosis easier to understand because changes in cell structure can be seen rather than inferred only from theory. In this study, the practical activity was designed as a simple laboratory demonstration in which students can compare cells before and after exposure to a hypertonic NaCl solution.

Apart from its educational value, the osmotic principle demonstrated in this experiment is also relevant to food preservation. Osmotic dehydration uses concentrated solutions to remove water from food materials, thereby contributing to moisture reduction and longer shelf life. Recent reviews describe osmotic dehydration as an established food-preservation approach and discuss the effects of solution concentration and processing conditions on preservation performance (Asghari et al., 2024; Mari et al., 2024).

Previous research provides a useful basis for the present observation. Zikri et al. (2024) investigated *Rhoeo discolor* epidermal cells exposed to sucrose solutions ranging from 0.14 to 0.26 M for 30 minutes and reported plasmolysis at different concentrations. The present study differs in using a single 10% NaCl solution and focusing on a simple before-and-after microscopic demonstration of visible cellular changes. Thus, the purpose is not to claim a new mechanism, but to provide a straightforward and reproducible laboratory procedure for demonstrating osmosis and plasmolysis.

The present study is therefore positioned as a simple undergraduate laboratory demonstration that combines direct microscopic visualization with a reproducible 10% NaCl treatment. Its contribution is the clear comparison of cell condition before and after treatment using an accessible plant material and a straightforward procedure, rather than a claim of a new biological mechanism.

Based on these considerations, this study aimed to observe the effect of a hypertonic NaCl solution on *Rhoeo discolor* leaf epidermal cells and describe the plasmolysis process caused by osmotic pressure differences.

METHOD

This study used a qualitative descriptive method because the observations focused on visible morphological changes in *Rhoeo discolor* epidermal cells before and after treatment with a hypertonic NaCl solution. The observations were used to describe changes in cell turgidity, cytoplasmic position, color appearance, and membrane attachment.

The independent variable was exposure to a 10% NaCl solution. The dependent variable was the condition of the epidermal cells, including cell turgidity, cytoplasmic appearance, and the occurrence of plasmolysis. The control variables included the type of plant material, microscope magnification, observation procedure, and the same observation conditions before and after treatment.

The tools used in this study included a microscope, beaker, razor blade, digital balance, dropper pipette, glass slide, cover slip, spatula, tissue paper, camera, and notebook.

The materials used were fresh *Rhoeo discolor* leaves, distilled water, and sodium chloride (NaCl). A 10% NaCl solution was used to create a hypertonic environment that promotes outward movement of water from plant cells.

Biological Sciences and Pedagogy Journal (BioSPed)
Volume 2, Issue 1 (2026), 28-33
DOI: 10.61142/biosped.v2i1.444

First, 5 g of NaCl were weighed using a digital balance and dissolved in 50 mL of distilled water to prepare a 10% NaCl solution. A thin layer of *Rhoeo discolor* leaf epidermis was carefully peeled and placed on a clean glass slide. Two drops of distilled water were added to the specimen before covering it with a cover slip. The specimen was then observed under a microscope at 4× and 10× objective magnifications to examine the initial condition of the cells. After the initial observation, excess water was removed using tissue paper placed at the edge of the cover slip. Two drops of the 10% NaCl solution were added from the opposite side so that the solution entered the specimen by capillary action. Simple Experimental Procedure is in the Figure 1.

The specimen was allowed to stand until visible cellular changes developed and was then re-observed under the microscope using the same magnifications. Changes in cell shape, cytoplasmic position, color intensity, and membrane attachment were recorded and compared descriptively. Plasmolysis was identified by the visible separation of the plasma membrane from the cell wall following osmotic water loss.

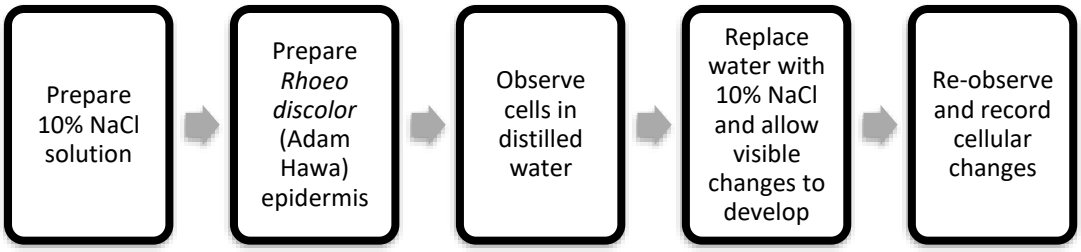


Figure 1. Simple Experimental Procedure

RESULT AND DISCUSSION

The observations showed noticeable differences between epidermal cells placed in distilled water and those treated with the hypertonic NaCl solution.

Table 1. Observation Results of *Rhoeo discolor* in Distilled Water

Magnification	Cell Condition	Color Appearance	Information
4×	Between cells are tight	Condensed	Does not undergo plasmolysis
10×	Between cells are tight	Condensed	Does not undergo plasmolysis

The cells observed in distilled water remained turgid, indicating that the cells retained sufficient water to maintain turgor pressure. The plasma membrane remained closely attached to the cell wall, and the purple pigment appeared relatively evenly distributed. This condition represents the initial state before exposure to the hypertonic solution. The observation of *Rhoeo discolor* epidermal cells exposed to 10% NaCl solution revealed a loose appearance between cells and faded coloration at both 4× and 10× magnification. Similar changes were reported by Nafisah and Sofiatun (2025), who observed that *Rhoeo discolor* cells exposed to saline solution exhibited a shrunken appearance and faded purple coloration. Arnas et al. (2026) also reported cell shrinkage associated with plasmolysis in *Rhoeo discolor* exposed to NaCl solution. These findings suggest that the observed changes may be related to the osmotic effect of the salt solution.

The mechanism can be further explained by the findings of Elmaghrabi et al. (2019), who investigated the effects of NaCl-induced salt stress on plant cells. Their study showed that increasing NaCl concentrations were associated with reductions in cell and nuclear area in tobacco and *Medicago truncatula* cells. These findings support the interpretation that salt exposure can alter plant cell morphology. In the present experiment, the concentrated NaCl

Biological Sciences and Pedagogy Journal (BioSPed)
Volume 2, Issue 1 (2026), 28-33
DOI: 10.61142/biosped.v2i1.444

solution was expected to create a hypertonic environment, causing water to move out of the cells by osmosis. This water loss reduces turgor pressure and can cause the protoplast to shrink away from the cell wall. However, the loose appearance between cells and faded coloration alone are insufficient to confirm plasmolysis; direct microscopic evidence of protoplast shrinkage and separation from the cell wall is needed.

The similar observations at 4× and 10× magnification indicate that the changes in cell appearance were visible at both magnifications. Nevertheless, these observations do not establish differences in the severity of plasmolysis between magnifications. Further observations at higher magnification, preferably with a distilled-water control, would help confirm the cellular changes.

Table 2. Observation Results of *Rhoeo discolor* in 10% NaCl Solution

Magnification	Shape Change	Discoloration	Information
4×	Between cells is loose	Faded	Undergoes plasmolysis
10×	Between cells is loose	Faded	Undergoes plasmolysis

After treatment with the 10% NaCl solution, the cells showed clear signs of plasmolysis. The cytoplasm shrank inward, and spaces appeared between the plasma membrane and the cell wall. The purple pigment appeared more concentrated toward the center of the cell, while the overall color appeared paler. These observations are consistent with water moving out of the cells into the surrounding hypertonic solution through osmosis. The observed shrinkage of the cytoplasm and separation of the plasma membrane from the cell wall are consistent with cellular responses to hyperosmotic stress, which can reduce turgor pressure and cause cell shrinkage (Yu et al., 2024).



Figure 2. Observations of *Rhoeo discolor* epidermal cells in distilled water at 10× magnification.

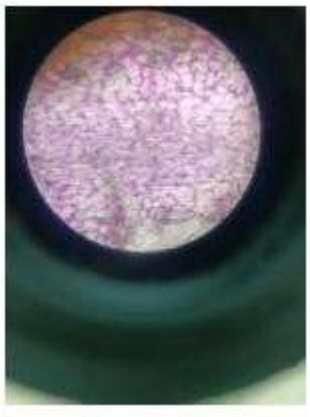


Figure 3. Observations of *Rhoeo discolor* epidermal cells in 10% NaCl solution at 10× magnification.

These observations are consistent with osmosis, in which water moves from higher to lower water potential across a selectively permeable membrane. As water leaves the cell, turgor pressure decreases and the protoplast can separate from the cell wall. Zikri et al. (2024) also reported plasmolysis in *Rhoeo discolor* epidermal cells exposed to hypertonic sucrose solutions, supporting the interpretation that hypertonic conditions can produce visible plasmolysis.

This experiment demonstrates the relationship between a concentration gradient and water movement in plant cells. Because the NaCl solution outside the cells was hypertonic relative to the cell contents, water moved outward and the cells lost turgidity. The visible separation between the plasma membrane and cell wall provided direct evidence of the plasmolysis process.

The findings also have practical significance. In food preservation, osmotic dehydration uses concentrated salt or sugar solutions to remove water from food materials, thereby reducing moisture availability and contributing to preservation. Recent reviews describe osmotic dehydration as an established food-preservation approach based on immersion in hypertonic solutions and highlight its continuing development in food processing (Asghari et al., 2024; Mari et al., 2024). Similarly, plants exposed to saline environments or drought conditions may experience loss of turgor pressure and wilting due to osmotic stress. Salt stress can impose osmotic stress on plant cells and affect cellular structures, including the cell wall and associated processes (Colin et al., 2023).

From an educational perspective, this practicum can help students understand osmosis and membrane transport because the cellular changes can be observed directly under the microscope. The before-and-after comparison provides a simple way to connect an abstract concept with visible cellular evidence.

CONCLUSION

The experiment showed that *Rhoeo discolor* epidermal cells remained turgid in distilled water but underwent visible plasmolysis after exposure to a 10% NaCl solution. Under the microscope, the cytoplasm appeared to shrink inward and spaces developed between the plasma membrane and cell wall. These observations are consistent with osmotic water loss from cells exposed to a hypertonic solution.

The observations demonstrated how a hypertonic environment affects water movement and cell structure. The simple before-and-after procedure also provides a practical way to demonstrate osmosis and plasmolysis in a biology laboratory.

For future studies, different NaCl concentrations or different observation intervals could be tested to compare the degree and progression of plasmolysis more clearly. Quantitative measurements, such as calculating the percentage of plasmolyzed cells, could also improve the accuracy and reliability of the observations.

REFERENCES

Arnas, A. D., Dwitama, A. S., Sari, D. N., Hamidah, N. W., Huki, S. D. P. D., Meldalina, S., & Arini, L. D. D. (2026). Perbedaan pewarnaan *Rhoeo discolor* pada aquadest dan NaCl. *Corona: Jurnal Ilmu Kesehatan Umum, Psikolog, Keperawatan dan Kebidanan, 4*(2), 29–38. https://doi.org/10.61132/corona.v4i2.2270

Asghari, A., Zongo, P. A., Osse, E. F., Aghajanzadeh, S., Raghavan, V., & Khalloufi, S. (2024). Review of osmotic dehydration: Promising technologies for enhancing products' attributes, opportunities, and challenges for the food industries. *Comprehensive Reviews in Food Science and Food Safety, 23*(3), e13346. https://doi.org/10.1111/1541-4337.13346

Campbell, N. A., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Orr, R. B. (2020). *Campbell biology* (12th ed.). Pearson.

Colin, L., Ruhnow, F., Zhu, J.-K., Zhao, C., Zhao, Y., & Persson, S. (2023). The cell biology of primary cell walls during salt stress. *The Plant Cell, 35*(1), 201–217. https://doi.org/10.1093/plcell/koac292

Elmaghrabi, A. M., Francis, D., Rogers, H. J., & Ochatt, S. J. (2019). Nuclear migration: An indicator of plant salinity tolerance in vitro. Frontiers in Plant Science, 10, Article 783. https://doi.org/10.3389/fpls.2019.00783

Mari, A., Parisouli, D. N., & Krokida, M. (2024). Exploring osmotic dehydration for food preservation: Methods, modelling, and modern applications. *Foods, 13*(17), 2783. https://doi.org/10.3390/foods13172783

Nafisah, D. F., & Sofiatun. (2025). Implementation of experiments in science learning in the form of *Rhoeo discolor* plasmolysis practicum. Journal of Progressive Science Education, 1(1), 43–51. https://journal.kopialinea.com/index.php/JPSE/article/view/10

Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant physiology and development* (6th ed.). Sinauer Associates.

Yu, B., Chao, D.-Y., & Zhao, Y. (2024). How plants sense and respond to osmotic stress. *Journal of Integrative Plant Biology, 66*(3), 394–423. https://doi.org/10.1111/jipb.13622

Zikri, H., Azijah, F. M., Aprilia, H., Syahla, K. K., Fitriyyah, I., & Wijaya, S. S. (2024). Penentuan pengaruh plasmolisis pada sel daun *Rhoeo discolor*. *Flora: Jurnal Kajian Ilmu Pertanian dan Perkebunan, 2*(1), 11–20. https://doi.org/10.62951/flora.v2i1.209