Reproductive Strategies and Embryonic Development of Monacha cartusiana Insights into Fertility and Growth Patterns With Some Medical Importance Of Human

Hajir . M. Kadhim [1], Israa. N. Ghulam [2], Fatima. K. Jassim [3]

[1,2] Department of Biology , College of Education for pure Science, University of Kerbala, Kerbala, Iraq

[3] Al Zahraa Center for Medical and Pharmaceutical Research science , Al Zahraa University for women, Kerbala, Iraq

[1] Email: hajer.m@uokerbala.edu.iq (Corresponding author)

Received: 02/03/2026
Accepted: 14/04/2026
Published: 30/06/2026
DOI: https://doi.org/10.65682/kjnhs.v2.i2.198-206

Abstract

Introduction: Snail mucus of *Monacha cartusiana*, a terrestrial snail with agricultural and medical significance, forms an adhesive and protective layer on the internal lining of the gastrointestinal tract, so prevents the ulcerative effects of acid-base digestive enzymes. This study discusses its reproductive strategy and embryonic development. *Monacha cartusiana* has been identified as an intermediate host for parasites that are aetiological agents of human and veterinary diseases, besides being an important agricultural pest. The objectives are to elucidate fertility patterns, staged embryonic development, and the linkage between adult shell length and reproductive output.

Methods: On farms in Al-Hussainiya, Karbala, Iraq, field- observations indicated that the reproductive period commenced herein above local climatology as early as October 2023. Fecundity was investigated in relation to adult shell length after calculating the number of eggs deposited during one spawn season. Embryonic development was observed using a non-invasive light-based method that enabled embryonic growth to be tracked within the eggshell. Embryogenesis was divided into five developmental stages during nine days, with hatching on the tenth day. The gonadal structure and maturity were assessed by histological cross sections of hermaphroditic gonads.

Results: There was a good correlation between shell length and fecundity. The maximum fecundity (39 eggs) was observed in an adult snail, which had a shell length of 16.2 mm, whereas the minimum fecundity (11 eggs) was recorded in snails with spawning occurred at 9.1 mm shell length. Histology revealed that a longer shell was related to more advanced gonad development and greater fecundity.

Conclusion: Shell length is a reliable indicator of sexual maturity and reproductive potential in *Monacha cartusiana*. Understanding the reproductive biology and population dynamics of this snail is essential for effective agricultural pest management, reducing the risk of parasite transmission, and supporting public and environmental health. These bear underscores of the importance of incorporating snail-targeted control strategies, alongside ongoing preventive chemotherapy to reduce diseases.

Keywords: snail mucus; embryonic; *monacha*; land; Iraq.

1. Introduction

Snails play crucial roles in ecosystems as decomposers and food sources for various animals. Their unique anatomy, featuring a muscular foot for locomotion and a protective shell, has evolved over millions of years. Beyond their ecological importance, snails have found their way into human culture, appearing in cuisine, art, and even health and skincare. Their seemingly simple existence belies a complex biology that continues to intrigue scientists and nature enthusiasts alike (Rashad et al., 2025), and they use shells for calcium supplements and snail meat for food (Kougiagka et al., 2022). There were immunotoxic effects reflected and some morphological alterations in the hemocytes (Ibrahim et al., 2025) with an estimated 35,000 species, terrestrial molluscs are one of the most successful and diverse animal groups in land-based ecosystems. Natural bioresources have emerged as promising candidates, with snail slime gaining particular attention due to its documented antimicrobial, antioxidant, anti-inflammatory, and wound-healing properties. This viscoelastic secretion, produced by specialized epithelial cells, plays a vital role in snail survival by facilitating locomotion, protection, and defence against pathogens. Its therapeutic potential is attributed to a complex mixture of bioactive compounds, including allantoin, hyaluronic acid, proteins, and peptides, whose composition is modulated by biological, environmental, and nutritional factors (Chinaka et al., 2021). They are called vine snails or grape snails, and they are terrestrial gastropods that are widespread in most Al-Husseiniya farms in Karbala Governorate/ Iraq. This type of land snail attracts scientific interest due to its ecological importance and its distinctive reproductive biology. Therefore, understanding the fecundity of land snails in general and *M. cartusiana* in particular is crucial in estimating the population dynamics, reproductive strategies of this type of snail, and conservation needs. The mating behavior of *M. cartusiana* is a ritual, the first of which is courtship and then complex physical interactions. To ensure successful mating and successful reproductive ability, individuals engage in physical contact and mutual sperm transfer. These behaviors are necessary for the process of effective fertilization and subsequent egg production (Stringer et al., 2003). snails are good invertebrate models for evaluating the chemical toxicity in freshwater habitats, Also, most terrestrial gastropod species are oviparous and for oviposition some of them utilize natural holes or crevices in the soil or under stones and pieces of wood (Bishop et al., 1992) . Data indicated that, the total number of deposited eggs per individual differed according to species and season (Capinera, 2001). External factors, such as seasonal variations, for example, affect the reproductive production of *M. cartusiana* in terms of population dynamics. Not only that, but there are other factors such as the duration of light, and environmental signals, all of which in turn either stimulate or inhibit reproductive activity according to favorable or unfavorable conditions (Kovalenko, 2019). As for internal factors, such as the physiological state of the snail, its size, age, and general health, which can directly affect reproductive ability and fertility, Although *M. cartusiana* has relatively great reproductive potential, it still faces challenges related to the fertility of the snail itself and the success of the snail. Reproductive in addition, predation, habitat degradation, and human practices negatively affect population size and reduce reproductive output (Heller, 2001). It was found that it possesses a mechanism to withstand environmental conditions and low temperatures (Schweizer et al., 2019). Also, at high temperatures, it immerses itself in the roots of some plant (Mahrous et al., 2002). Reproductive system and mating behavior *M. cartusiana* is hermaphrodite, meaning that individuals have both male and female reproductive organs and so can act as sperm donors or recipients during mating. This is because of the unique feature possessed by the aforementioned snail, which allows self-fertilization or cross-pollination with other individuals of the same species.

2. Materials and Methods

2.1. Sample collection

Adult snails *M. cartusiana* were collected from the Al-Husseiniya Farms area in the Holy Governorate of Karbala during the month of October 2022. The samples were brought to laboratories and placed in a glass aquarium (50x50x50 cm) for several days to observe their behaviors. Movements and mixing for the purpose of mating with each other.

2.2 Taking the standard dimensions of the shell

After that, the standard dimensions of the snail shell were taken and the snail was placed in a box containing food to monitor the adult snail and collect the eggs. Eggs were also collected and the number of eggs recorded according to the length of the shell of the mother that laid the eggs.

2.3 Fertility

Then the fertility rate of the snails was extracted according to the straight line equation (I. Ghulam & Magid, 2016; I. N. Ghulam, 2020).

2.4. embryonic development

Monitoring embryonic development from the outside without breaking the egg shell daily by inventing a method of placing eggs directly on a light source in completely dark conditions in the laboratory to see the size increase of the embryo as an indication of embryonic development.

2.5. Preservation and dissection of samples

Samples from adult mother snails were also dissected, and the gonads were extracted and preserved in a tissue preservation solution containing 70% ethyl alcohol for 3 days, after which tissue cutting operations were performed according to (Mubarok et al., 2021).In the method, the eggs, their shapes and sizes were photographically documented using a Sony camera

3. Results

Figure 1. shows dorsal view shape of *Monacha cartusiana*.

Figure (1): How the mother snail looks from its dorsal view.

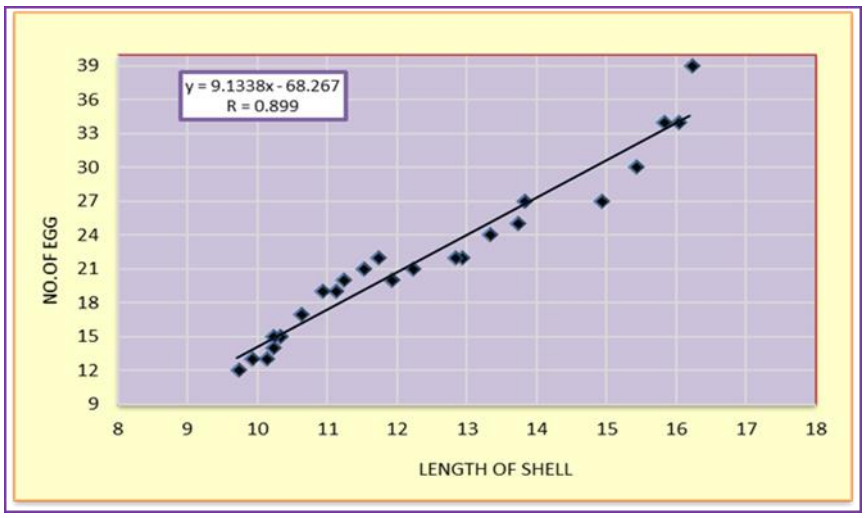

Figure 2. Fecundity of Monacha cartusiana based on the length of the snail shell.

Figure (2): The shape, color and size of the eggs of this land snail can be seen. They are spherical and white in colour. Sometimes you find the eggs tending to be yellow in color, which indicates the embryonic development of the embryos inside the egg. This type of land snail lays its eggs in a single spherical shape. But it is kept inside a hole in the soil to protect it from weathering and corrosion factors, and for the purpose of completing embryonic development.

Figure 3. show the shapes and size of Monacha cartusiana.

A- Eggs and mother snail **B-** Size of the egg **C-** Eggs from inside the incubators

Figure (3) : The linear relationship to fertility, as shown in Figure (3), was represented by the presence of a positive direct relationship between the number of eggs laid by the mother snail and the length of her shell. It can be noticed how the snail, which is 16.2 mm long, laid 39 eggs, while the

snail, whose shell length is 9.1 mm, laid only 11 eggs. The stages of embryonic development of the snail *M. cartusiana* can be divided through the outer shell of the egg by the size increase of the embryo inside the egg and according to age into five starting starting with stage A, in which the splitting and splitting of the egg can be clearly observed and continuing through the stages.

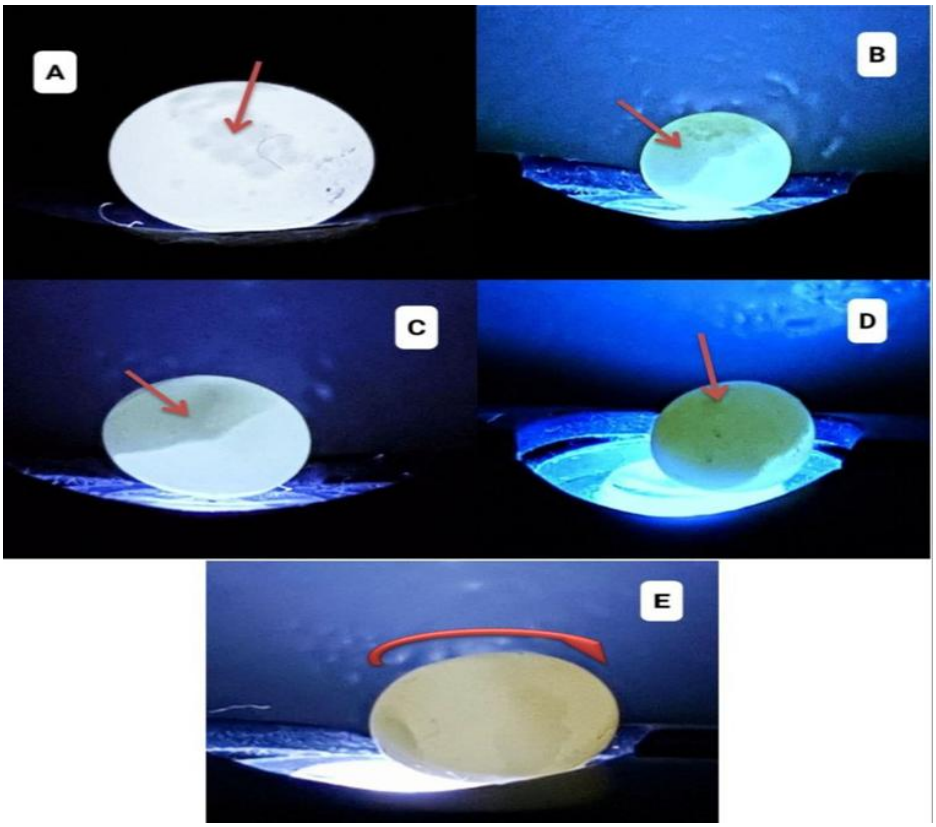

Figure 4. stages of snail embryonic development of Monacha cartusiana according to incubation period.

A- 1 Day **B-** (2-3) Day **C-** 4 Day **D-** (5-6-7) Day **E –** (8-9) Day

Figure (4): it can be seen how the increase in the size of the embryo and the speed of its development. Up to the E stage before hatching, where a lack of internal space for the egg can be found, as the embryo has used all of the space due to its large size. It is worth noting that this embryonic development from the inside is accompanied by a change in the color of the egg and its shell to yellow from the outside, and this is an indication of the development that is taking place in the embryo, as mentioned above. Here, the reasons for resorting to this method are explained through examining embryonic development because the egg shell is opaque and it is difficult to follow development under the microscope.

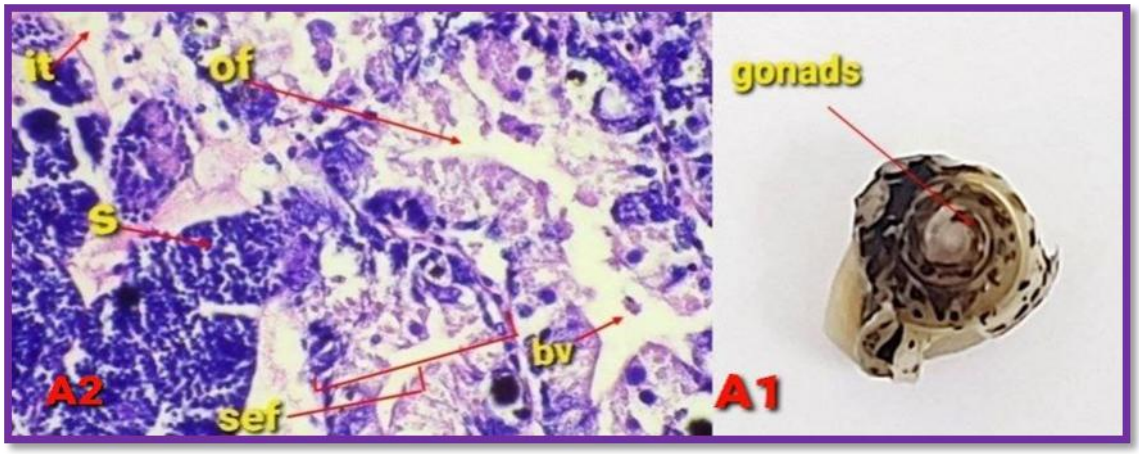

Figure 5. Monacha cartusiana , A1: without shell, location of the gonad A2: C. S. of the hermaphrodite gonad showing parts, 20X stained by H&E *bv: blood vessel, c.s.: cross-section, H&E : Hematoxylin and eosin, it: Interstitial tissue, of: ovarian follicle, s : Sperm, sef: stages of egg formation.

Figure (5): shows a cross-section of the reproductive glands in a land snail, which is a hermaphrodite gland in which the male and female follicles appear. In the histological section, the maturation of the male and female follicles is observed at the same time, and it shows the integrity and interconnectedness of the tissues. It is an adult snail (mother snail). The reproductive gland tissue is of great importance in understanding the philosophy of reproduction and Fertility factors.

4. Discussion

These animals have long been of importance to human societies as food, medicine, crop pests and the Slime derived from plant-fed snails exhibited significantly enhanced bioactivity, characterized by stronger antibacterial effects, increased antioxidant capacity, and improved anti-inflammatory and wound-healing responses (Elkhayari et al., 2026). vectors of parasites, and as tools, personal ornamentation and currency in trade (Heller, 2001) .Snails are considered intermediate hosts for parasites that cause serious human diseases, whether they are aquatic or terrestrial snails, such as Schistosomiasis (Hailegebriel & Kabtimer, 2026). Through the research results, a difference in the shape and color of the eggs can be noticed, and this is one of the signs of the continuous development of the embryo, as the color begins to change gradually from white to dark yellow, and perhaps this is due to the secretions of the embryo inside the egg, which is reflected in the color of the egg from the outside. This study was identical to the study of (I. N. Ghulam, 2020) during her study of the eggs of the snail *L. auricularia*. This was also confirmed by Fretter (1984) that the size of the eggs changes with the progress of embryonic development, and he attributes these changes to genetic and environmental factors. This is what was confirmed by both research (Goulding et al., 2023). On the characteristics of snail eggs during embryonic development, with a focus on how egg color changes as the development progresses. The study by Heller (2001) explain that eggs typically start out translucent or white and become darker as the embryo develops. This reference discusses the different stages of embryonic development in snails and how environmental factors such as humidity and temperature affect egg color and size. It is suggested that environmental conditions can influence embryo development and external appearance, which is also confirmed by (Sands et al., 2020). The physiological state of the snail, its age and size have a direct impact on the fertility and reproductive capacity of the snail. This means that the more the physiological condition and its accessories are very good, the more these snails will lay a greater number of viable eggs. In addition to that, the

availability of the necessary nutrients and the appropriate environmental conditions for them, including humidity and temperature factors, contribute. In maintaining the periodic growth of this snail and thus increasing the quantity and quality of eggs during the reproductive process (Arnaud et al., 2001; Schubert et al., 2023) . Understanding the internal anatomy of the reproductive gland and its tissues gives an in-depth understanding of the mechanism and method of animal mating, and thus it is possible to interpret the fertility results in a correct scientific manner. *M. cartusiana*, as one of the wild hermaphroditic snails, is capable of producing eggs or sperm in a method of mutual fertilization, meaning each partner can switch roles, and this works on increasing the chances of mating and thus increasing the number of eggs produced. In other words, increasing the flexibility of the hermaphroditic gonads increases the chances of producing eggs, and this is confirmed by (Arnaud et al., 2001). It is important to understand a variety of information about the relationship between the type of reproductive system in snails and its relationship to egg production, as the type of sex, whether it is hermaphroditic or separate, may affect as a factor in increasing or decreasing egg production, as (Chase & Vaga, 2006) showed that the chance of a hermaphroditic snail may be greater. Of the snails, separate sexes increase egg production. Although separate sexes are able to produce a larger number of eggs compared to hermaphrodites, the fact that hermaphrodites need to divide their energies and body resources between producing eggs and forming sperm, the chances of hermaphrodites are higher and more stable in continuously producing eggs, thus increasing A continuous population, while others with separate sexes have their reproductive efficiency affected due to the challenge in finding the opposite sex as a partner and the success of mating, thus limiting mating and decreasing or limiting egg production , Hence, the importance of understanding the biology of reproduction through knowing the tissue of the reproductive system of the study snail. Thus, it can be known that the eggs produced by this snail are of high production compared to its size, in addition to the availability of environmental factors and food for it.

5. Conclusion

The larger (and longer) snails are often the ones that can lay the largest number of eggs, due to the maturity of their reproductive systems. The sexual maturity of the snail can be known by the length of its shell, as it reaches a certain length to prepare for the production of eggs. The population size of the snail increases as the environment improves. Rich in food and moisture resources, the faster the snails grow and produce more eggs compared to others in poor environments, determining the sex of the snail and the method of fertilization gives a clear idea about the factors of fertility and egg production , Many parasites that use gastropods as intermediate hosts cause very severe illnesses in humans and animals worldwide , reported that diseases caused by gastropod-borne helmets (GBHs) are thought to affect millions people globally These findings illuminate promising pathways for the development of innovative therapeutic agents targeting microbial infections, oxidative stress, and wound healing, presenting significant potential for advancing health and wellness solutions.

6. Acknowledgments

I am grateful to the following individuals and institutions for their support and valuable contributions to this research, Professor Dr. Ibtisam Mahdi Abdel-Sahib for his continuous assistance to me. And to the laboratories of biology Department at the College of Education for Pure Sciences, University of Kerbala, and those in charge of them for providing the necessary resources, facilities, and the appropriate environment for research. I also extend my thanks to some of my professors and colleagues in the same specialty who helped me in collecting samples, and to the researchers whose

I cited in producing this research. I extend my sincere thanks to each of them for their role in making this research a success.

7. References

Arnaud, J. -F., Madec, L., Guiller, A., & Bellido, A. (2001). Spatial analysis of allozyme and microsatellite DNA polymorphisms in the land snail *Helix aspersa* (Gastropoda: Helicidae). *Molecular Ecology*, *10*(6), 1563–1576. https://doi.org/10.1046/j.1365-294X.2001.01292.x

Bishop, J. A., Formby, J. P., & Thistle, P. D. (1992). Convergence of the South and Non-South Income Distributions, 1969-1979. *The American Economic Review*, *82*(1), 262–272. http://www.jstor.org/stable/2117614

Chase, R., & Vaga, K. (2006). Independence, not conflict, characterizes dart-shooting and sperm exchange in a hermaphroditic snail. *Behavioral Ecology and Sociobiology*, *59*(6), 732–739. https://doi.org/10.1007/s00265-005-0103-y

Chinaka, N. C., Chuku, L. C., George, G., Oraezu, C., Umahi, G., & Orinya, O. F. (2021). Snail Slime: Evaluation of Anti-Inflammatory, Phytochemical and Antioxidant Properties. *Journal of Complementary and Alternative Medical Research*, 8–13. https://doi.org/10.9734/jocamr/2021/v13i130214

Elkhayari, A., Rour, E., Raoui, S. M., Bouymajane, A., M'hamdi, Z., Moutaoikil, M., hajjaj, H., Mzoudi, N., & Filali, F. R. (2026). Therapeutic enhancement of Cornu aspersum snail slime through medicinal plant diets. *BIO Web of Conferences*, *215*, 01001. https://doi.org/10.1051/bioconf/202621501001

Fretter, V. (1984). *Prosobranchs In: TOMPA, AS; VERDONK, NH; van. den BIGGELAAR, JAM The Mollusca vol. 7 Reproduction*. New York: Academic Press Inc.

Ghulam, I., & Magid, G. (2016). Study of fertility and development stages of freshwater snail Physa acuta Draparnaud, 1805 (Mollusca: Gastropoda) in Al-Hussainia channel. *The Holy Karkala*, *14*(3), 106–113.

Ghulam, I. N. (2020). PHENOTYPIC DESCRIPTION OF THE MELANOPSIS BUCCINOIDEA OLIVIER, 1801 (MOLLUSCA: GASTROPODA) AND THE WAY OF ITS REPRODUCTION IN THE HOLY KARBALA. *Biochemical & Cellular Archives*, *20*(2).

Goulding, T. C., Strong, E. E., & Quattrini, A. M. (2023). Target-capture probes for phylogenomics of the Caenogastropoda. *Molecular Ecology Resources*, *23*(6), 1372–1388. https://doi.org/10.1111/1755-0998.13793

Hailegebriel, T., & Kabtimer, N. (2026). Distribution and Prevalence of Schistosome Infection among Intermediate Snail Hosts in Ethiopia: A Systematic Review and Meta-Analysis. *Acta Parasitologica*, *71*(1), 41. https://doi.org/10.1007/s11686-026-01234-z

Heller, J. (2001). Life history strategies. In *The biology of terrestrial molluscs* (pp. 413–445). CABI Publishing. https://doi.org/10.1079/9780851993188.0413

Ibrahim, A. M., Wang, C., Al-olayan, E., & Abdel-Tawab, H. (2025). Insights into biological, immunological, biochemical and ultra-histopathological perturbations as biomarkers to Fluroxypyr-1-methylheptyl ester pollution in freshwater snail, Biomphalaria alexandrina. *Ecotoxicology*, *34*(6), 1020–1035. https://doi.org/10.1007/s10646-025-02871-2

Kougiagka, E., Apostologamvrou, C., Giannouli, P., & Hatziioannou, M. (2022). Quality Factors of Commercial Snail Fillets as Affected by Species. *Food Technology and Biotechnology*, *60*(3), 330–337. https://doi.org/10.17113/ftb.60.03.22.7403

Kovalenko, D. (2019). The features of the land snail monacha (monacha) cartusiana (O.F. Muller, 1774) ecological niche in technosol on gray-green clay (nikopol manganese ore basin). *Lesya Ukrainka Eastern European National University Scientific Bulletin. Series: Biological Sciences*, (3), 91–100. https://doi.org/10.29038/2617-4723-2019-387-91-100

Mahrous, M. E., Ibrahim, M. H., & Abdel-Aal, E. M. (2002). Ecological aspects of the glassy clover snail, Monacha cartusiana (Muller) under field conditions in Sharkia Governorate. Egypt. 2nd. *Intern. Conf. PPRI. Cairo, Egypt*, 21–24.

Mubarok, M. I., Rochmanti, M., Yusuf, M., & Thaha, M. (2021). The anti-inflammatory effect of ACE-I/ARBs drug on hs-CRP and HDL-cholesterol in CKD patient. *Indian Journal of Forensic Medicine & Toxicology*, *15*(3), 3743–3750.

Rashad, M., Sampò, S., Cataldi, A., & Zara, S. (2025). From Nature to Nurture: The Science and Applications of Snail Slime in Health and Beauty. *Journal of Cosmetic Dermatology*, *24*(2). https://doi.org/10.1111/jocd.70002

Schubert, H., Duda, M., Eschner, A., Weigand, E., & Kruckenhauser, L. (2023). DNA barcoding as a tool to monitor the diversity of endangered spring snails in an Austrian National Park. *Biodiversity Data Journal*, *11*. https://doi.org/10.3897/BDJ.11.e91496

Schweizer, M., Triebskorn, R., & Köhler, H. (2019). Snails in the sun: Strategies of terrestrial gastropods to cope with hot and dry conditions. *Ecology and Evolution*, *9*(22), 12940–12960. https://doi.org/10.1002/ece3.5607

Stringer, I. A. N., Bassett, S. M., McLean, M. J., McCartney, J., & Parrish, G. R. (2003). Biology and conservation of the rare New Zealand land snail *Paryphanta busbyi watti* (Mollusca, Pulmonata). *Invertebrate Biology*, *122*(3), 241–251. https://doi.org/10.1111/j.1744-7410.2003.tb00088.x