

An Insight into Breeding of Medicinal Leeches: A Review

Shaziya Begum, M.¹Shoaib, Asifa Sultana and Sohail Ahmad

¹Research Scholar, Department of IBT, Ajmal Khan Tibbiya College, AMU, U.P., India;

²Asst. Professor, Department of IBT, Ajmal Khan Tibbiya College, AMU, U.P., India;

³Professor, Department of IBT, Ajmal Khan Tibbiya College, AMU, U.P., India;

⁴Asst. Professor, Department of Orthopaedic Surgery, J N Medical College and Hospital, AMU, U.P., India

*Corresponding Author: Mobile no. 9501116783, e-mail ID: mdshaziya21@gmail.com

Abstract:

Leech therapy is a traditional method in the Unani System of Medicine. It involves applying live leeches on affected parts of the body surface to evacuate morbid matter and harness the therapeutic benefits of leech saliva.

The declining population of medicinal leeches necessitates breeding these creatures to ensure a constant supply for clinical applications. This research paper primarily aims to highlight crucial aspects of successful medicinal leech breeding. It offers insights into the necessity, methodologies, and procedures involved in the breeding process. Additionally, it imparts fascinating information about the world of leeches.

Keywords:

Aquaculture, Breeding, Hirudinaria, Leech, Unani, Leeching, Irsale Alaq.

Introduction:

Leech is a blood-sucking creature belonging to the Hirudinea subclass within the animal kingdom's phylum Annelida. They possess flexible, muscular, segmented bodies capable of extending and contracting. These creatures thrive and reproduce in freshwater environments. For centuries, medicinal leeches have played a role in traditional medicine across ancient civilisations, including Rome, Greece, India, and China. In Iran also, Avicenna (980-1037) documented their medicinal use in his book 'Canon of Medicine' [Malek M et al., 2019]. Bloodletting with leech therapy has been employed by ancient Unani scholars both for prevention and treatment over thousands of years [Shoaib M et al., 2016]. Out of approximately 600 species, only around 15 are used in medical applications [Michalsen A et al., 2007]. *Hirudinaria medicinalis* (European species) and *Hirudinaria granulosa* (Indian species) are favoured for their exceptional medicinal properties [Shoaib M et al., 2016].



Fig.1 *Hirudo medicinalis* sucking blood

The popularity of leech therapy is on the rise due to its effectiveness in treating various conditions such as varicose veins, non-healing ulcers, arthritis, psoriasis, etc. Consequently, there is a growing demand for leeches among clinicians [Kumar M., Rani M., 2020], making leech breeding essential to ensure a continuous supply of medicinal leeches. A thorough and precise understanding of leech behaviour, habitat, and reproduction forms the foundation for proper leech cultivation, breeding, and maintenance [Michalsen A et al., 2007].

Commonly used Medicinal Leeches:

Hirudinaria granulosa, *Hirudo medicinalis*, *Hirudo verbana*, *Hirudo orientalis*, *Hirudo nipponica*, *Hirudinaria javanica*, *Hirudinaria manillensis*, *Haementeria officinalis*, *Haementeria ghilianii*, *Limnatis paluda*, *Limnatis nilotica*, *Haemopsis sanguisuga*, *Macrobdella decora*, *Placobdella costata*, *Whitmania pigra*.

Hirudinaria Granulosa:

Hirudinaria granulosa, commonly known as the Indian buffalo leech, is characterized by its granulated dorsal surface. The dorsal side of the leech has small granules or bumps, which distinguish it from some other leech species. Additionally, it typically has a flattened body and is known to inhabit freshwater habitats, often found in muddy or slow-flowing waters.



Fig.2 *Hirudinaria granulosa*

Hirudo Medicinalis:

Hirudo medicinalis, also known as the European medicinal leech, is recognized by its segmented body, typically featuring a greenish-brown or olive coloration. It has a distinctive pattern of dark spots on its dorsal side.

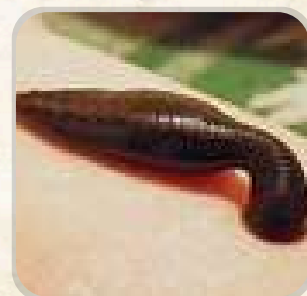


Fig.3 *Hirudo medicinalis*

Hirudo Verbana:

Hirudo verbana, known as the Medicinal leech or the Spanish medicinal leech, is identified by its distinctive olive-green coloration and the presence of irregular dark spots on its dorsal surface.



Fig.4 *Hirudo verbana*

Hirudo Orientalis:

Hirudinaria orientalis, commonly referred to as the Oriental medicinal leech, is recognized by its olive-green to brownish coloration. It features a segmented body with a distinctive pattern of dark spots on its dorsal side.



Fig.5 *Hirudo orientalis*

Hirudo Nipponica:

Hirudo nipponia, commonly known as the Japanese medicinal leech, is identified by its elongated and cylindrical body, typically with a brownish to olive-green coloration. A distinguishing feature is the presence of longitudinal stripes or markings along its dorsal surface.



Fig.6 *Hirudo nipponica*

Hirudinaria Javanica:

Hirudo medicinalis, also known as the European medicinal leech, is recognized by its segmented body, typically featuring a greenish-brown or olive coloration. It has a distinctive pattern of dark spots on its dorsal side.



Fig.7 *Hirudinaria javanica*

Hirudinaria Manillensis:

Hirudinaria manillensis, commonly known as the Philippine medicinal leech, is identified by its elongated and cylindrical body, typically brown or olive-green in color. It has longitudinal stripes along its dorsal surface, contributing to its distinctive appearance.



Fig.8 *Hirudinaria manillensis*

Haementeria Officinalis:

Haementeria officinalis, commonly known as the Amazonian medicinal leech, is characterized by its flattened and elongated body. The dorsal side often exhibits a distinctive pattern of dark spots, and the coloration can vary from greenish-brown to olive.



Fig.9 *Haementeria officinalis*

Haementeria Ghiliani:

Haementeria ghiliani, commonly known as the Mexican medicinal leech, is recognized by its segmented body with a flattened appearance. It typically has a brownish to olive-green coloration, and the dorsal side may display a pattern of dark spots.

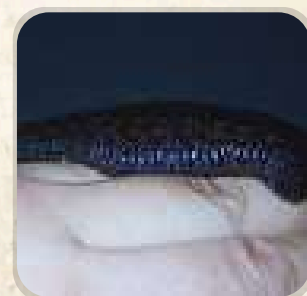


Fig.10 *Haementeria ghiliani*

Limnatis Paluda:

Limnatis paluda, commonly known as the marsh leech, is identified by its elongated and cylindrical body, typically with a brownish or olive-green coloration. There is presence of longitudinal stripes or markings along its dorsal surface.



Fig.11 *Limnatis paluda*

Limnatis Nilotica:

Limnatis nilotica, commonly known as the Nile leech, is recognized by its elongated and cylindrical body, which can vary in color from olive-green to brown. One of its notable features is the presence of longitudinal stripes along its dorsal surface.



Fig.12 *Limnatis nilotica*

Haemopsis Sanguisuga:

Haemopsis sanguisuga, commonly known as the horsehair worm leech or the European medicinal leech, is identified by its elongated and cylindrical body with a dark olive-green or brownish coloration. A notable feature is the presence of distinct dark spots on its dorsal surface.



Fig.12 *Hirudinaria Sanguisuga*

Macrobella Decora:

Macrobella decora, commonly known as the North American medicinal leech or the ornate medicinal leech, is identified by its ornate and intricate coloration. It typically has a yellow to olive-green background with dark markings that form a unique pattern, creating an ornate appearance.



Fig.13 *Macrobella Decora*

Placobdella Costata:

Placobdella costata, commonly known as the ribbed medicinal leech, is identified by the distinct rib-like ridges along its body. These ridges run longitudinally and give the leech a unique appearance. The coloration of *Placobdella costata* can vary but often includes shades of brown or green.



Fig.14 *Placobdella Costata*

Whitmania Pigra:

Whitmania pigra, commonly known as the Oriental medicinal leech or the horse leech, is characterized by its elongated and cylindrical body with a dark olive-green or brownish color. One distinctive feature is the presence of longitudinal stripes along its body.



Fig.15 *Whitmania Pigra*

What Is Leech Breeding ?

Breeding means the process of sexual reproduction to produce offspring. This breeding practice falls within the domain of aquaculture, which is also referred to as aquafarming. Aquaculture encompasses the deliberate breeding, cultivation, and harvesting of aquatic organisms for commercial purposes and the conservation of endangered species. Leech breeding is conducted in a carefully controlled environment to ensure these creatures' healthy and efficient reproduction.

Materials and Method

Literature was searched from all relevant articles upto 2023 including text books, research and review papers. Additionally search engines like Google Scholar, Pubmed, Research Gate etc. were browsed and various published journals of Elsevier, Bio One, Springer etc. were selected and referred in this paper.

Need of Breeding of Medicinal Leeches

In recent times, environmental pollution resulting from industrial waste and the widespread use of chemical fertilisers in agriculture has caused a decrease in the natural leech population. Conversely, the rising popularity of Leech Therapy has led to an increased demand for medicinal leeches [Kumar M., Rani M., 2020]. The collection of medicinal leeches for various purposes has contributed to the depletion of natural populations [Malek M et al., 2019]. Additionally, leeches are also required for conducting scientific research [cani M., 2020]. Ensuring the health of these leeches is paramount because they come into direct contact with a patient's blood. Presently, there is no established and trustworthy source for obtaining leeches. Furthermore, there is a potential risk of leeches serving as vectors of blood-borne diseases like Hepatitis and HIV if obtained from unapproved suppliers [Ugural B et al., 2018].

Breeding Techniques

Three prevalent leech breeding methods include laboratory breeding, intensive breeding in artificial ponds, and semi-intensive breeding in natural pond [Ugural B et al., 2018].

The semi-intensive breeding approach is the most cost-effective method, involving the management of a natural pond and providing appropriate feed. However, it is susceptible to contamination risks due to its open environment.

The intensive breeding method required fully controlled ponds and all the food is under control. This method minimises the risk of contamination but not as laboratory ones. Laboratory breeding is operated carefully and properly and it is the best way to breed hygienic leeches for human use.

Leech Behaviour and Habitat

The natural behaviour of leeches consists of a repetitive cycle of events:

a) Calmly searching for food and carefully observing potential prey. They either swim slowly or affix themselves to floating leaves near the water surface for extended durations, which can span from months to years; b) Swiftly attaching to their prey and

and engaging in a rapid series of movements to feed. Typically, the feeding process concludes within a few minutes; c) Submerging themselves to find a concealed location in the deeper sections of the water body, where they can rest and digest their meal. This period of rest may extend for several months to years [Michalsen A et al., 2007].

Leeches filled with blood protect themselves from hungry leeches and other predators by hiding in safe, dark places [Michalsen A et al., 2007]. Leeches thrive in temperature range 26–30°C [Cheng B. et al., 2016]. Leeches may become overactive in hot environment and sluggish in cold [Michalsen A et al., 2007]. Quiet, shallower eutrophic ponds, typically with depths ranging from 1 to 1.5 meters and featuring loamy or peaty bottoms, are particularly suited to leech habitat. The reproductive success of leeches is intricately linked to the characteristics of the pond banks, including their profile, mineral composition, flora, and fauna [Michalsen A et al., 2007]. Leeches lay their cocoons in the soil of these pond banks. This choice of location is strategic, as it offers protection to the young leeches from dehydration, drowning and predators [Kutschera U, Wirtz P. 2001]. Upon hatching, young leeches initially rely on the yolk mass within their cocoons for sustenance. Subsequently, they start to feed on benthic and planktonic organisms, then proceed to amphibians, and ultimately target mammalian prey. Remarkably, young leeches can survive for up to six months without food following hatching. Given their frequent molting, which occurs every 3 to 10 days, leeches require specific environmental features such as hard-leaved plants, branches, rocks, etc., to facilitate the shedding of their skin. The ideal leech pond should encompass various species of amphibians and fish and it should serve as a watering site for warm-blooded terrestrial vertebrates [Michalsen A et al., 2007]. Leech has thermoreceptors especially in the skin of the upper lip. It must sense heat in order to bite. The ideal temperature range is 35 to 40°C, corresponding to body temperature of the mammals [Michalsen A et al., 2007]. It is crucial to maintain water quality by preventing contamination with heavy metals, as leeches exhibit a high sensitivity to such pollutants [Petrauskiene L., 2004]. Additionally, leeches are extremely susceptible to disinfectants, with even minimal concentrations of chlorine proving fatal, hence medicinal leeches can be used as indicator of water toxicity [Michalsen A et al., 2007]. The pond water should possess minimal hardness and maintain a pH level between 6 and 7 to support the thriving of leech populations [African Journals Online].

Reproduction

Medicinal leeches achieve sexual maturity between two to four years of age, and an interesting facet of their sexual development is their reliance on mammalian blood. Tranquillity and a peaceful environment are crucial for the survival and reproductive success of leeches [Michalsen A et al., 2007]. They require a minimum temperature of roughly 28°C [Michalsen A et al., 2007] and adequate feeding [Australian Museum] for successful reproduction. Leeches are hermaphrodites, possessing both male and female sex organs, but they do not engage in self-fertilization. Instead, they copulate with other leeches [Michalsen A et al., 2007], typically during the morning hours [Zhonghua L et al., 2014] of summer [Michalsen A et al., 2007] months (April to September).

This mating process can take place in or out of the water and may extend for up to 18 hours [Michalsen A et al., 2007], although it generally lasts for 1 to 2 hours [Zhonghua L et al., 2014]. During copulation, two leeches attach themselves to each other in the clitellar region on their ventral surface. One leech's head end aligns with the other's tail end, allowing the male gonopore of one leech to make contact with the female gonopore of the other.

A spermatophore is then passed into the female's vagina [Wikipedia], and fertilization occurs as the sperm reach the ovaries.



Fig.17 Copulation in Leeches

Approximately one month after copulation, the clitellum secretes a durable, gelatinous cocoon [Australian Museum]. Inside this cocoon, the leech injects 10 to 30 eggs [Michalsen A et al., 2007]. The time between copulation and egg-laying can range from one to nine months. Afterward, the leech frees itself from the cocoon, sealing it as it passes over its head [Australian Museum]. These cocoons are typically deposited in tunnels that the leeches burrow in the soil along the pond banks [Michalsen A et al., 2007]. The cocoon provides nourishment and protection to the developing eggs. It also protects the embryos from dehydration.

It generally takes 2 to 3 weeks for the cocoon to hatch into juvenile leeches [Tarin A et al., 2005]. Newly hatched leeches measure approximately 1 to 2 cm in length and have a diameter of 1 to 1.5 mm [Michalsen A et al., 2007].

In a span of 5 to 12 days during a single summer, mature leeches have the capacity to lay eight or more cocoons. If we consider a scenario where a leech lays four cocoons, each housing 15 eggs per year, this would lead to an estimated 60 offspring annually [Michalsen A et al., 2007].

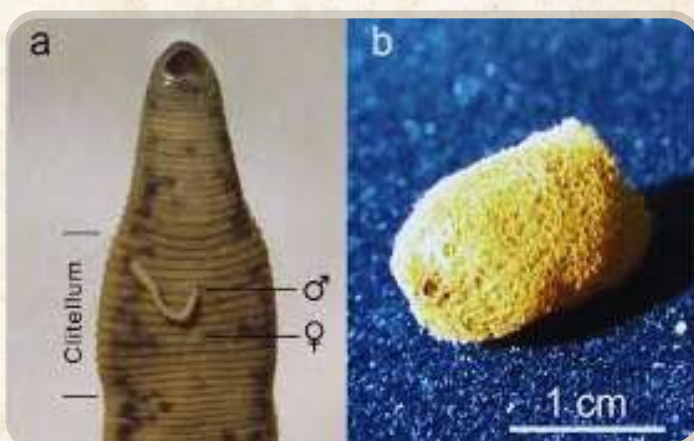


Fig.18 a. Male and female gonopores
b. Leech cocoon



Fig.19 Juvenile leeches.

Leech-Keeping Practice

Upon arrival, it is essential to separate deceased or ailing leeches. Indications of illness encompass a noxious odour, skin that is limp and lacks firmness, a pallid complexion, the presence of firm spots, nodules, or constrictions, swelling of the head, ulcers, pustules, reddened lips, a white mucous coating, injuries, and traces of blood in some cases. Subsequently, the leeches should undergo a thorough cleansing beneath a mild lukewarm water spray.

i) Leech Container and Accessories:

To store leeches temporarily, you'll need a waterproof container filled about two-thirds full with water and a tightly fitting lid. Approximately 1 litre of water is sufficient for preserving around 15 to 20 leeches. Inside the container, it is essential to place calcium-free stones on the bottom, ideally with sharp edges to aid in leech molting. Additionally, include hard-leaved plants within the container to facilitate the molting process, as these plants can absorb metabolic byproducts from the leeches and release oxygen. Rocks and plants also serve as hiding spots, providing leeches with a sense of security. To prevent leeches from escaping, cover the container with gauze, cheesecloth, or fine-mesh synthetic netting, ensuring that the edges of the covering are securely fastened with an elastic band [Michalsen A et al., 2007].

ii) Leech Water:

Water quality requirements:

- Chlorine-free
- pH 6 to 7
- Ammonium < 0.5 mg/L
- Nitrate < 25 mg/L, nitrite < 0.4 mg/L
- No heavy metals

Rainwater proves to be a valuable water source due to its typically low pH and absence of calcium. Alternatively, distilled water is suitable but requires supplementation with 0.5 grams of sea salt per litre [Michalsen A et al., 2007].

iii) Cleaning and Changing the Water:

The molted skins of the leeches can often be seen on the water. Greenish brown discoloration occurs due to leech excreta. Leeches excrete the bacterium *Aeromonas*, which settles on the walls of the leech container [Michalsen A et al., 2007]. The water may be changed in 2 to 7 days [Michalsen A et al., 2007]. The greater the amount of water, the less it needs changing. Do not overcrowd the leeches. Clean the leech container thoroughly before refilling it in order to reduce bacterial density [Michalsen A et al., 2007].

iv) Leech Feeding:

Leeches have the remarkable ability to survive up to two years without food, making regular feeding generally unnecessary. However, to maintain water cleanliness and prevent cannibalism among leeches, it is advisable to feed them outside the water.

For this purpose, blood is typically provided in pig bladders, intestines, linen cloths, or other suitable materials. Importantly, mammalian blood appears to play a crucial role in their sexual maturation [Michalsen A et al., 2007].

Because of their cannibalistic tendencies [Kutschera U, Roth M., 2005], the feeding status of all leeches kept in a single pot should be the same.

v) Temperature and Light:

Leeches remain calmest and healthiest in slightly darkened and cool places [Michalsen A et al., 2007]. The room temperature should be maintained at 26 to 30°C.

vi) Quiet Environment:

When undisturbed, leeches exhibit accelerated regeneration, reduced oxygen requirements, increased reproductive activity in breeding centers, and greater willingness to feed. Moreover, their lowered metabolism results in the production of fewer water impurities [Michalsen A et al., 2007].

vii) Leech Breeding in Aquariums:

A limited number of leeches are introduced into individual aquariums and encouraged to breed. Specialized areas are designated for the deposition of cocoons, which are subsequently gathered and permitted to undergo hatching [Michalsen A et al., 2007].

viii) Leech Breeding in Artificial Ponds:

The pond's ecological conditions should align with the natural needs of the leeches. Cocoons are typically deposited in designated areas along the pond bank. To shield the leeches from excessive sunlight, it is beneficial to install camouflage nets. Furthermore, the water should undergo continuous filtration using various types of filters [Michalsen A et al., 2007].

After feeding, the leeches must complete a "purification stage" i.e. a fasting period of at least three months, before being sold [Michalsen A et al., 2007].

Steps Involved in Breeding Medicinal Leeches:

- Take pan like rectangular container of 150 liter capacity.
- Put this container in a tilted position to provide it a sloping base.
- An outlet with valve is provided at lower side of the container, to remove water at the time of changing water.
- 60 litre water [Swathy C.R et al., 2023] purified with Reverse Osmosis system, is filled in the lower side and soil with moss is put in the higher side of the container. The soil and water are separated with the help of some barrier.
- Add 30 gram sea salt to water.
- Put small pebbles under the water in container.
- Upto 600 medicinal leeches of approx. 4cm may be put in this container. Select healthy, strong, vivaciously active leeches more than 2 years old, weighing 25–30 g each [Zhonghua L et al., 2014]. It is important to ensure that the leeches come from a reliable source.

- Cover the container with a cheesecloth for proper aeration and to prevent the escape of leeches. Cover has a U-shaped zip for access to leeches.
- Temperature of water should be around 28°C (optimal for breeding) [Michalsen A et al., 2007] and humidity should be 60–80% [Yuan G., 2010]. Both are regulated with an air conditioner.
- Monitor pH (6 to 7) and Total Dissolved Solids (50 TO 300) of water [Swathy C.R et al., 2023].
- Maintain minimum noise level in the room as leeches don't reproduce when they get disturbed [Michalsen A et al., 2007].
- Change the water every other day.
- Feed the leeches every 2 months preferably with mammalian blood (eg sheep blood). Blood to be fed is put in a container and shaken well to avoid clotting, it is then warmed upto 37°C by putting the blood container in warm water for 20 minutes. Put some blood in a pan then put a flat sieve containing leeches on the blood. Feed the leeches for 30 minutes. Adequate feeding is required for successful reproduction.
- Observe mating behaviour: Monitor the leeches closely to observe their mating behaviour, which involves the formation of clusters or pairing of leeches. Leeches breed in summer season [Michalsen A et al., 2007].
- Moss and soil provide place to lay cocoon. Sandy soil rich in humus is used as a platform, so as to facilitate the leeches to dig holes and lay cocoons. Cocoons are laid chiefly in July and August [Elliot J.M., Kutschera U., 2011].
- Take care of eggs: Carefully collect the cocoons and transfer them to a separate container having moss and soil.
- Wait for 21 days, for exit of juvenile leeches from the cocoons. After 21 days, gently break the cocoon to get the juvenile leeches.
Rear the offspring: Put juvenile leeches in separate container of 10–20 litre water [Yuan G., 2010]. Provide small blood meals. As they grow, gradually increase the size of their meal.
- Continue care and maintenance: Regularly monitor the health and growth of the leeches. Ensure that the water quality remains optimal, and provide appropriate nutrition. Regularly clean and maintain the tanks to prevent the accumulation of waste and potential infections. It takes 18 months for the journey from a cocoon to become a mother leech.

Leech Breeding in Artificial Ponds:

Construct 0.5 - 1 meter deep artificial pond at a quiet place and fill it with underground natural water. The water level should be $\frac{1}{2}$ to $\frac{2}{3}$ of the depth of pond. Install filters for continuous cleaning of water. Put lot of spiral shells and pebbles to provide hiding places for leeches and help them in molting. Put sandy soil rich in humus at the banks of pond which acts as platform for cocoons of leeches. Cover the pond with camouflage net to protect leeches from excessive sun exposure.

Put leeches in the pond preferably in the month of April [Zhonghua L et al., 2014]. Follow the previously mentioned guidelines for the care of leeches, cocoons and juvenile leeches.

Result:

Feasible techniques for breeding of medicinal leeches are provided in this paper along with all relevant information about leech reproduction.

Discussion and Conclusion:

The breeding of medicinal leeches can be successfully achieved both in controlled water containers and within artificial ponds. The adherence to standard parameters governing water quality, soil composition, and temperature plays a pivotal role in the practice of leech farming. The promotion and establishment of leech farming centres are strongly advocated to ensure a consistent supply of dependable medicinal leeches. Furthermore, it is highly recommended that additional research endeavors be undertaken in this domain to contribute to the preservation and thriving of this invaluable species.

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