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REVIEW ARTICLE

Importance of Leech Farming: A Review

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ABSTRACT

Background: The use of leeches in blood letting therapy holds a very special place in medical science since antiquity. The global demand for leech and its product is enormous owing to its variety of wide range of therapeutic uses. "Decrease in the natural habitat of leeches and increase in worldwide demand" creates a big void in demand and availability. Hence ways should be employed to make sure its availability throughout the year. The objective of this article is to review the historical use, favourable conditions for breeding, conservation, and various leech farming techniques and their advantages and disadvantages on each other.
Main text: A comprehensive literature review was performed searching through the electronic database as well as standard textbook available on leeches and bloodletting therapy.
Conclusion: Leech farming is the need of the hour, to provide leeches frequently to practicing clinicians and to pharma companies. The future horizon of teaching training and patient care will expand and open new areas of the research paradigm in coming years. In the current scenario where the data on safety factors and complications arising due to leech therapy is not available, leech farming should be encouraged in different habitats under different climatic conditions to not only meeting the safety standards but also make a common standard operative procedure to obtain a standardize quality leech.

Key Words*Leeches, Bloodletting, Leech Farming, Hirudin, Tissue Transplants*

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INTRODUCTION

Bloodletting is one of the ancient therapies used for curing many diseases caused due to vitiation of blood and one of its popular ways of doing it is by the use of Leeches. Medicinal leeches, their usefulness is briefly described in ayurvedic classical texts. Prefer to stay in stealth mode these creatures are found abundantly when the monsoon season starts. Owing to its variety of wide range of therapeutic uses leeches are in great demand among physicians. Known by the term *Jalauka* in Ayurvedic classics, the use of leeches has shown promising outcomes in various diseases. Their use in phlebectomy and other skin diseases is widely explained. Because of lesser availability in comparison to the increase in demand obtainability of leeches is limited because of the decrease in the natural habitat of these creatures. Hence ways should be employed to make sure its availability throughout the year. This article traces the methods used for leech farming, their importance, and favourable

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conditions for breeding leeches and takes a brief look at the possible future of leech therapy.

Historical Review

Leeches are abundantly available in warmer and temperate areas of the world. They come in such proximity to humans, that it is not surprising to find their description in the both ancient and modern literature of the leading nations of the world. Medicinal leeches are looked upon for phlebectomy since the time of *Sushruta*, a whole chapter is dedicated to the description of leeches and their use in different medical conditions. In Egyptian literature, there is no word for the leech, in Sinhalese (Sri Lankan literature) it appears to have no derivative of jaluka-juko family. In Chinese literature, the references to leech are very scanty and are known as Ch'i, and in Syriac, there are a few references to leeches as iliqitu corresponding to aleqetha (leech).[1]

In modern surgery also, it showed promising and effective results for example in reliving post-operative venous congestion in patients recovering from tissue flap and replantation therapy.[2]Haycraft (1857-1922) studied that the substance in the mouth and throat of Leech prevented blood coagulationand named this substance hirudin in 1904. In 1817, Thomas Bell treated a case of oroantral fistula with facial swelling using six leeches applied to the face in 1817[3]. For the drainage of an abscessed tooth, Chaplin A Harris recommended application of leeches to the gum in 1839 [4]. Leeches were used to treat odontalgia, periodontitis, and alveolar abscess. They gave the patient immediate relief from pain[5]. A medical leech is also used to eliminate post-operative occlusion, so that tissue transplants will be more successful and fingers an d ears will be joined (Henriot et al., 1990). Necrosis (cell death), sometimes followed by gangrene can occur as a result of an inadequate blood supply. A leech stimulates blood flow into the wound and capillary growth by removing stagnant blood[6].In July 2004 , the FDA approved leeches as a medical device f or the treatment of wounds and burns[7].

Morphology

Leeches are parasitic or predatory worms that belong to the phylum Annelida and comprise the subclass *Hirudinea*. Leeches are hermaphrodites, the majority of which are found in freshwater habitats, while other are of the terrestrial or marine variety. The structure of leech is multi-segmented, including brain segment and each segment has different organs. It contains two sucker parts; a wide posterior for adherence and a narrow anterior “in which jaws are present” for biting and feeding onto the host’s body. There are several annuli in each segment. Every segment contains sensory papillae marked by a bright spot of pigment which are prominent in the middle annulus. (Fig. 1A).

Black pigmented eyespots replace some of the sensory papillae on the first few segments of the

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body, the number of which varies with species. The commonest medicinal leech *Hirudo medicinalis*, has five pairs of eyes are arranged in a crescent. (Fig. 1B)

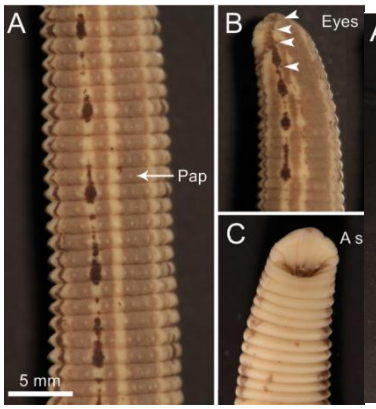

Figure 1

Figure 2

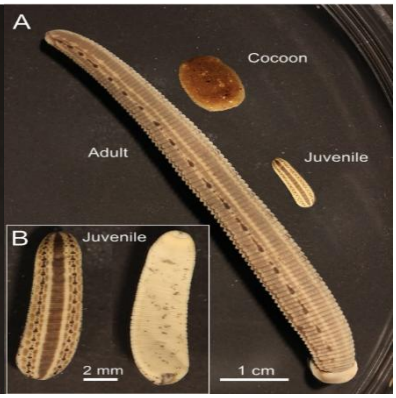

Figure 3

(Source: U. Kutschera et. al., The European medicinal leech Hirudo medicinalis L.: Morphology and occurrence of an endangered species, zoosystematic and evolution 2004, 90(2):271-280)

The medicinal species, *Hirudo medicinalis* a hematophagus that feeds on the blood of the host with the help of suckers present in the mouth.In the buccal cavity, there are muscular ridges overlaid by cuticular teeth, and the mouth extends over the majority of the anterior sucker. (Fig. 1C). A dilated portion of the alimentary canal, the crop, follows the pharynx. In the anterior region of the body, the clitellum is situated (Fig. 2A). The mail reproductive aperture is median and unpaired. Two internal ducts lead to the male copulatory organ, but these ducts form a single genital with one external gonopore and a tube-like male copulatory organ. (fig. 2B). Female pores are similarly median and unpaired, and they are posterior to male pores.

Hirudinaria manillensis is a variety of medicinal leech found in Indian subcontinent and neighbouring countries of Southeast Asia and prove to have a close phylogenetic relationship with two of its most important European counterparts *Hirudo medicinalis* and *Hirudo verbena*. Adult specimens of *Hirudinaria manillensis* can reach upto 18centimeters in length.The animals of this species may reach enormous body lengths, which is why they are sometimes referred to as "buffalo leeches"[8].

Reproduction

Mating in leeches occurs via tube-like structure present on clitellum in summers and proper diet is essential for successful reproduction. There may be a postpone of 1 to 9 months between copulation and cocoon deposition. During the reproductive process, parent leeches secrete cocoons Fig. 3A that protect and often nurture the developing eggs during the critical stages of early development. These spongy cocoons are laid chiefly in July and August. Over one to twelve days, each mature leech will lay one to eight cocoons with commonly 12 to 16 eggs from one cocoon. Hatching time usually varies from 4 to 10 weeks depending upon temperature.[9]

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Component of the cocoons are released from specialized glands situated inside the clitellar sex segments, forming a sheath around the clitellum into which fertilized eggs are deposited. The cocoon membrane is then passed over the head and sealed at both ends forming "plugs" at either end[10]. Embryos are dependent upon cocoon fluid contained in hard-shelled cocoons, while embryos from membranous cocoons can develop independently of the cocoon[11]. The marking of juveniles is very similar to those of the adults except there is less pigment on the ventral surface. (Fig 3B)

Leech Farming

Leeches are generally collected from the bottom of submerged items in tanks, ponds, lakes, mountain streams, and rivers where they cling. They can also be collected by dredging the bottom of tanks, basins and lakes using a water network. They can also be found as ectoparasites in crustaceans, molluscs, amphibians, reptiles, and fish. Leeches can also be seen from deep, wet forests, wet and swampy places, and rice fields.[12]

The first medicinal leech farm, biopharma, was set up in Swasnea in 1981 by Dr. Roy Sawyer, and now supplies leeches to all over the world[13]. Leech farming is very essential for the procurement of sufficient and high-quality leeches for use in medical field. It requires minimum space area. It is odourless, unlike fish farming. It requires low-cost feed like eel, vegetation, coconut, moss, fish and requires minimum maintenance. The choice of pool/tank can be an earthen pond, canvas pond, concrete tank, custom build concrete pool, polythene tanks, glass aquarium or any large liquid container will be suitable.

For a considerable part of the year when the water temperature is low, medicinal leeches are in a dormant stage and remained buried in mud or under submerged objects at the edge of the pond. As the water temperature increases, leeches respond very well to disturbances in the water caused by the potential host and swim towards the source of blood. Laboratory experiments have reported that when a medicinal leech approach near a mammalian host, such as the skin of a human, it uses heat detection, the optimal response occurring at 33 to 40 °Celsius (Dickinson and Lent 1984), and also chemosensory stimuli (Elliot 1986), both receptors being located in the anterior end of the leech. The leech explores the outer cell layer of the host for a suitable feeding site, then pierces the skin with its three jaws armed with numerous sharp teeth, and finally sucks host's blood[14].

A decrease in the accessibility of appropriate vertebrate hosts is the conceivable justification for the decrease in the accessibility of parasites in nations where troughs are currently utilized rather than lakes for the watering of steers and ponies. Changes in land utilize not just caused the loss of lakes yet in addition the detachment of the leftover freshwater biological systems, even to wild creatures, and this might have added to a decrease in blood suppers from this source. The extraction of hirudin from whole *Hirudo*

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medicinalis leads to the destruction of large amount of leeches and at least 12000kg of leeches used each year (Well & Coombes, 1987). Major pharmaceutical companies are now in business of hirudin-based products[15]. The slow growth of the leeches could be partially caused due to the shortage of mammalian blood in their feed. Temperature of water will also have impact on the growth of *Hirudo medicinalis*.Quick developing bloodsuckers that accomplished development after just 289 days were kept at a consistent 20 °C. The high-temperature requirements of medicinal leeches (*Hirudo medicinalis* and *Hirudo verbana*) impose limitations on their occurrence. Therefore, the depletion of these species from many water bodies may be due to the relatively more temperature required for the activity, feeding, growth, and breeding, as well as the scarcity of mammalian hosts. It should be noted that there has been a loss of many small, shallow ponds throughout India, and these are often the ideal habitat for medicinal leeches, especially if they contain amphibian species and water birds.

Various Breeding techniques

Amongst the most serious complications of leech therapy is infection. Aeromonas hydrophila a gram-negative bacteria that is responsible for the digestion of blood and other bacteria which can lead to infection like cellulitis. Also, it can be a vector of various blood-borne diseases like HIV and hepatitis if came in contact with those disease-carrying hosts. So, procurement of hygienic medicinal leeches is of prime importance. Three common leech breeding techniques, breeding in laboratory, breeding in artificial ponds, and semi-intensive breeding in natural ponds. Semi-intensive is the cheapest method in which in a natural pond breeding is done and feeding is enough and are in natural form, but it is open to contamination risk because of the open environment. The intensive breeding method requires a fully controlled pond with all the food is under control. This minimizes the risk of contamination but not as laboratory ones. Laboratory breeding is generally opted where cold weather conditions are prevailing because leeches prefer warm environments. It requires utmost care proper vigilance and is considered the optimum way to breed hygienic leeches for human use[16].

Broodstock management is another technique that can be used. Broodstock management involves all the measures taken by the leech breeder/ aquaculturist to enable a captive group of leeches to undergo reproductive maturation and spawning and produce fertilized eggs. In a study conducted at the Nakhon Si Thammarat Island Aquaculture Research and Development centre of the department of fisheries of Thailand from 1 September 2017 to June 2018. The leeches were gathered from a swamp and kept in the laboratory at room temperature of 19-35^{o} C. The leeches were fed with animal blood every 15 days (approximately five times the weight of leeches). The water in the bottle was changed after feeding the leeches. These leeches were

selected and randomly transferred to plastic boxes (35.0cm x 56.0cm x 16.5cm) for breeding. The broodstock densities (number of leeches per box were two, three, and four leeches per box. Each breeding box was filled with ten- centimetre thick clay loam soil sloping down to one side and five centre deep water. The breeding box is covered with a lid that has a hole with a screen for air ventilation. Cocoons were deposited in the boxes on 3rd and 4rth January. Cocoons were deposited in five-litre hatchery bottles with soil and water. Cocoons were hatched on 18th and 19th January 2018. The juvenile leeches were removed from hatchery bottles and cultured from 1st February to May 2018. Animal blood was fed to juvenile leeches (three times of leech weight) every 15days[17].

Favourable conditions for breeding

An investigation has demonstrated that temperature, light intensity, and diet significantly affect the reproductive efficiency of the leech, *Hirudinea* species. A growth condition at a temperature of 25-28°C and zero light intensity fed with fresh eel blood is recommended for the commercial breeding of this species.[18] Zulhisyam et al. bred *Hirudinea manillensis* in different densities per tank which showed that cocoon length and weight in low leech density were greater than high leech density[19].

In a study conducted by Mahesh et al. in which the survival of leeches was seen in RO water and freshwater it was observed that fresh natural water is best for the survival of the leeches. Recommended parameter of water for the breeding of leeches is freshwater (TDS-1396avg.), water pH-9 (avg.), water specific gravity (1011 avg.), nature of water- (natural groundwater freshwater). The soil, water, temperature (water body and environmental), and humidity(environmental) have a very important role in leech farming[20].

CONCLUSION

Due to its wide spectrum health potentials, Leech therapy rather than considering it as alternative therapy should be taken into mainstream complementary and integrative medicinal treatment approach. Leech farming is the need of the hour, to provide leeches frequently to practicing clinicians. The horizon of teaching training and patient care will expand and open new areas of research in the coming years. In the current scenario where the data on safety factors and complications arise due to leech therapy is not available, leech farming should be encouraged in different habitats under different climatic conditions to meet the safety standards. As the demand for leech therapy is growing up it can be seen as a very good option for a low-cost start-up with high returns.

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