

Review Article

Therapeutic Uses of Earthworm – A Review

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Abstract Based on review of literature on Unani Medicine and contemporary scientific investigations, the study demonstrates enormous potential of common Indian earthworm to combat many human ailments. The information on clinical, pharmacological and chemical studies carried out on earthworms between 1930 and 2009 in India and abroad has been reviewed in an effort to substantiate their medical efficacy. In this paper, the methods of collection and processing of earthworms, their pharmaceutical composition, preliminary pharmacological and clinical effects on (i) nervous system; (ii) blood circulatory system; (iii) cardiovascular system; (iv) respiratory system; (v) uterus smooth muscle function; and (vi) anticancer properties are reviewed. Therapeutic efficacy of earthworms has been shown for *tracheitis* and *bronchial asthma*, *epilepsy*, *high blood pressure*, *schizophrenia*, *leg ulcers*, *mumps*, *eczema*, *urticaria* and *anaphylaxis* diseases, *burns* and *scald fractures*, *erysipelas*, *sequel of encephalitis*, *chronic lumbago*, *skin crevices*, *blood deficiency*, *apoplexy*, *acute injury of soft tissues*, *vertigo*, *hematemesis* and *hematuria*, *digestive ulcer*, *vesicle calculus* and *cancer*. Taking lead from the present reports detailed scientific investigations are needed to discover new therapeutic agents of zoological origin which might be very specific to treat certain diseases and conditions, thus far, incurable in modern medicine.

Keywords *Earthworm; Unani Medicine; Materia Medica; Indian Systems of Medicine*

Introduction

Earthworms (Figure 1) have been used in traditional medicine in India for at least 2,300 years (Puri, 1970). Results from the studies of Zhang *et al.*, (1988), Alumets *et al.*, (1979) and Reynolds and Reynolds (1972) show that some nitrogenous substances extracted from the earthworm can dilate bronchi and can be used as anti-histamine to treat asthma. In Unani texts, such as *Khawasul Advia* (1911), *Unani Chikitsa Sagar* (Shukla, 1950), *Village Physician* (1959), *Havial Mutradat Wa Jamial Mustalehal* (Hussain, 1901) and '*Makhzanal-Advia*' (Hussain, 1771), it is recorded that '*Kharteeri*' (Unani name for earthworm) was used as an antipyretic and anesthetic, for detoxification, treatment of hypertension and hastening parturition, as well as in the treatment of many common ailments, such as arthritis, itching, burns, carbuncles, erysipelas, and inflammation. With the development of modern science, some active compounds from earthworm, such as linmbritin and terrestrolumbralisim, have been isolated. Recently, an enzyme has been extracted from earthworm that can dissolve blood

thrombi in experimental conditions. This will probably be made into an oral medicine by the pharmaceutical industry for use in the prevention of cardio-vascular disease (Zhenjun, 2007). Based on earlier studies the present paper highlights the enormous medicinal potential of earthworm to combat many of the present day diseases and conditions. Further, investigations comprising advanced Pharmacological, Phytochemical and Clinical studies are needed to develop new drugs of zoological origin.

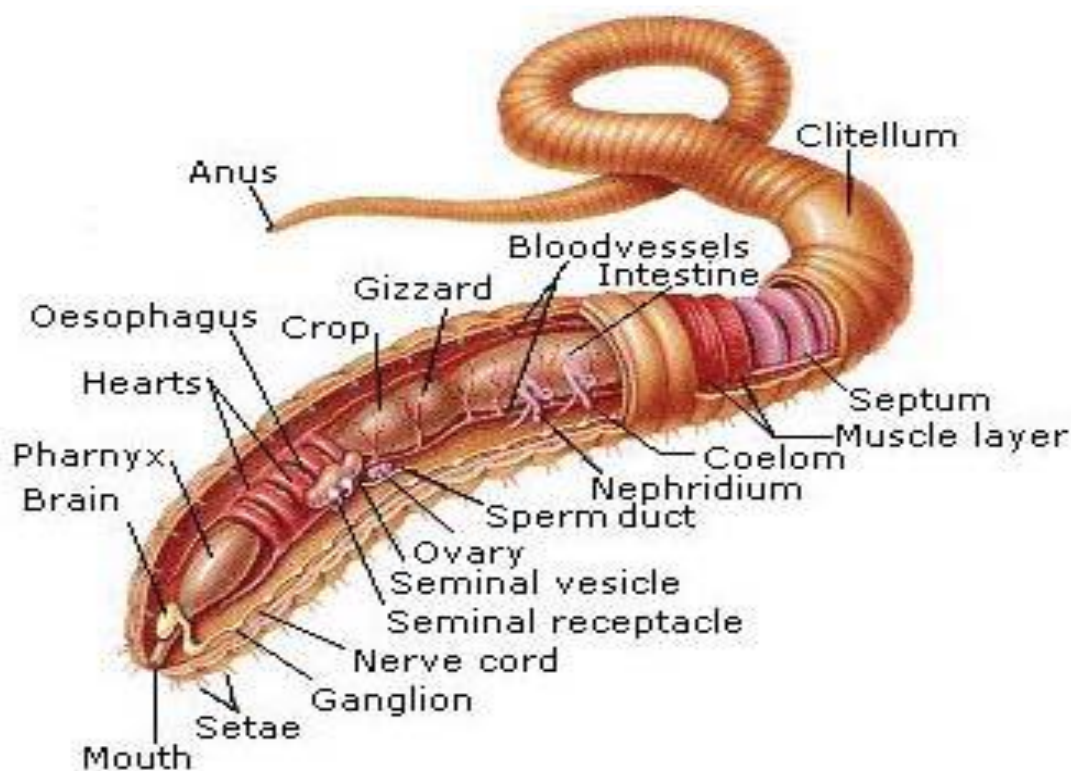


Figure 1: *Drawida grandis* – An important medicinal earthworm

Chemical Composition

Earthworms contain lumbriferrine, terrestrolumbrin, lumbricin, hypoxanthine and other purines, pyrimidines, choline and guanidine. The fat of earthworm is composed of octadec acids, palmitic acids, high-chain unsaturated fatty acids, linear and carbon fatty acids, branched fatty acids, phosphate, cholesterol etc. The yellow chloragogenous cells and organs of *Lumbricus terrestris* contain large amount of carbohydrates, lipid, protein, pigments and some alkaline amino acids. The yellow pigments perhaps consist of riboflavin or its analogues (Anonymous, 1985). The tissues of *Pheretima* species contain large amount of microelements-Zn 59.1 µg/g, Ca 25.4 µg/g, Fe 1735.5 µg/g, Cr 10.93 µg/g, Mo 0.25 µg/g, Ca 1019.2 µg/g and Mn 1143 µg/g (Zhang, 1988). Those of *Allolobophora caliginosa* contain crude protein 57.96%, crude fat 6.53%, crude ash 21.09%, crude fibre 0.36%, N extract 14.06%. Those of *Eisenia foetida* contain crude protein 64.61%, crude fat 12.29%, crude ash 10.16%, crude fibre 0.27%, N extract 12.67%. Those of *E. rosea* contain crude protein 63.71%, crude fat 12.29%, crude ash 10.66% crude fibre 0.21%, N extract 12.67% (Zhang, 1987). The blood and body fluids of *Lumbricus terrestris* contain small concentration of glucose (0.01-0.05 µg/ml), considerable lipids, including 35.14% neutral fat, 41.74% glucolipid, and 23.12% phosphatide. The neutral fat consists mainly of lauric acid, oleate, myristic acid and decanoic acid.

The fatty acids of the glucolipids are decanoic acid and some short chain fatty acids. The acids of phosphatide are mainly oleate, decanoic, linoleate and behenic acids. The proportion of unsaturated fatty acids is higher than that of neutral fatty acids and saccharides (Hu, 1980). A peptide substance exists in gut wall of *Lumbricus terrestris* (Kaloustain, 1986). The dormant species of *Allobophora caliginosa* contain a protein which can hydrolyze collagen (Kaloustain, 1986). Scientists from Japan, China and Korea isolated the enzymes from earthworm gut and body fluids which can dissolve fibrin. These enzymes have been developed as innovative medicines to treat cerebral thrombosis and myocardial infarction (Cheng, 1985). Sun (1989) reported a kind of acid antibacterial peptide, a tetradecapeptide, which has produced a disease resistant, nutrient earthworm preparation and which can be used in plant and animal production. There is also an enzyme in the earthworm body tissue, which can dissolve the earthworms after death under certain conditions (Sun, 1997). Some active enzymes occur in the yellow chloragenous cells and organs of *Lumbricus terrestris* in high concentrations. These include catalase, peroxidase, dismutase, α -D-glucosyl-enzyme, alkaline phosphatase and porphyrin synthetase. The body fluids of *Eisenia* species contains at least 18 proteins with molecular weights between 1000 and 95,000 Da. (Cheng, 1985).

Pharmacological and Clinical Effects

1. Effects on the Nervous System

Zhang (1984) first reported that earthworm can reduce blood pressure (Zhang, 1984). Xu *et al.*, (1963) observed the phenomenon of significant blood pressure decrease of anesthetized dogs, that were injected with macerated earthworm extracts in hot water and ethanol solution significantly. Kaloustain, (1986) reported that an 100% extract of earthworm tissue can improve the metabolism of dopamine (DA) and 5-hydroxy tryptamine (5-HT), monoamine nerve medium of the central nervous system, so it can have a protective function against blood-deficiency brain death.

2. Effects on Blood

Rao (1986) reported that the enzymes in earthworm body fluids can dissolve fibrin thrombosis. Hu (1980) studied extracts from earthworms to restrain the formation of blood thrombi, by comparing six indices of thrombosis including viscosity angle, development time of prothrombosis, formation time of a characteristic thrombus, dissolving time of the fibrin thrombus, length of the thrombus and dry weight. Bharati and Shweta (2009) reported the effect of different extracts of earthworm on the rates of decomposition of experimental thrombus of rabbits, with whole blood coagulum, blood plasma with platelets and with pure fibrin coagulum of albino mice.

3. Effects on Cardiovascular System

Shukla (1950) reported that earthworm injections (0.5g/ml) could act against arrhythmia of various experimental models involving chloroform-adrenaline, ectisine and barium chloride. It can also cause short blockade conduction between the atrium and ventricle, which is not due to K⁺ in the agent.

4. Effects on Respiratory System

An effective asthma-preventing component from earthworms was separated early in the 1930s. This component was used in experiments with rabbit lungs and it was reported that the component produced broncho-dilation, which could be used to resist asthma caused by histamine and pilocarpine. This component was injected intra-venously in experimental animals.

5. Effects on Uterine Smooth Muscle

Xu (1964) separated a kind of substance, which can contract the uterus. Experimental results show that this substance significantly increased the tension of the pregnant or non-pregnant uterus. Xu (1964) reported earthworm injections increased contraction of the mouse uterus more than the standard solution of pituitrin (0.01 mg/ml).

6. Anticancer effect

Earthworm extracts have been used successfully to cure transplanted cancer, in S-180 cells of rats (Wang, 1986) and it suppressed the cancer significantly after treatment for 88 days' with 5mg/ml of extract as enema without any adverse side effects (Wang, 1988). Han (1991) isolated some components by a dialysis method and observed their effects on MGc 803 gastric cancer in participation of 3H-TdR. The results showed that some earthworm components could inhibit 3H-TdR participation of MGc 803 gastric carcinoma ($p < 0.01$), and still had an inhibitory function, even when the component was heated up to 560c for half an hour ($p < 0.05$). This means that the dialysis components of earthworm have a strong heat-resistance on a limited scale (Han, 1991). Sun (1989) compared the cancer killing ability of four treatments, including cancer cell suspension, earthworm extract-blood porphyrin derivative-laser, blood porphyrin derivative-laser, and earthworms extracts. The depression rate on cancer cells was highest in a treatment with an earthworm extract-blood porphyrin derivative-laser. With a chemical-luminous method, Sun (1989) concluded that the mechanism by which the earthworm extract increased the cancer-killing capability of blood porphyrin derivative-laser is by increasing active oxygen.

7. Sperm-killing effect of Earthworm Extracts

Succinic acids and hyaluronic acids in earthworm tissue can agglutinate and kill sperm (Zhang, 1987 & 1988). The results showed that earthworms contain upto 200 ppm of arsenic. The arsenic toxicity can decrease by washing and was comparatively low in experiments with rabbit, rats and dogs that were administered with earthworm extract as enema or intravenously. Zhang (1990) suggested the use of sperm-killing function for birth control in China.

Clinical Applications of Earthworms

1. Treatment of Tracheitis and Bronchial Asthma

Fried hot earthworm powder was taken orally 3-4 times per day. With a dose of 3- 4 g each time, for the treatment of bronchial asthma (Cheng, 1985). An earthworm preparation, "Chuan-shuning pill" was used for treatment of bronchial asthma patients, and 84.09% of the patients responded favorably to the treatment. This method is characterized by lasting and moderate anti-asthma (Ling, 1961). A single earthworm injection was used to treat 275 cases of bronchial asthma and 78% of patients recovered fully; especially for children, the therapeutic effects were better than for adults (Shanghai Huashan Hospital, 1971). According to a report by Huang Wenda, a 30% earthworm injection was used to treat children's asthma and adult stubborn asthma with a single dose of 0.1-2ml for children and 2ml for adults, once a day after the asthma occurred. After 10 to 30 minutes' treatment, the breathing became smoother. Wheezing etc, of asthma eased and phlegm was expelled easily. With two to four treatments, the symptoms of asthma disappeared entirely (Hu, 1980). Usually a 1 ml earthworm extract preparation (equal to 1g earthworm) for adults was used as intra muscular injections on the first day and 2ml per day for a second dose if no side effects appeared on the first day. Ten days was regarded as complete course of treatment (Anonymous, 1985). Some reports said

that mixtures from several earthworm species were better than single species earthworm preparations, in curing 101 cases of asthma. A dose of 2ml intramuscular injection of earthworm extract per day, every other days, resulted in 88.1% of the patients responding to the treatment in 1 to 2 weeks (Shanghai Cooperative Group for asthma treatment, 1982). The results of germ culture and bacterial checks showed that earthworm tissue components were effective in controlling tracheitis inflammation and repairing mucosa membranes. Earthworm powder was used in treatment of 100 cases of children with asthma, and the therapeutic effects were very good, especially for active asthma (Liang, 1984).

2. *Treatment of Epilepsy*

An earthworm pill, a secret recipe handed down from generation to generation, which was composed mainly of earthworms (*A. caliginosa*) had therapeutic effects against epilepsy. Xu (1963) concocted a mixture of earthworm 3 to 5 g, used once a day, to treat 20 cases of partial epilepsy, 16 cases recovered fully, 3 cases were improved and in one case there was no effect. Zhang used another earthworm extract to treat 12 cases of epilepsy, dosed once a day for 10 to 20 days. In four cases there were no epilepsy attacks for one year, in five cases there were hardly any epilepsy attacks for half a year, and there were obvious decrease in attack times in other patients (Zhang, 1984).

3. *Treatment of High Blood Pressure*

An earthworm extract tincture, applied twice a day at 20ml per dose was used to cure 34 cases of hypertension in patients who were treated with other medicines without effect. High blood pressure was usually reduced within 4 to 10 days by this earthworm treatment (Hu, 1980). An earthworm extract (named "Earth dragon B1") was used 3 times per day and 2ml once, to treat 11 cases of hypertension, the results showed an effective ratio of hypertension suspension of 90.9% without any obvious side-effects. An earthworm mixture extract was also used to treat 17 cases of hypertension with very good therapeutic results (Hu, 1980). A K factor extracted from earthworm was injected intramuscularly to lessen high blood pressure, and 86.6% improvement occurred in 30 cases, and were better than most chemical treatments to control high blood pressure (Zhang, 1984).

4. *Treatment of Schizophrenia*

Zhenjun (2007) reported that earthworms were used to treat 110 cases of schizophrenia which were divided into two groups; 60 cases in the first group with treatment of earthworm powder and 50 cases in the second group with treatment with an earthworm extract injection. During a 60 day treatment course, 18 patients were improved in the first group and 11 in the second group. Materials from fresh earthworms were reported more effective than dried ones.

5. *Treatment of Leg Ulcers*

An earthworm ointment for external uses, "Xin-fu-Shuang" in Chinese was used to treat 50 cases of leg ulcers; 17 cases recovered fully and 37 cases improved. It functioned to lessen pain, to dispose of rotten tissues, remove pus and improve the growth of muscle buds. A syrup, made from earthworms and powdered sugar, was put on the ulcers with good results (Anonymous, 1960). Earthworms were also used orally to cure leg ulcers. The method was to rinse earthworms with cold water and soya-bean milk. This was taken before dinner. A patient took 300 earthworms and recovered fully (Wang, 1963).

6. *Treatment of Mumps*

Earthworms were rinsed and put into container, and the same quantity of sugar added to the container, and the earthworms were submerged. The earthworms gradually secreted yellow-white mucus and this mucus was put on to affected parts covering them with gauze. The mucus was changed once every 2 to 3 hours. Observation of 20 cases showed that this was a better method of treating mumps, because of its fast detumescence and antifever effects. In another report 170 cases of mumps were cured fully within 1 to 3 days using this method (Li, 1988).

7. *Treatment of Eczema*

Urticaria and Anaphylaxis diseases Earthworm tissue extracts were used to treat 35 cases of eczema with injections at acupoints and results indicated that 14 patients recovered fully, 13 improved, 5 responded to the treatment and in 3 patients there were no effects. A sample of 60g earthworms was mixed with 30g sugar and the patients recovered after application of the mixture. It was put on the affected part, 4 to 5 times daily. This method was used to treat skin chronic itches and repeated eczema attacks (Hu, 1980). Earthworm injections were used to treat 100 cases of urticaria, treated once a day with 2ml dose of treatment resulted in an 84% of cure rate. With this 15 patients were recovered, 24 improved and 9 responded to the treatment and in 2 there were no effect (Anonymous, 1980).

8. *Treatment of Burns and Scald*

A sample of 15 earthworms were put into a sugar solution and soaked for 10 hour to produce an infusion. Using this earthworm infusion on the wounded surface, 50 cases of burns and scalds (10 to 110) recovered fully in one week (Zhang, 1990). Li (1988) reported application of 5011 cases of burns and scalds (first and second degree) showed that 98.7% of wounds recovered fully. In 32 cases of serious burns and scalds, 23 were completely cured.

9. *Healing of Fractures*

Using earthworm extracts to treat 63 cases of femur fracture, the pain stopped within one hour of treatment, tumescence disappeared within 24 hours and the bone grew well over an average of 38.7 days. Li (1988) observed 264 cases of fractures of femur stem (within 7 days) and found that the healing time of fractures was 3.6 days earlier after earthworm treatments, compared to that of other treatments.

10. *Treatment of Erysipelas*

A mixture of fresh earthworm tissues and red sugar was applied to parts affected with erysipelas and some 11 patients were cured in 3 to 5 days (Vohora and Khan, 1978).

11. *Treatment of Sequelae of Encephalitis B*

Fresh earthworms were stewed into an extract which was taken orally to treat 10 cases of sequelae of encephalitis B, for 30 days, as a treatment and satisfactory therapeutic results were obtained (Gates, 1982).

12. *Treatment of Blood Deficiency Apoplexy*

Han (1991) reported that when extracts from fresh earthworms were used to treat 381 cases of blood deficiency apoplexy, there was an average effective cure rate of 79%.

13. *Treatment of vertigo*

An earthworm tissue extract was used to treat vertigo. Of 32 treatments, 20 cases were cured fully, 7 proved, 2 responded to the treatment and 3 had no effects (Zhang, 1988).

14. *Treatment of Hematemesis*

A batch of 50 fresh earthworms was mixed with 250 g red sugars. A yellow secretion emerged from the body pores of earthworms. Patients took this secretion orally at a dose of 20 ml per treatment which stopped *Hematemesis* within 2 hours. The disease healed fully when a dose of 100 ml of the secretion was taken (Wu, 1985; Li, 1988).

15. *Treatment of Digestive Ulcer*

A dried earthworm powder was taken orally to treat 40 cases of digestive ulcers at the rate of, 2g per dose, 3 to 4 times a day, with this 34 cases were cured fully and 6 cases improved (Shweta and Singh, 2006).

16. *Treatment of Vesical Calculus*

Chen (1985) reported that earthworms were applied to treat 5 cases of vesical calculus of cystolith with significant therapeutic effects.

Summary

Indian systems of medicine have understood the importance of the drugs of animal origin right from the ancient times. The Indian *Materia medica*, which includes drugs of Ayurveda, the Indian system of medicine, and Unani the Greco-Arabian system of medicine, at present has about 2000 drugs, out of these about 200 are obtained from animals (Zhenjun, 2007). The present review provides various therapeutic uses of earthworm to treat many human ailments. Earthworms have been used in traditional medicine in India for at least 2,300 years (Puri, 1970). In ancient India, *Kharteen* (Unani name of earthworm) has been used as antipyretic and anaesthetic, for detoxification, treatment of hypertension and hastening parturition, as well as in the treatment of many common ailments, such as *arthritis*, *itching*, *burns*, *carbuncles*, *erysipelas* and *inflammation*. With the development of science, some active compounds of the earthworm, such as linmbritin and terrestrolumbrolysim, have been isolated. In 1986 a Japanese scientist extracted an enzyme from earthworms that can dissolve thrombi in laboratory experimental conditions. This enzyme preparation has been made into an oral medicine by the pharmaceutical industry for use in the prevention of cardiovascular disease in Hong Kong, Japan, Korea and China, (Han, 1991). In view of the enormous potential of earthworm to treat many diseases and pathological conditions as indicated in preliminary clinical and pharmacological investigations, detailed scientific studies are suggested to develop new therapeutics of animal origin.

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Some common medicinal giant earthworm species found in India

Sl. No. Species Length (mm) Distribution

1. *Drawida grandis* Bourne 520 Tamil Nadu
2. *Drawida naduvatamensis* Bourne 500 Kerala
3. *Drawida nilamburensis* Bourne 1000 Tamil Nadu
4. *Megascolex imperatrix* Bourne 650 Karnataka
5. *Megascolex konkanensis* Fedarb 415 Annamalai Hills
6. *Megascolex Konkanensis longus* 570 Tamil Nadu Stephenson
7. *Eutyphoeus gammiei* Beddard 405 E. Himalaya
8. *Perionyx macintoshi* Beddard 375 E. Himalaya