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Literary and Analytical Study of the Source Plants of *Kshara* (Alkali) for *Ksharasutra* Preparation in the Management of Fistula-in-ano

G.V.P. Samaranayake[1*], W.A.L.C. Walivita[2], K.M. Chandimal[3]
[1]Department of Ayurveda Basic Principles, Gampaha Wickramarachchi Ayurveda Institute, University of Kelaniya University Kandy Road Kelaniya, 11600, Sri Lanka
[2]Department of Chikitsa, Gampaha Wickramarachchi Ayurveda Institute, University of Kelaniya, Sri Lanka University Kandy Road Kelaniya, 11600, Sri Lanka
[3]Department of Anatomy, Faculty of Medicine, University of Wayamba, Sri Lanka B308 Negombo-Kurunegala Rd, 60170, Sri Lanka
*Email: prabashi185@gmail.com

ABSTRACT. The different surgical techniques and importance in disease treatment were explored by *Sushruta*, the father of surgery. Furthermore, *Anushastra* or parasurgical substances and methods from Ayurveda are distinctive in surgical fields as discovered by *Sushruta*. *Kshara* or alkali are useful for performing excision/removal, incision/cutting, scraping, alleviating three *Doshas* and several special procedures, and therefore superior to *Shastra* (sharp instruments) or *Anu Shastra* (accessory apparatuses). Also, *Kshara* is derived from diverse Ayurveda plants and applied in different ways to manage various diseases, including *bhagandara* (fistula-in-ano) and other numerous anorectal conditions. This study implemented a literary analysis of the plant sources employed to prepare Kshara sutra. There are 23 *Kshara* source plants provided by *Sushruta*. The specimens were identified by a comparison of the description to previously published Kshara sutra references. The data recorded encompassed botanical name, local label, location, pharmacodynamics, morphology characteristics, action, chemical constituents, and antimicrobial activity. There are three source plants provided by Sushruta to prepare Kshara sutra for fistula-in-ano management in this study including *Curcuma longa* Linn., *Commiphora mukul*, and *Euphorbia antiquorum*. It is possible to become a reference for Kshara sutra, a novel drug delivery system in Ayurvedic surgery for anorectal diseases and involves a thread smeared with kshara (alkali) applied to induce both mechanical and chemical cutting and healing.

Keywords: Anushastra; Ayurveda; fistula-in-ano; Kshara; Ksharasutra

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INTRODUCTION

The different surgical techniques and importance in disease treatment were explored by Sushruta, the father of surgery. Furthermore, Anushastra or parasurgical substances from Ayurveda are distinctive in surgical fields as discovered by Sushruta. *Anushastra* refers to any substance or procedure capable of use as surgical instruments with minimized invasion and stress on the patients, and is known as *hinashastra* or *shastra sadrushya* (Acharya & Acharya, 2008; Lobo *et al*., 2012).

Importance of *Kshara*. According to *Susruta Samhita*, *Kshara* or alkali is useful to perform excision/removal, incision/cutting, scraping, alleviation of three *Doshas*, for various special procedures, and therefore superior to *Shastra* (sharp instruments) and *Anu Shastra* (accessory apparatuses) (Ammon & Wahl, 1991). *Ashtanga Hridaya Samhita* posits *Kshara* is the best of all the sharp equipment, usable in inaccessible places, and performs many functions including incising and excising. Also, this substance is successfully used for difficult to cure diseases, and is capable of application in form of a drink (Banerjee & Nigam, 1977). Therefore, *Kshara* or alkali substances are considered one of the most important parasurgical methods.

Kshara is obtained from different Ayurveda plants and applied in diverse ways to manage several diseases, including *bhagandara* (fistula-in-ano) and other ano-rectal conditions. *Ksharasutra*, a novel drug delivery system, is commonly used for Ayurvedic surgery in ano-rectal diseases and involves a thread smeared with *kshara* applied to induce both mechanical and chemical cutting and healing. Furthermore,

Sushruta describes an exhaustive list of *Kshara* source plants, and *Kshara* of *Achyranthes aspera* is majorly applied in *Ksharasustra* preparation. However, different *Kshara* source plants are suited for individual patients due to the diverse exerted pharmacological behaviour, and therefore, the *Prakriti* (constitution) of the patients and *dosha* involvement in the clinical conditions is different.

Types of *kshara.* *Sushruta* classified *Kshara* into two types: *Pratisaraniya Kshara* and *Paaniya Kshara*, for external application and internal use respectively.

This study implemented a literary analysis of three plant sources used to prepare Kshara sutra for the management of fistula-in-ano.

MATERIALS AND METHODS

The specimens were identified by a comparison of the description to previously published Kshara sutra references. The data recorded encompassed botanical name, local label, location, pharmacodynamics, morphology characteristics, action, chemical constituents, and antimicrobial activity.

RESULTS AND DISCUSSION

The result indicated both *Kshara* types possess individual indications and precautions, and *ksharasutra* application resulted in a modified form of *Pratisaraniya kshara*. Table 1 shows there are 23 list of *Kshara* source plants provided by *Sushruta*, while Table 2 further divides this according to the *doshas*.

The textual description of the plants shows *Kshara dravya* potential, with individual *Rasapanchaka*. Therefore, the resulting *Kshara* is likely to possess diverse set of pharmacological properties and effects, and this causes application in several patients to reduce regular undesirable effects including pain, burning, itching, without affecting the primary aim of fistula- in-ano management.

Properties of *Kshara*. According to *Susruta Samhita*; *Kshara* properties contain several drugs and alleviates the three *doshas.* Furthermore, the material is colored white, placid (*Saumya)*, but incapable of performing cauterization, digestion and splitting. Also, the content is majorly drugs with heating effect causing a pungent taste, and other characteristics includes heat-making potency, sharp, digestive, dissolving, cleansing, healing, drying, checking and scraping. The material destroys worms, *ama Dosha*, *kapha*, skin diseases, poisons, fat, and sexual potency after prolonged administration.

Table 1. List of source plants of *Kshara* according to *Sushruta Samhita* (Rath *et al*., 2012).

Local Name	Botanical Name	Family
Mushkka	*Elaeodendron glaucum Pers.*	Celastracea
Kutaja	*Holarrhena antidysentrica Linn*	Apocynaceae
Palash	*Butea monosperma Linn.*	Fabaceae
Ashwakarna	*Dipterocarpus turbinatus Gaertn.F.*	Dipterocarpacea
Paribhadrak	*Erythrina variegata Linn*	Fabacea
Bibhitaka	*Terminalia belerica. Roxb*	Combretacea
Aragvadh	*Cassia fistula Linn.*	Caesalpinoidae
Tilwaka	*Symplocos racemosa Roxb*	Symplocaceae
Arka	*Calotropis procera(Ait)R.Br.*	Asclepiadaceae
Snuhi	*Euphoria nerifolia Linn.*	Euphorbiaceae
Apamarg	*Achyranthes aspera Linn*	Amaranthaceae
Patla	*Stereospermum suaveolens DC.*	Bignoniaceae
Naktamal	*Pongamia pinnata Pierre.*	Fabaceae
Vrusha	*Adathoda vasica Nees.*	Acanthaceae
Kadali	*Adathoda vasica Nees.*	Acanthaceae
Chitraka	*Plumbago zeylanica Linn.*	Plumbaginaceae
Putika	*Holoptelia integrifolia Planch*	Ulmaceae
Asphota	*Hemidesmus indicus R.Br*	Asclepiadaceae
Ashwamarak	*Nerium indicum Mill*	Apocynaceae
Saptachhada	*Alstonia scholaris R,Br*	Apocynaceae
Agnimantha	*Premna mucronata Roxb*	Verbenaceae
Gunja	*Abrus precatorius Linn*	Fabaceae
Koshataki	*Luffa acutangula Roxb*	Cucurbetaceae

Table 2. List of source plants of *Kshara* according to *Sushruta Samhita*, division of plants based on the *Doshaghnatva* (Rath *et al*., 2012).

Vataghna	Kadali
Pittaghna	Aragvadha, Krutavedhan, Kutaja
Kaphaghna	Palash, Karanj, Tilvak, Vasa, Agnimanth, Apamarg, Snuhi, Putika, Ashwakarna, Nimba, Bibhitaka, Karavira, Arka, Saptachhada, Chitraka, Krishnamushkaka
Tridoshghna	Patala, Sariva, Gunja

Indications for *Pratisaraniya Kshara* (external use of *Kshara*). The external application is advisable for use against *Kustha* (ermatoses), *Kitibha (*hyperkeratosis), ringworm patches, *Kilasa* (vitiligo), fistula-in-Ano, tumors, piles, dirty wounds, sinus, warts, moles, birth marks, facial hyperpigmentation, external abscess, worms and poisoning. Furthermore, the substance is recommended as an alternative for sharp apparatuses in several mouth diseases including *Upajivha, Adhijivha, Upakusa*, *Danta Vaidarbha*, and three types of *Rohani*, and is fit for application as subsidiary instruments (Edwin *et al.*, 2008). According to *Ashtanga Hiradhaya Samhita*, the direct usage of *Pratisaraniya Ksharayoga* as *Kshara* comprises *Mashaka* - moles/warts, *Shvitra* - leukoderma, *Bahya Arsha* - external piles, *Kushta* - skin diseases, anesthetic patches, *Bhagandara* - ano-rectal conditions, *Arbuda* - cancerous growth, *Granthi* - tumors, fibroids, *Dushta Nadi vrana* - foul, and sinus ulcers.

Indication of *Paniya Kshara.* The internal application of alkalis includes treatment for *Gara* (poisons), abdominal swellings disorders, dyspepsia, indigestion, loss of appetite, constipation, urinary gravel/stones, deep seated abscess, worms and piles (Gayathri *et al*., 2009).

***Paniya Kshara* indication.** The drinkable form is applicable for treatment of *Arsha* (haemorrhoids), *Agnisada* (dyspepsia), *Ashma* (renal calculus), *Gulma* (tumors of the abdomen), *Udara* (ascites/enlargement of the abdomen), *Garavisha* (chronic poisoning) (Khan *et al.*, 2010). However, where the alkali loses water content, alkali solution is added in quantities for boost (Kimura *et al*., 2001).

Indications of Three Kinds of Alkali.

Teekshna Kshara - The strong potency alkali is useful for treatment of diseases arising from *Vata*, *Kapha*, *Medas* (fat) *Arbuda (*cancerous growth) and ailments with high curing difficulty.

Madhyama Kshara - The medium potency alkali is effective in moderate strength diseases with ease in curing.

Mrudu Kshara - The mild alkali is applied for in diseases occurring from *Pitta*, *Asra-Rakta* and hemorrhoids.

Source plants of Kshara sutra preparation.

Achyranthes aspera

Botanical Name. *Achyranthes aspe*ra Linn.

Family. Amaranthaceae

Pharmacodynamics. Taste (*Rasa*) - pungent (*Katu*) and bitter (tikta); Qualities (*Guna*) - lightness (*Laghu*), dryness (*Rooksh*), strong, sharp; (*Teeksna*, *Vipaka-Katu,Veerya - Ushna* (hot potency) effect on *Tridosha* - balances *Kapha* and *Vata Dosha.*

Actions (*Karma)*. *Dipana, pachana, krimighna, rochana, sangrahi, pettasaraka, ptittasamshodhaka, durjara, vishtambhi, (bija or seeds), raktaprasdana, hridya, raktashodhaka, raktavardhaka, shothahara, kaphanissaraka, mutrala, ashmarihara, svedajanaka, kandughna, katupaushtika, vedanasthpaka, vishaghna, vranashodhaka, raktarodhaka, shirovirecana, medohara, lekhana, vatakaphaghna, arshoghna*.

Morphology. *Achyranthes aspera* is an erect or procumbent annual or perennial herb with height of about 1- 2 meter, and occasionally a woody base. The stems are angular, ribbed, simple or branched from the base, often with tinged purple colour, while the branches are terete, totally quadrangular, striate or pubescent. Also, the leaves are thick, 3.8-6.3 × 22.5-4.5 cm in ovate-elliptic or obovate-round shapes, finely and softly pubescent on both sides, with entire petiolate or petiole 6-20 mm length. The flowers are greenish white, and numerous axillary or terminal spikes were about 75 cm long. The seeds are subcylindric, truncate at the apex, rounded at the base and reddish brown.

Chemical constituents. The content of the leaves, stems and roots were alkaloids, sterol and saponins. Furthermore, the root possess ecdysone, ecdysterone (polypodine A) and insect moulting hormones while the seeds contain saponin A&B. The fruit comprises two oleanolic acid based saponins. Also, the plant encompasses an alkaloid achyranthine (betaine), amino acids, arginine, histidine, lysine, cystine, threonine, methionine, lucine, isolucine, phenylalanine, tryptophan and carbohydrate, valine, α-rhamnopyranosyl, ß-D gluuronopyranosyl, ß-D galactopyranosyl, galactose, xylose, rhamnose and glucose, large amount of potash, hormones, ecdysterone and inokosterone.

Antimicrobial Activity. Khan *et al.* (2010) reported an indication of mild to moderate antibiotic activity against *B. subtilis*, *E. coli* and *P. aeruginosa* in the ethanol and chloroform extracts of *Achyranthes aspera* seeds. The studies of Prasad *et al.* (2016) revealed antimicrobial action from the various extracts of the plant leaves and callus. Misra *et al.* (1992) discovered 17-pentatriacontanol was a major constituent isolated from essential oil of the plants sprouts, and showed antifungal activity against *Asperigillus carneus* (Prasad *et al*., 2016). Antibacterial and antifungal effect against various pathogenic strains including *E. coli*, *P. aeruginosa*, *Citrobacter* sp., *B. subtilis*, *Micrococcus* sp., *Klebsiella* sp. using disk diffusion and well-plate method (Malarvili & Gomathi, 2009; Manjula *et al.,* 2009; Samaranayake *et al*., 2020). The extracts indicated maximum inhibition of *E. coli* (17 mm), followed by species of *Pseudomonas* (14 mm), *Citrobacter* (12 mm), *Bacillus* (12 mm) and *Micrococcus* (12 mm). Also, predominant prevention from gram negative bacteria at a higher concentration of 50µg/ml was displayed (Saravanan *et al.,* 2008).

Antioxidant Activity. Tahiliani & Kar (2000) researched several leaves extracts for anti-oxidant effect, and Gayathri *et al.* (2009) found this in the leaves and roots while Malarvili & Gomathi (2009) reported this in seeds. Therefore, the presence of phytoactive constituents is found in *Achyranthes aspera* (Sharma, 1977). The phytoactive component caused reduction in lipid peroxidation rate, and enhancement in free radical scavenging activity of the herbal seed powder.

Wound Healing Activity. Edwin *et al*. (2008) explored the ethanolic and aqueous extracts of the leaves for injury healing potential, using two wound models comprising excision and incision.

Curcuma longa Linn.

Family. Scitaminaceae

Sanskrit names. *Haridra, Nisha*

Pharmacodynamics. *Rasa-Tikta, Katu,Guna-Ruksa, Laghu, Virya-Ushna, Vipaka-Katu, Dosha karma-Kapha-vatashamaka, Pittarechaka-shamaka*

Actions *(Karma*). *Vamya,Krimighna,tvachya, mukhakantikara, dehavarnaprada, kushtaghna, kandughnakasaghna, vedanasthapana, shothahara, raktaprasadhaka, raktastamhaka, vranaropana, vranashodhana, lekhana, mustrasangrahaniya, mutravirajaniya, garbhashayashodhana, stanyashodhana, shukrasodhana, hikkanigrahana, anulomana, arshoghna, tvakdoshahara*.

Morphology. A tall herb with large rootstalk, ovoid in shape and possessing sessile cylindrical tubers colored orange inside. Furthermore, the leaves are very large with tufts length of 1.2 meters or more, including the petiole with similar measurement as the blade, oblong–lanceolate, and tapering to the base. The flowers had autumnal spikes of 10-15 cm length, peduncle of 15 cm or more, concealed by the sheathing petiole while the flowering bracts were pale green and the coma tinged with pink.

Pharmacology. Curcumin (I, II, III) is a major component in *Curcuma longa*, and responsible for the biological actions. Furthermore, this exhibits anti-parasitic, anti-spasmodic, anti-inflammatory and gastro-intestinal effects in vitro, and constrains carcinogenesis and cancer growth in parental and oral application on animal models. According to Araújo & Leon (2001), the extraction of dried powder with 95% ethanol yielded cured ethanol extract of 29.52% (w/w) containing curcumin (11.6%), demothxycurcumin (10.32%), and

bisdemothxycurcumin. The agar disc diffusion method was employed to test this for antifungal effect against 29 clinical strains of dermatophytes, and an inhibition zone range of 6.1 to 26.0 mm was found. Wuthi-Udomlert *et al.* (2000) discovered improved cutaneous wound healing in rats and guinea pigs by curcumin (diferuloymethane), a natural product derived from *C. longa* rhizomes. Also, the animal injuries treated with oral and tropical curcumin in diabetic model indicated timelier re-epithelialisation, improved neo-vascularisation, enhanced migration of several cells including dermal myo-fibroblasts and macrophages into the wound bed, and a higher collagen content (Sidhu *et al.,* 1999). Furthermore, the popular ability of the transforming growth factor beta 1 to enhance wound healing is likely due to curcumin.

The *C. longa* extract exhibited an anti-inflammatory action in standard animal models, partly due to curcuminoids, turmerones and the volatile oil (Aggarwal *et al*., 2013; Krup *et al.,* 2013). In addition, the antibacterial activity of the essential oil is significant, and relatively better against *Staphylococcus aureus* (Teow *et al.,* 2016), *Salmonella paratyphi* (Kodjio *et al.,* 2016), *Mycobacterium tuberculosis* (Bai *et al.,* 2016), *Proteus mirabilis* (Prywer & Torzewska, 2012) *Klebsiella pneumoniae* (Bansal & Chhibber, 2010), while the curcuminoids at 5 mg/kg, turmerones at 0.05 mL/kg dose levels, oil-free aqueous extract of *C. longa* at 45 mg/kg was revealed as the minimum dose required for considerable anti-inflammatory effects (Bagad *et al*., 2013).

Commiphora wightii (Arn.) Bhandari/ *Commiphora mukul* (Hook. ex Stocks)

Family. Burseraceae

Sanskrit names. *Guggulu*

Morphology. Shrubby, pubescent, with 1.2-1.3 m and glandular young parts. The branches are knotty and crooked, with divaricate normally ending in a sharp spine. The flowers are triangular, tube has 2-5 fascicles, with brownish red petals, broadly linear, nearly thrice of calyx length, and possessing reflexes at the apex. There are 8-10 stamens, alternatively long and short, and half the petals length. The disk are 8-10 lobed, alternate deeper sinuses with insertion of shorter stamens, and ovary oblong-ovoid, attenuated into the style

Pharmacodynamics. *Rasa-Katu, Tikta, Madhura, Kashaya, Guna-Laghu, Ruksha, Tikshna, Snigdha, Picchila, Sara, Virya-Ushna, Vipaka-Katu, Dosha karma -Tridosha hara*

Actions (*Karma)*. *Vedanasthapana, nadibalya, vatashamaka, shothahara, vransashodhana, vranaropana, jantughna, dipana, pachana, yakrit uttejaka, arshoghna, krimghna, hridya, rakta-svetakana vardhana, raktaprasadana, kaphanissaraka, sandhaniya, dourgandhyahara, putihara, mutrala, ashmaribhedana, kamottejaka, artavajanana, vandhyatvadoshahara, kushtaghna, varnya, tvachya, shiaprashamana virshya.*

Pharmacology. The segment of *Guggulu* containing oleoresin possessed significant anti-arthritic and anti-inflammatory attributes, and the minimum effective dose is 12.5 gm/100 gm per body weight (Pillai & Santhakumari, 1981; Sunarwidhi *et al*., 2014). In addition, a novel triterpene isolated from *Guggulu gum* resin is myrrhanol A, and exhibits strong anti-inflammatory effect on exudative pouch fluid, angiogenesis and granuloma weights in adjuvant-induced air pouch granuloma of mice. However, the effects were more apparent in hydrocortisone and 50% aqueous methanolic crude drug extract (Kimurai *et al*., 2001).

The aqueous resin extract of *Commiphora mukul* substantially constrains both the maximal and total oedema response during 6 hours of *carrangeenan*-induced rat paw edema. Also, daily administration of mansumbinoic acid at a single dose level of 1.5×10 (-4) mol kg^{-1} considerably minimized joint swelling in adjuvant arthritis in rats. The essential oil was fungistatic or fungicidal to the moulds of *Aspergillus flavus*, *A. furnigatus*, *A. sulphueus*, *Mucor fragilis* and *Rhizopus stolonifer*, based on the concentration (Sarbhoy *et al*., 1978). The application of *Guggulu* caused reduction in oedema (37.14%) compared to prednisolone (43.60%); fluid volume by 54.98%, contrasted with prednisolone (64.5%), and granuloma pouch weight was 60.80% measured against prednisolone (71.47%). For five months, anti-inflammatory agents including

phenylbutazone, ibuprofen and fraction of *gum-guggulu* derived from *C. mukul* were administered orally resulted in decreased thickness of joint swelling, proving the beneficial role in arthritis research (Sharma, 1977). *Guggulu* resin fraction at a dose of 300 mg inhibits 30% of acetylcholine effect. This almost entirely blocked the impact of agonists comprising acetylcholine, histamine, bradykinin and 5-hydroxyl-tryptamine, while intra-peritoneal administration of resin fraction of C. *mukul* resulted in statistically significant percentage inhibition of oedema (Sharma, 1977).

Euphorbia antiquorum
Family. Euphorbiaceae
Sanskrit names. *Snukhi*
Pharmacodynamics. *Rasa-Katu, Guna-Lagu, Snigdha, tikshna, Veerya-Ushna Vipaka-Katu*
Actions *(Karma*). Alleviate *Vata & Kapha*. Purgative. Promote appetite (*medas kshaya*), reduce fat tissue, cure pain, *Ama dosha, Ashtilika, flatulence, Gulma,* stomach disorders, skin diseases, piles, edema, urinary calculi, anemia (*pandu*), wounds, fever, splenic disorder, poisoning. Latex-applicable as purgative for persons suffering from *Gulma, Kushta, Udara* & other long-lasting diseases.
Morphology. A large shrub or small, spinous tree of 4.5-9 m, white latex. The numerous branches curve upwards, stout, fleshy, green, jointed and thick sinuate wings of 3-5 width. The leaves are 6-13 mm, subsessile, obovate-oblong, fleshy, deciduous while the spines are stipular, short, divaricate. Hemispherical involucres, yellow, 3-nate, forming small pedunculate cymes in the sinuses, with the central flower sessile and female.
Chemical constituents. The content of the latex in the branches comprise β-amyrin, cycloartenol, euphol, euphadienol and euphorbol. The juice encompasses diterpene esters, euphorbin while the stem-bark and latex possess triterpenoids, taraxerol and taraxerone, friedelanol and epi-friedelanol, euphol. Also, the roots contain taraxerol.

CONCLUSION

There are three source plants provided by Sushruta to prepare Kshara sutra for fistula-in-ano management in this study including *Curcuma longa* Linn., *Commiphora mukul*, and *Euphorbia antiquorum.*

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