

RASONADI KASHAYA IN MANAGEMENT OF OSTEOARTHRITIS: A CONCEPTUAL STUDY

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ABSTRACT

Vata is responsible for *Sthiti*, *utpatti*, and *nasha*. Its *Achintya veerya*, *Ashukaritva*, *swatantra*, and *nitya guna* makes it the supreme of all other components. As *vata* is one of the main causes of vitiation of *pitta*, *kapha*; other *dhatu*s, and *malas* and is the root cause of manifestation of all *vyadhis*; it is of utmost importance to understand and treat *vata vyadhis* with a holistic approach. *Janusandhi gata vata* is one such degenerative disorder affecting the articular surface of the knee joint in the older age group. It can be correlated to Osteoarthritis of the knee joint. The overall prevalence of knee OA in India was found to be 28.7%. It is more common in women than in men; increases with age and causes major mobility impairment. As the global burden of knee OA is increasing it is important to find effective medication for the same. All degenerative diseases which are included in *vata vyadhis* should be treated with *snehana*, *svedana*, *shamana*, *shodhana*, *brimhana*, and *rasayana* therapy. Highlighting *Rasonadi Kashaya*, an herbal preparation mentioned in *Sahasrayoga*; this article aims in understanding its mode of action and effectiveness in the treatment of osteoarthritis.

Keywords: *Janusandhigata vata*, *Janu bedha*, Osteoarthritis, *Rasonadi Kashaya*.

INTRODUCTION

Vata vyadhis are one of the major groups of disorders which we come across in clinical practice. It constitutes around 80 *nanatmaja rogas* described in our literature. *Vata* dosha having *ruksha*, *sheeta*, *laghu*, *khara guna* and predominance of *rajas*, due to *prakopaka nidana* causes various diseases either affecting one part of the body or whole body. The predominance of *vata vyadhis* is due to *ati Balatva*, *ashukaritva*, *gariyastva* of affecting *vata dosha*. It is due to these properties that *vata vyadhis* need *Vishistha chikitsa* and *abhidhana*.¹ Among them, *Sandhigata vata* is one of the most common diseases affecting joints and articular structures. It usually is seen in *vrudha avastha* owing to its *dhatu kshaya* *nidana*. *Sama dhatu gati* means normal metabolic transformation from one *dhatu* to successive *dhatu*s. *Gata vata* is that vitiated *vata* which moves from *kupitha sthana* to the *kha vaigunya* when it has favourable *nidana*. The symptoms include *shotha* (localised swelling), *prasarana akunchanayoho pravrutthischa vedana* (difficulty in joint movements associated with pain), and *vata poorna dhriti sparsha* (crepitus of the affected joint).²

NIDANAS:

Nidanans can be classified into *Aharaja*, *viharaja*, *manasika* and *anya nidanas*. *Aharaja nidanas* include *Atiruksha*, *atishushka bhojana*, *alpa*, and *laghu bhojana*. Dairy products, monosaturated fatty acids, complex sugars, and refined carbohydrates increase inflammation and worsen the condition of Osteoarthritis.³ *Manasika nidanas* like *chinta*, *shoka*, *krodha*, *bhaya* said to increase *vata dosha*. Worse baseline mental health is associated with worsening knee pain, and improvement in mental health is associated with a reduction in pain⁴ proving the relationship between *manasika nidanas* and *vata dosha*. *Dhatukshaya* *nidana* can be understood in terms of the degeneration of joint structures due to age factors. Secondary Osteoarthritis like congenital dislocation of the knee, osteogenesis imperfecta; Gout, ankylosing spondylitis; endocrinal disorders like hypothyroidism, diabetes; neuropathic conditions like syphilis; other infectious arthropathy, Paget's disease, osteonecrosis all

can be included under *margavarana janya nidana*. Numerous types of joint injuries including meniscal, ligament, and joint capsule tears, joint dislocation, and intra-articular fractures are referred to as Post-traumatic OA caused due to *Abhigataja nidana*.

SAMPRAPTI:

The above-mentioned *nidanans* lead to *vata dosha* *vriddhi*. It affects *janu asthi*, *sandhi*, *snayu*, and *khandara* related to *janu* and causes *asthidhatwag-nimandhya*. *Vata* moves from *swasthana*, takes *adhithana* in *janu sandhi*, and further causes *asthivaha srota sangha* and *vyadhi lakshana* is manifested. It is characterized by *vata pura druthi sparsha* (crepitus on examination), *shotha* (knee joint inflammation), *vedana* during *prasarana*, and *akunchana* of *janu sandhi* (pain and restrictive movement of the knee joint during flexion and crossing knee joint).⁵ In the early stages of OA, the pain is episodic, triggered by overactive use of the affected joint; as the disease progresses, pain becomes continuous. Morning stiffness however is less than 30 minutes. Here *gata vata* can be considered *kaarana* for *utpatti* of *janu shoola* or *gata vata* can be considered as a stage of *janu bhedha*. As *janu bhedha* is one of the *nanatmaja vyadhi*⁵ and the main symptom of osteoarthritis is knee joint pain, *janu bhedha* is correlated to osteoarthritis. It is said to be a *kruchra sadhya vyadhi* because it involves deeper *dhatu*s and is chronic in nature. Main line of treatment includes *snehana*, *swedana*, *mrudu virechana*, *vatanulomana*, *basti*, *nasya karma*. Besides this *agnikarma*, *upanaha* has been described by Bhavaprakasha.⁶

OSTEOARTHRITIS:

Osteoarthritis is a chronic, progressive, musculoskeletal disorder that is characterized by the gradual loss of cartilage in weight-bearing joints which results in the narrowing of joint space, increased joint friction, stiffness of the joint, and painful and impaired movement. Knee osteoarthritis occurs in the patella-femoral and medial tibulo-femoral compartments of the knee joint. It presents with two or more of the following symptoms: antalgic gait, joint line and/or periarticular tenderness, weakness and wasting of the

quadriceps muscle, restricted flexion/extension with coarse crepitus, bony swelling around the joint, difficulty in standing, walking, climbing up and down the stairs.⁷ It occurs as an outcome of a large number of disorders that result in structural and functional failure of synovial joints. Structural failure results in abnormal mechanical strains injuring healthy cartilage which gradually causes degeneration abnormalities.⁸ Some of the common risk factors include age, sex, obesity, heredity, previous injury, decrease in bone mass density, and occupation requiring physical activity like miners, and footballers.

STHOULYA AND OSTEOARTHRITIS:

Sthoulya is one of the important risk factors of osteoarthritis as an increase in BMI leads to an increase in a load of weight-bearing joints. *Ateeva meda vrudhi* leads to *aniladi vikara*. As quoted by *Acharya Charaka* “*medastu sarvabhootanam udareshu asthishu bhavet*”.⁹ In *medo roga* as there is increased production of *medas*, increased accumulation of *medas* in *asthi* takes place. It causes increased Bone Mass Adiposity (BMA). This leads to lower bone mineral density (BMD) and increased skeletal fragility. This causes osteoporosis, and the development of osteoblasts further leads to osteoarthritis.¹⁰ Hence, one of the *upadrava* of *sthoullya* is *anila vikara*, which can be considered osteoarthritis.

PRAMEHA AND OSTEOARTHRITIS:

Vataja Prameha causes *sarva dhatu kshaya*. As *janusandhigata vata* is *dhatu kshaya janya vikara*, it can be considered as one of the *nidanarthakara roga* for *janusandhigata vata*. Also, one of the *upadras* of *kaphaja prameha* is *shaitilya* which can be correlated to *sandhi shaitilya* in the initial stages of *janu sandhigata vata*.¹¹ Hyperglycaemia favours the production of advanced glycation end products (AGEs) and their accumulation in articular cartilage which facilitate OA pathogenesis. This further promotes the release of pro-inflammatory factors such as TNF- α , and Nf-kB, which cause inflammation and oxidative stress intracellularly and promote cartilage degradation.¹²

CURRENT TRENDS:

Current knowledge indicates the involvement of matrix metalloproteases (MMP) of which collagenases, Stromelysins, and gelatinases are elevated in human articular tissues. Enzymes from the serine- and cysteine-dependant protease families such as plasminogen activation and cathepsin b respectively, have been proposed as activators, and enhanced levels of urokinase (uPA) and plasmin have been identified in human OA cartilage. Current evidence suggests that proinflammatory cytokines are responsible for the catabolic process occurring in pathological tissues. IL-1 beta and TNF- alpha are catabolic systems involved in the destruction of joint tissues and may constitute a source of tissue degradation. In addition, inorganic free radical NO promotes cartilage catabolism both under spontaneous and pro-inflammatory cytokine-stimulated conditions. In the inflammatory response of osteoarthritis articular cells, the change in COX-2 expression is one of the major determinants for PGE2 production. Although cartilage degeneration characterizes human OA, alterations of this disease involve the participation of synovial membrane and subchondral bone. Abnormal OA osteoblasts coupled with mechanical or chemical stress promote cartilage breakdown and/or subchondral turnover is gaining support. In subchondral bone, healing of trabecular microfractures, due to repeated joint load and remodelling of bony internal architecture can generate stiff bone.¹³

MODE OF ACTION OF RASONADI KASHAYA ON JANUSANDHIGATA VATA:

Rasonadi Kashaya is explained in *Sahasrayoga* in *Kashaya Prakarana* under *vata vikaras*. It contains *Rasona*, *Karavi*, *Pippali*, and *Sthira*. It is indicated to be the best *vatanulomana* of *kupita vata dosha* and effectively treats *vata vyadhis*.¹⁴

1. RASONA:

Botanical Name: *Allium sativum*

Family: Alliaceae

Classical Names: *Lashuna*, *Rasona*, *Uragandha*, *Mlechchhakanda*, *Rasonaka*

Vernacular Names: English- Garlic, Hindi- *Lasun*, Bengali- *Lashan*, Kannada- *Bellulli*, Malayalam- *Velulli*.

Parts Used: Bulb

Rasa- *Katu, Madhura, Tikta, Kashaya, Lavana*

Veerya: *Ushna*

Vipaka: *Katu*

Doshagnata: *Vata Kaphashamaka*

Karma: *Shotahara, Vedanasthapana, Deepana, Pachana, Anulomana, Shoolaprashamana, Kaphanisharaka, Rasayana, Sandhaneeya, Amapachana, Kothaprashamana.*

Rogagnata: *Sandhigata vata, Shotha, Vibandha, Shoola, Ajeerna, Krimi, Asthibhagna, Vishama jwara, Dourbalya.*

Dose: *Kalka-* 3-6 g, *Taila* (oil extract)- 1 to 2 drops

Chemical Composition:

Allicin (diallyl disulphide oxide), Scordinine A, A1, A2, and B, saponins, Diallyl trisulphide, Diallyl disulphide, Diallyl sulphide, allyl methyl trisulphide, allyl methyl disulphide, alliin.

Pharmacological Actions: Antibacterial, Antiviral, Antifungal, Antiprotozoal, Antioxidant, Anti-inflammatory, and Anticancer activities.¹⁵

Mode of Action on Osteoarthritis:

Aqueous garlic extract exerts antioxidant action by scavenging ROS and enhancing cellular antioxidant enzymes.¹⁶ Allicin is responsible for the anti-inflammatory effect of garlic extract. It inhibits the production of NO and pro-inflammatory cytokines.¹⁷ Downregulation of COX genes by diallyl sulphide; inhibition of the activity of NF-kB and COX 2 genes by S-allyl cysteine, uracil; inhibition activity of diallyl disulphide is observed on IL-1 beta-induced stress and cell death in chondrocytes. In vivo studies proved the anti-arthritic activity of garlic oil enhanced by the use of boron administered to mice with formaldehyde-induced arthritis.¹⁸

2. KRISHNAJEERAKA:

Botanical Name: *Carum carvi*

Family: *Apiaceae*

Classical Names: *Krishnajeeraka, Sugandhah, Jaranah*

Vernacular Names: English- Black Caraway, Hindi- *Shiajira*, Bengali- *Kaljira*, Kannada- *Kari jeerige*, Malayalam- *Karujiraka*.

Parts Used: Fruit

Rasa: *Katu*

Veerya: *Ushna*

Vipaka: *Katu*

Doshagnata: *Vatakaphahara*

Karma: *Rochaka, Deepana, Pachana, Medya, Vrushya, Balya, Shothagna.*

Rogagnata: *Agnimandhya, Ajeerna, Jeerna Jwara, Hrudroga*

Dose: *Churna* 1-3g

Chemical Composition: Volatile constituents, Cuminaldehyde, carvone limonene, dihydrocarone, and carvacol in trace amounts.

Pharmacological Actions:

Appetizer, Anti-flatulent, Anti-inflammatory, Cardio-tonic, Antispasmodic, Diuretic.¹⁹

Mode of action on Osteoarthritis:

Cumin Essential oil extracted from seed was studied. It significantly inhibits iNOS, COX-2, IL-1, and IL-6. Moreover, it blocks NF-κB and mitogen-activated protein kinase which can be used as a source of anti-inflammatory.²⁰

3. PIPPALI:

Botanical Name: *Piper longum*

Family: *Piperaceae*

Classical Names: *Pippali, Magadhi, Krishna, Kana, Chapala, Ushana, Shaundi, Vaidehi, Tikshna tandula.*

Vernacular Names: English- Indian long pepper, Hindi- *Pipli*, Bengali- *Pipul*, Kannada- *Yippali*, Malayalam- *Cutta terpali*.

Parts Used: Fruit, Root.

Rasa: *Katu.*

Veerya: *Anushna sheeta*

Vipaka: *Madhura*

Doshagnata: *Kaphavatashamaka*

Karma: *Raktavardhaka, Jantughna, Vatahara, Deepana, Vatanulomana, Shoolaprashamana, Mrudurechaka, Raktashodhaka, Balya, Rasayana,*

Rogagnata: *Shotha, Vataavyadhi, Agnimandhya, Amavatha, Vatarakta, Samanya dourbalya*

Dose: *Churna-* 0.5- 1.0 g

Chemical Composition:

Two alkaloids piperlongumine and piperlonguminine, piperidine, isobutylamides, volatile oils, and esters.

Pharmacological actions:

Antibacterial, Anti-inflammatory, Cns stimulant, Anti spasmodic, Immuno- stimulatory, Cough suppressor, Antiulcerogenic.²¹

Mode of Action on Osteoarthritis:

Piperlongumine also known as Piplartine has anti-thrombotic, anti-atherosclerotic, anxiolytic, antihyperlipidemic, and anti-inflammatory activity Q Piperine inhibits IL6 and MMP13 and reduces the production of PGE2, significantly reduced nociceptive and arthritic symptoms based on in-vitro studies. Histological staining revealed that it significantly reduced the inflammatory area in ankle joints. The phenolic compounds and flavonoids exhibit antioxidant activity against free radical-induced oxidative damage.²²

4. SHALAPARNI:

Botanical Name: *Desmodium gangeticum*

Family: Fabaceae

Classical Names: *Shalaparni*, *Sthira*, *Deerghangi*, *Anshumati*, *Vidarigandha*

Vernacular Names: Hindi- *Salpan* , Bengali- *Salpani* , Kannada- *Nariyalavona* , Malayalam- *Ranbhal*

Parts Used: Root, Whole Plant.

Rasa-Madhura, Tikta

Veerya: Ushna

Vipaka: Madhura

Doshagnata: Tridoshashamaka

Karma: Deepana, Snehana, Anulomana, Shothahara, Shonitasthapana, Kaphanissaraka, Vrishya, Balya, Brimhana, Rasayana, Angamardhaprashamana.

Rogagnata: Tridoshajavikara, Vatavyadhi, Agnimandhya, Dourbalya, Kshaya, Shosha, Angamarda.

Dose: *Kashaya*- 50ml-100ml

Chemical Composition: Gangetin, Gangetinin, Desmocarpin, Desmodin.

Pharmacological Actions: Antileishmanial, Anti-asthmatic, smooth muscle relaxant, Anti-inflammatory, Anti-ulcer, and cardio-protective activities.²³

Mode of action on osteoarthritis:

In vivo studies on *Desmodium gangeticum* were conducted which showed strong antioxidant activity. It is likely that the antioxidant activity is a result of the

synergistic activities of its polyphenolic compounds and caffeic acid, and chlorogenic acid proved useful antioxidants in experimental animal models.²⁴ The compound also showed a significant dose dependant analgesic effect.

DISCUSSION

Rasonadi Kashaya consists of 4 drugs. Out of which most drugs have *snigdha guna*; *rasona* and *shalaparni* have *guru guna*; *rasona* and *pippali* have *teekshna guna*; *rasona* and *krishna jeeraka* have *ushna veerya*; *pippali* and *shalaparni* have *madhura vipaka* which helps in *vata hara* property. *Shothahara* and *vatanulomana* property of *rasona*, *krishna jeeraka*, and *sthira* relieves the inflammation process of osteoarthritis. *Balya* and *Brimhana* property of *krishna jeeraka* and *sthira* increases the integrity of the *asthi dhatu* and does *poshana*. *Deepana* and *Pachana* action of *rasona*, *krishna jeeraka*, and *shalaparni* helps to remove *agnimandhya*, and *ama* and thereby helps increase *dhatwagni* which helps in *asthi dhatu vridhhi* and *dooshita dhatu kshaya*. *Vedanasthapana* and *Shoolaprashamana* properties of *rasona* and *pippali* respectively help in the management of pain associated with osteoarthritis. *Rasayana* property of *Rasona*, *Pippali*, and *Sthira* may help in the regeneration of the knee joint components.

Pre-clinical studies proved *Rasona* has antioxidant action and anti-inflammatory effect thus having a significant anti-arthritic effect. *Pippali* has exhibited antioxidant activity against free radical-induced oxidative damage, an antihyperlipidemic, and anti-inflammatory activity which significantly reduced nociceptive and arthritic symptoms. *Sthira* has antioxidant and analgesic effect.

CONCLUSION

All the above said properties favour relieving the symptoms of osteoarthritis and preventing further damage to the knee joint. Thus, *Rasonadi Kashaya* is proved to be effective in the treatment of osteoarthritis. Clinical studies have to be done to understand the extent of effectiveness and to draw conclusions about the efficacy of the drug.

REFERENCES

1. Udupa Mahesh, Comprehensive Kayachikitsa and Principles of Ayurveda., 2004, 1st Ed, Chowkamba Orientalia, 1208.
2. Acharya J T, editor, (1st ed). Charaka Samhita of Agnivesha. Chikitsa sthana; Vatavyadhi Chikitsitam: chapter 28, verse 37. Varanasi: Chaukhamba prakashan, 2020; 618
3. <https://www.medicalnewstoday.com/articles/322603>.
4. Wise BL, Niu J, Zhang Y, Wang N, Jordan JM, Choy E, Hunter DJ. Psychological factors and their relation to osteoarthritis pain. *Osteoarthritis Cartilage*. 2010 Jul;18(7):883-7. doi: 10.1016/j.joca.2009.11.016. Epub 2010 Mar 24. PMID: 20346403; PMCID: PMC2912218.
5. Acharya J T, editor, (1st ed). Charaka Samhita of Agnivesha. Sutrasthana: Maharogadhyaya; chapter 10, verse 11. Varanasi: Chaukhamba prakashan, 2020; 113.
6. Byadgi P S, Pandey A K. A Textbook of Kayachikitsa vol III. Chaukhambha Publications, reprint 2019; 101.
7. Nicholas. A. Boon, Nicki & Colledge, editor. Davidson's Principle and Practice of Medicine, 20th Edition, Churchill Livingstone Elsevier publication, 2006, p.1096-1100
8. Nuki G. Osteoarthritis: a problem of joint failure. *Z Rheumatol*. 1999 Jun;58(3):142-7. DOI: 10.1007/s003930050164. PMID: 10441841.
9. Udupa Mahesh, Comprehensive Kayachikitsa and Principles of Ayurveda., 2004, 1st Ed, Chowkamba Orientalia, 1208.
10. <https://www.endocrinology.org/endocrinologist/126-winter17/features/why-are-our-bones-full-of-fat-the-secrets-of-bone-marrow-adipose-tissue/>
11. Acharya J T, Ed., Sushruta Samhita of Sushruta, Sri Dalhanacharya. Commentary, Nidanasthana chap 6 verse 13, Varanasi: Chaukhamba Oreintalia, 2021 ed, pg?
12. Piva SR, Susko AM, Khoja SS, Josbeno DA, Fitzgerald GK, Toledo FG. Links between osteoarthritis and diabetes: implications for management from a physical activity perspective. *Clin Geriatr Med*. 2015 Feb;31(1):67-87, viii. doi: 10.1016/j.cger.2014.08.019. Epub 2014 Oct 7. PMID: 25453302; PMCID: PMC4254543.
13. [https://www.oarsijournal.com/article/S1063-4584\(03\)00267-X/fulltext](https://www.oarsijournal.com/article/S1063-4584(03)00267-X/fulltext)
14. G Prabhakar Rao. English translation on Sahasrayogam, with Prabhakar Vyakhyanam. Choukambha Publications. First ed. 2016, page 166
15. Neeraj Tandon, Madhu Sharma, Ed., Reviews on Indian Medicinal Plants, Volume 2, New Delhi, ICMR, 2004, 4.
16. Arreola R, Quintero-Fabián S, López-Roa RI, Flores-Gutiérrez EO, Reyes-Grajeda JP, Carrera-Quintanar L, Ortuño-Sahagún D. Immunomodulation and anti-inflammatory effects of garlic compounds. *J Immunol Res*. 2015;2015:401630. doi: 10.1155/2015/401630. Epub 2015 Apr 19. PMID: 25961060; PMCID: PMC4417560.
17. Shin, Jung-Hye & Ryu, Ji & Kang, Min & Hwang, Cho & Han, Jaehee & Kang, Dawon. (2013). Short-term heating reduces the anti-inflammatory effects of fresh raw garlic extracts on the LPS-induced production of NO and pro-inflammatory cytokines by down-regulating allicin activity in RAW 264.7 macrophages. *Food and chemical toxicology: an international journal published for the British Industrial Biological Research Association*. 58. 10.1016/j.fct.2013.04.002.
18. Pareek, Shalini & Dixit, Meenal & Govil, Sumit & Jadhav, Indrani & Shrivastava, Divya & Vahedi, Maryam & Bisen, Prakash. (2019). Garlic and Its Role in Arthritis Management. 10.1016/B978-0-12-813820-5.00015-5.
19. Neeraj Tandon, Madhu Sharma, Ed., Reviews on Indian Medicinal Plants, Volume 5, New Delhi, ICMR, 2007, 582.
20. Wei J, Zhang X, Bi Y, Miao R, Zhang Z, Su H. Anti-Inflammatory Effects of Cumin Essential Oil by Blocking JNK, ERK, and NF-κB Signaling Pathways in LPS-Stimulated RAW 264.7 Cells. *Evid Based Complement Alternat Med*. 2015;2015:474509. doi: 10.1155/2015/474509. Epub 2015 Sep 6. PMID: 26425131; PMCID: PMC4575746.
21. Sharma p.c, Yelne M.B., Dennis T.J., Database on Medicinal plants used in Ayurveda, Volume3, New Delhi, CCRAS, reprint 2005, 472.
22. Bang JS, Oh DH, Choi HM, Sur BJ, Lim SJ, Kim JY, Yang HI, Yoo MC, Hahm DH, Kim KS. Anti-inflammatory and antiarthritic effects of piperine in human interleukin 1beta-stimulated fibroblast-like synoviocytes and rat arthritis models. *Arthritis Res Ther*. 2009;11(2):R49. doi: 10.1186/ar2662. Epub 2009 Mar 30. PMID: 19327174; PMCID: PMC2688199.

23. Neeraj Tandon, Madhu Sharma, Ed., Reviews on Indian Medicinal Plants, Volume 9, New Delhi, ICMR, 2009, 313.
24. Govindarajan R, Vijayakumar M, Rawat Ajay Kumar Singh, 2006 'Antioxidant activity of Desmodium gan-

geticum and its phenolics in arthritic rats' Acta Pharm. 56 (2006) 489-496.

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