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COMPARATIVE STUDY ON THERAPEUTIC EFFECT OF BALASAHACARADI KASAYA AND DASANGALEPAYA IN THE MANAGEMENT OF KNEE OSTEOARTHRITIS

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ABSTRACT

Knee Osteoarthritis (KOA), a prevalent degenerative joint disease, significantly impacts millions globally by causing pain and reduced range of motion (ROM). Study evaluated efficacy of two Ayurvedic treatment protocols in managing KOA. Treatment Protocol 1 combined *Balāsahacarādi Kaṣāya* (BS) and *Daśaṅgalēpaya* (DL), while Treatment Protocol 2 included *Dashamul kvātha* and *Shūlahara thailaya*. A randomized clinical trial was conducted at Rural Ayurveda Hospital, Kesbewa, Sri Lanka, involving 60 female patients equally divided into test and control groups. Pain (using Visual Analog Scale), ROM (using a Goniometer), swelling, evaluated before and after a 2-week treatment period as key parameters. Pharmacological properties antioxidant, anti-inflammatory, analgesic, anti-oedema effects of herbal ingredients were analyzed. Data analysis using paired t-tests and non-parametric tests (Wilcoxon-signed rank test, $p = 0.05$) revealed significant clinical improvements with Treatment Protocol 1. Participants experienced marked pain reduction, improved ROM, and decreased swelling, tenderness, and

crepitus compared to Protocol 2, which showed moderate but less pronounced efficacy. Crepitus demonstrated minimal change, possibly due to advanced joint degeneration. Study highlighted therapeutic potential of Ayurvedic treatments for KOA, with Protocol 1 proving superior in alleviating symptoms and improving joint function. Short treatment duration and lack of follow-up were the limitations. Future studies with larger samples, extended duration, and follow-up assessments are recommended to validate findings and explore preventive benefits.

KEYWORDS: Ayurveda, Knee Osteoarthritis, Herbal Formulations, Clinical Trial, Analgesic.

INTRODUCTION

Osteoarthritis (OA) is one of the most common joint disorders worldwide, characterized by the gradual degeneration of joint cartilage and the subsequent remodeling of underlying bone. The prevalence of OA has been increasing globally, primarily due to the aging population in both developed and developing countries, as well as lifestyle factors such as obesity and physical inactivity.[1] Often referred to as degenerative joint disease or "wear and tear" arthritis, OA most frequently affects the hands, hips, and knees. The breakdown of cartilage, a tissue that cushions the ends of bones, leads to pain, swelling, and decreased joint movement, ultimately impacting the quality of life of those affected.[2] Among the various joints, knee is particularly vulnerable to OA. Knee osteoarthritis (KOA) is common among elderly populations and has a substantial impact on both physical and mental health, causing significant pain, loss of function and disability. Studies suggest that approximately one-third of people over 60 years of age are affected by KOA, presenting symptoms such as stiffness, swelling, pain, crepitus, and tenderness. These symptoms can make everyday activities like walking, bending the knees, or standing from a seated position extremely challenging.[3] KOA can significantly impair mental well-being, contributing to overall poor quality of life.[4]

In Sri Lanka, estimated age-standardized prevalence of clinical KOA is 21.8%.[5] Inflammation is recognized as a key component in OA pathophysiology. Immune-mediated processes involving T-cells, B-cells, and macrophages have been identified in OA affected synovial tissue. Proinflammatory cytokines are significantly elevated in synovial fluid of OA patients compared to healthy individuals.[6] Chondrocytes, mesenchymal stem cells in subchondral bone, and synovial fibroblasts also play crucial roles in OA progression, contributing to inflammatory milieu and cartilage degradation.[4] Diagnosis of OA involves

both clinical and radiographic assessment. Imaging techniques, including X-rays, magnetic resonance imaging (MRI), and ultrasonography, are used to confirm the presence of joint damage. MRI is useful for visualizing articular cartilage and other joint tissues like meniscus, tendons, muscles, and effusions, providing a comprehensive view of the joint's condition.

Ayurveda and *Sandhigata Vāta*: An Ancient Perspective on Osteoarthritis

The condition of OA has been described in Ayurveda as '*Sandhigata vāta*.' According to *Charaka Samhithā*, this condition arises when the *Vāta dōsha* (one of the fundamental bio energies in Ayurveda) becomes imbalanced, affecting the joints. This leads to the degradation of cartilage and a reduction in synovial fluid, resulting in painful joint movement and swelling.[6] Accumulation and vitiation of *Vāta dōsha*, exacerbated by incompatible dietary habits and activities, is believed to lodge in joints and bones (*Asthi dhātu*), causing classic symptoms like pain (*shūla*) and swelling (*shōtha*). The detailed description of *Sandhigata vāta* in texts like *Sushrutha Samhithā*[7] highlights its similarity to the modern understanding of OA, where pain, stiffness, and limited mobility are the main manifestations.[8] Ayurvedic treatments for *Sandhigata vāta* aim to alleviate symptoms and address underlying *dōshi*c imbalances, to prevent disease progression. Various treatments[9] such as oleation therapy (*abhyanga*) using medicated oils, sudation therapy (*svēdana*) involving steam or heat application, and panchakarma (bio-purification) procedures like *Virēchana* (therapeutic purgation), *Vasti* (medicated enema), and *Nasya* (nasal administration of medications) are utilized depending on patient's constitution (*Prakrithi*) and disease severity.[7] These treatments are believed to restore balance to the *dōshas*, strengthen the joints, and improve mobility.

Current conventional treatments for OA primarily focus on symptom management, including pain relief and improved joint function. Nonsteroidal anti-inflammatory drugs (NSAIDs) are often prescribed as a first-line treatment due to their efficacy in reducing pain and inflammation.[2] However, their long-term use is associated with significant side effects, including gastrointestinal and cardiovascular complications, which limits their suitability for long-term management. In advanced cases, surgical interventions like arthroscopy, osteotomy, or joint replacement may be necessary. These are invasive options with potential complications, and their accessibility is limited, particularly in low-resource settings.[2]

Justification

Despite the availability of these treatments, there remains an unmet need for holistic and

sustainable management strategies that address both the symptoms and the underlying disease processes. This is where Ayurveda, with its emphasis on individualized treatment, offers a promising alternative approach. Ayurveda's goal is not merely to alleviate symptoms but to treat the root cause, prevent disease progression, and improve overall quality of life. The present research sought to explore the efficacy of two specific Ayurvedic formulations *Balāsahacarādi Kaṣāya* (BS)[10] for internal use and *Daśaṅgalēpaya* (DL)[11] for external application in the management of KOA. These formulations have been traditionally used to balance *Vāta dōsha*, reduce inflammation, and enhance joint lubrication, potentially offering a safer and more effective alternative to conventional NSAIDs. The clinical study conducted aimed to evaluate whether this treatment protocol provides symptomatic relief, improves physical function, and reduce the need for surgical intervention.

OBJECTIVES

General Objective was to analyze the effect and efficacy of *Balāsahacarādi Kaṣāya* and *Daśaṅgalēpaya* in the management of Knee Osteoarthritis (*Jānusandhigatha vāta*).

Specific Objectives were to evaluate effects on clinical features (pain, tenderness, stiffness, oedema, range of movement of knee joints), Anthropometric measurements, BMI, Circumference of knee joints before and after treatment, to determine side effects and complications related with novel treatment protocol used, to analyze therapeutic effects of BS and DL in management of KOA based on the identified pharmacological properties and to evaluate the pharmacological mechanisms of drugs used in KOA management.

MATERIALS AND METHODS

Present study consisted of two parts. Part I is Systematic literature review on the disease and the pharmacological activity of the selected medicines. Part II is a Clinical trial that was conducted at the Rural Ayurveda Hospital - Kesbewa.

Part I – Literature Review

Narrative Literature review and Systematic Literature review was conducted. Narrative Literature review was conducted with reference to authentic Ayurveda texts, books on Medicine to study available information on *Jānusandhigatha vāta* and KOA. Books on Ayurveda Pharmacology and Pharmacology was referred to analyze the already discovered information on pharmacological properties of herbal drugs used in the treatment protocol. Systematic Literature Review was conducted with the objective of updating knowledge about

KOA and pharmacological properties of treatment protocol by using recent evidence published in the PubMed Central Database. "And" was used as the Boolean operator to identify the relevant publications. The PRISMA model was applied in selecting the relevant publications. Literature search was limited to the past 10 years from 01.01.2013 to 31.12.2023 and Title was used as the search field and if no results were found, Abstract was used as the search field. If no article was found, search was done without applying search fields and duration. Reasons for selecting last ten years were, with emerging technologies and developed scientific research findings, latest updates and results with regard to KOA were available in the articles published in the past 10 years compared to the older publications.

Review on KOA

Narrative Literature review - Information regarding KOA in comparison with views in authentic Ayurveda texts like *Charaka samhithā, Sushrutha samhithā, Ashtāngahrda samhithā*, and Modern medical texts like Hutchison's clinical methods, Davidson's principles of Medicine were analyzed.

Systematic Literature review - "Osteoarthritis", "Knee Osteoarthritis", "Definition", "Prevalence", "Etiology", "Signs and Symptoms", "Pathophysiology", "Risk factors", "Diagnosis", "Management", "Complications" and "Systematic Review" were the keywords used.

Review on Pharmacological properties of drugs used in the study

Narrative Literature review - Ayurveda texts related to Pharmacology such as Ayurveda Pharmacopoeia, *Bāvaprakāsha, Shārangadhara samhithā, Vruhath Nigantu-rathnākara* were referred. Pharmacological activity of herbal medicines and their mechanisms of action according Ayurveda views were developed through the literature review.

Systematic Literature review - was conducted to all the 18 herbal drugs included in the treatment protocol by using the PubMed Central database under the below mentioned search criteria. "Antioxidant", "Analgesic"/ "Pain", "Anti-inflammatory", "Oedema"/ "Swelling" were used as terms to find the required pharmacological properties.

Part II – Clinical Study

Study was conducted for 3 weeks (including the follow up) for patients with KOA and carried out to determine the therapeutic effect and efficacy of herbal medicines utilized in

treatment protocol.

Study Setting – *Sandhirōga sāyanaya* (Orthopedic Clinic) of Out-Patient Department (OPD) of Rural Ayurveda Hospital, Kesbewa - Sri Lanka.

Study Design – Randomized positive control comparative study.

Method of Sampling – Patients visiting the OPD of Rural Ayurveda Hospital - Kesbewa was initially interviewed about the presenting complaints, history of the disease and treatment history. Patients matched with the inclusion criteria, was selected for the study. Initially the selected patients were explained about the study and the informed written consent was taken (Annexure 1). Sample was divided randomly using the systematic random sampling method into two groups [Group A - Treatment Group and Group B - Positive control Group], every 2nd patient was selected to Group A and each group had 30 patients among selected patient list.

Diagnostic Criteria/ Method of Investigations – Interviewer administered questionnaire was used as the study tool to collect data before and after treatment (Annexure 1). In clinical examination stage of pain, Tenderness using VAS, Oedema (pitting/non-pitting), Range of movement using Goniometer, Anthropometric measures like BMI, Circumference of knee joints before and after the treatment was evaluated.[12] Although Radiological Investigations on X-ray of Knee joint (AP/Lateral view) before and after the treatment were planned to be analyzed, patients were reluctant to do X-ray imaging due to cost, getting exposed for radiation after a short-term treatment of 3 weeks.

Selection Criteria - Patients attending the *Sandhirōga sāyanaya* of Rural Ayurveda Hospital - Kesbewa for the treatment of OA (*Sandhigatha vāta*) were selected based on the following inclusion and exclusion criteria.

Inclusion Criteria

- Female patients between the age of 55 – 65 years diagnosed with KOA
- Patients with knee joint pain, tenderness, swelling and reduced range of movement knee joints
- Patients who have taken Ayurveda treatments from OPD of Rural Ayurveda Hospital - Kesbewa for KOA (*Sandhigatha vāta*) before

- Patients not taking Allopathic medicines for KOA
- Patients with positive family history of KOA

Exclusion Criteria

- Patients who have faced knee bone grafting, Hydrocortisone injections to knee joints
- Patients with past medical history of MI, Angina, CABG (Bypass surgery)
- Patients with chronic skin diseases, allergies and rashes
- Pregnant, Lactating mothers and patients with CKD
- Patients diagnosed with liver diseases, cirrhosis or abnormal baseline liver function tests
- Patient with past medical history of Gastritis, Peptic Ulcer disease
- Patients with mental, memory related disorders

Sample Size and Study Period - Phase 1 clinical trial was conducted with 60 patients, 30 patients in Treatment group (Group A) and 30 patients in Positive control group (Group B). Study period was 3 weeks including the follow up.

Preparation of Herbal Formula

1. *Balāsahacarādi Kaṣāya*[10]

Weight of *kalan* 1 *madata* 10 (7.5g) from all the 8 dried ingredients [Roots of *Sida cordifolia* L. (*Babila*), Stems of *Barleria prionitis* L. (*Katu Karandu*), Stems of *Ricinus communis* L. (*Beheth Endaru*), Rhizome of *Zingiber officinale* Roscoe. (*Viyali Inguru*), Bark of *Aegle marmelos* L. (*Beli*), Stems of *Cedrus deodara* Lamb. (*Devadāra*), Leaves of *Vitex negundo* L. (*Nika*) and Bulbs of *Allium sativum* L. (*Sudu lūnu*)] were measured and prepared decoction by boiling with 8 cups of water (1920ml) to 1 cup (240ml). Patients were advised to take ½ of it (120ml) in morning and evening after meal for 14 days.

2. *Daśaṅgalēpaya*[11]

Equal amounts (20g) of dried powder of all the ten ingredients [Bark of *Albizia lebbeck* L. (*Mahari*/ *Māra*), Roots of *Glycyrrhiza glabra* L. (*Walmee*), Bark of *Pterocarpus santalinus* L. (Rath handun), Leaves of *Valeriana wallichi* L. (*Thvarala*), Seeds of *Elettaria cardamomum* L. (*Enasahal* / *Ēlā*), Stem of *Nardostachys jatamansi* DC. (*Jatāmānsha*), Rhizome of *Curcuma longa* L. (Viyali kaha), Stem of *Berberis aristata* DC. (*Wenivel*), Bark of *Saussurea lappa* Falc. (*Suwanda kottan*) and Roots of *Vetiveria zizanioides* L. (*Savandarā*)] mixed together and made a paste by mixing with ghee (amount sufficient to mix the powder). Then the paste was heated in mild heat and the poultice was prepared.

Amount used at a time was able to cover the whole knee joint area (approximately 5g). Applied and covered on the affected knee joints with a thickness of 2mm two times daily in morning and evening. Patients were asked to remove the paste after 6 hours and washed with mild hot water and keep open to get ventilated.

Method of Management - Group A patients were given *Balāsahacarādi Kaṣāya* (120ml) for 2 weeks to be taken after meal in morning and night. *Daśaṅgalēpaya* to be applied on affected knee joint by mixing with ghee and making a poultice and applied on affected knee with a thickness of approximately 2mm and should be kept for at least 6 hours in morning and night. Group B patients were prescribed *Dashamul Kvāthaya* as the internal medication for 2 weeks morning and evening. They were advised to take this 30ml each twice a day after meal. Prescribed *Shūlahara thailaya* to be applied on affected knee and massage for 10 minutes and keep. Patients were asked to do this twice a day.

Dietary management and Follow up - Patients were advised to avoid oily and spicy foods and ensure adequate water intake during the treatment period. Other medications can be taken 15–30 minutes before consuming the prescribed decoction. Patients of Treatment protocol 1 (Annexure 4), after applying the poultice to the affected knee, should bandage the area and leave it on for 3–6 hours before removing it. Once removed, the knee should be kept free of any applications. Patients of Treatment protocol 2 should keep the applied oil till it dries off without washing. For aftercare, patients should visit the Orthopedic clinic twice on Fridays for regular follow-up.

Data Processing and Analysis - Data analysis was primarily conducted using SPSS, with additional support from MS Excel for data organization and visualization. Various statistical tests were applied to assess the effectiveness of the treatments, including paired and independent sample t-tests, along with non-parametric tests like Wilcoxon signed rank test where appropriate.

RESULTS

1. Systematic Literature review on KOA

KOA is a degenerative joint disease characterized by the progressive breakdown of articular cartilage, subchondral bone remodeling, synovial inflammation, and loss of joint function. It is a leading cause of disability worldwide, predominantly affecting older adults, although it can occur in younger individuals due to trauma or genetic predisposition. KOA is a

multifactorial disease resulting from a combination of mechanical, biological, and environmental factors. Repeated mechanical stress, joint instability, and inflammatory processes contribute to cartilage degeneration. Genetics, obesity, aging, and prior joint injury are recognized risk factors. This is commonly classified as, Primary KOA: Idiopathic and associated with aging and Secondary KOA: Resulting from identifiable causes such as trauma, metabolic disorders, or inflammatory joint diseases.[12]

KOA involves cartilage degradation, subchondral bone sclerosis, osteophyte formation, and synovitis. Increased mechanical stress and pro-inflammatory cytokines (e.g., IL-1, TNF-α) trigger the release of matrix-degrading enzymes like MMPs, accelerating cartilage erosion. These changes alter joint biomechanics, leading to pain, stiffness, and limited mobility. Common symptoms include, Pain that worsens with activity and improves with rest, stiffness, prominent after periods of inactivity, especially in the morning. Crepitus, grinding or cracking sound during joint movement. Swelling due to synovial inflammation or effusion and reduced range of motion (ROM)/ Limitation in knee flexion and extension.[13] Risk factors include Age: Incidence increases after 50 years, Obesity: Excess weight adds stress on knee joints, Gender: Women, especially post-menopausal, are at higher risk, Injury: Previous knee injuries or surgeries, Occupation: Jobs requiring repetitive knee movements, Genetics: Family history of OA. Management of KOA focuses on symptom relief, functional improvement, and slowing disease progression. Treatment options include: Non-Pharmacological: Weight loss, physiotherapy, orthotic devices and Pharmacological: Analgesics (e.g., acetaminophen, NSAIDs), corticosteroid injections, and hyaluronic acid injections. Surgical: Joint replacement (total or partial knee arthroplasty) in severe cases.[14] Untreated or advanced KOA can lead to, chronic pain and disability, muscle atrophy due to disuse, joint deformities and instability and decreased quality of life and increased risk of depression. KOA is a significant public health concern, requiring a multi-disciplinary approach to management. Preventive strategies such as weight control, regular exercise, and injury prevention can help mitigate its impact on individuals and healthcare systems.[15]

2. SYSTEMATIC REVIEW ON PHARMACOLOGICAL PROPERTIES OF DRUG FORMULAE USED

2.1 *Balāsahacarādi kashāya* (BS)[10]

Table 1: Ingredients of *Balāsahacarādi kashāya* (BS).

Botanical Name		Sinhala Name	Sanskrit Name	Used part	Amount used (g)
1.	*Sida cordifolia* L.	*Babila*	*Balā*	Roots	7.5g
2.	*Barleria prionitis* L.	*Katu Karandu*	*Katukarōsana*	Stems	7.5g
3.	*Ricinus communis* L.	*Beheth Endaru*	*Ēranda*	Stems	7.5g
4.	*Zingiber officinale* Roscoe.	*Viyali Inguru*	*Shunti*	Rhizome	7.5g
5.	*Aegle marmelos* L.	*Beli*	*Bilva*	Bark	7.5g
6.	*Cedrus deodara* Lamb.	*Devadāra*	*Dāru*	Stem	7.5g
7.	*Vitex negundo* L.	*Nika*	*Nirgundi*	Leaves	7.5g
8.	*Allium sativum* L.	*Sudu lūnu*	*Lashuna*	Bulbs	7.5g

2.1.1 *Sida cordifolia* L.

Potent antioxidant activity had been found in superoxide anion radical scavenging assay and DPPH free radical scavenging activity ensured potential antioxidant activity of the extracts.[16]

2.1.2 *Barleria prionitis* L.

Sahachara of ACANTHACEAE family have been tested for organic constituents and had given positive results for Steroid, Tannins, Saponins and Alkaloids.[17]

2.1.3. *Ricinus communis* L.

Exhibits defense mechanisms against cadmium (Cd)-induced oxidative damage through its antioxidant systems. The plant's cells and organelles produce antioxidant enzymes such as superoxide dismutase (SOD) and catalase (CAT), which help regulate redox balance and mitigate oxidative stress.[18] Leaves contain phenolic compounds, including caffeic acid, p-coumaric acid, and rutin, which exhibit strong antioxidant activity. Extracts from these leaves have shown potent antioxidant effects against stable free radicals like DPPH, which can help inhibit fungal growth by preventing food decay through oxidation.[19] Ricin, a highly cytotoxic protein from the plant, has been valuable in developing anti-cancer immunotoxins that target multiple molecular pathways in cells, making them potentially more effective than conventional chemotherapy.[20]

1.2.4. *Zingiber officinale* Roscoe

Ginger rhizomes are rich in potent polyphenols, including gingerols (6-, 8-, and 10-gingerol) and 6-shogaol, which exhibit significant antioxidant activity and show varying levels of efficacy against cancers.[21] Dried ginger displays the strongest antioxidant activity due to higher phenolic content compared to fresh, stir-fried, and carbonized ginger. Additionally, ginger extract helps mitigate oxidative stress in human chondrocyte cells by stimulating antioxidant enzyme expression and reducing reactive oxygen species (ROS) generation. Investigations have demonstrated that ginger possesses multiple biological activities, including antioxidant, anti-inflammatory, anti-obesity activities.[22]

1.2.5. *Aegle marmelos* L.

Fruit showed significant free radical quenching activity (reducing ferric chloride). May be used as antioxidant agent to treat cellular damage caused due to free radicals.[23] Inhibition of COX-2 modulated cytokines by increasing anti-inflammatory cytokine IL-2 and reducing pro-inflammatory cytokines like IL-1β and IL-6.[24]

1.2.6. *Cedrus deodara* Lamb.

No research articles were found on Antioxidant, Anti-inflammatory, Analgesic and Anti-swelling properties and burn wound healing activity of methanol extract has been reported. Oil has the potential to depress sexual power of male animals. Number of inflammatory cells, neovascularization and collagen density, good burn wound healing activity of methanol extract have been demonstrated.[25]

1.2.7. *Vitex negundo* L.

Leaves extract has been used as anti-inflammatory, analgesic and anti-itching agent in Ayurveda in management of various diseases associated with pain and inflammation.[26] Substantial effects on remyelination and neuroprotection through suppression of stress markers, which repair molecular and DNA damage was shown.[27]

1.2.8. *Allium sativum* L.

Black garlic (BG) is produced by aging whole garlic bulbs under high humidity, achieving optimal antioxidant properties.[28] Fresh garlic is known for its antioxidant capacity due to unstable organosulfur compounds. Allicin in garlic modulate carcinogenic metabolism and inhibit cell growth. Allyl sulfides block formation of nitrosamines and DNA alkylation, which are linked to cancer risk.[29] Garlic bulbs have shown potential for treating

inflammatory diseases like arthritis, with low toxicity. Reduces production of NO and prostaglandin E-2 by down-regulating expression of inducible NO synthase (iNOS) and cyclooxygenase-2 (COX-2) in lipopolysaccharide-stimulated RAW 264.7 macrophages.[30]

2.2 *Dashāngalēpaya* (DL)[11]

Table 2: Ingredients of *Dashāngalēpaya* (DL).

Botanical Name		Sinhala Name	Sanskrit Name	Used part	Amount used (g)
1.	*Albizia lebbeck* L.	*Mahari / Māra*	*Shīreesha*	Bark	20g
2.	*Glycyrrhiza glabra* L.	*Walmee*	*Yashti*	Roots	20g
3.	*Valeriana wallichi* L.	*Thvaralā*	*Anatha*	Leaves	20g
4.	*Pterocarpus santalinus* L.	*Rath handun*	*Chandana*	Bark	20g
5.	*Elettaria cardamomum* L.	*Enasahal*	*Ēlā*	Seeds	20g
6.	*Nardostachys jatamansi* DC.	*Jatāmānsha*	*Mānshi*	Stem	20g
7.	*Curcuma longa* L.	*Viyali Kaha*	*Haridrā*	Rhizome	20g
8.	*Berberis aristata* DC.	*Wenivel*	*Dāruharidrā*	Stem	20g
9.	*Saussurea lappa* Falc.	*Suwanda Kottan*	*Kushta*	Bark	20g
10.	*Vetiveria zizanioides* L.	*Savandarā*	*Vālā*	Roots	20g

2.2.1. *Albizia lebbeck* L.

Include various phytochemicals, including major alkaloids, flavonoids, saponins, and terpenoids. Crude extract, and bioactive compounds exhibited potent antioxidant, anti-inflammatory and wound healing activities.[31] Antihistaminic properties and regulates dopamine metabolism. *S*eeds also alleviate cholinergic deficits by inhibiting hyperactive acetylcholinesterase.

2.2.2. *Glycyrrhiza glabra* L.

Exhibits a range of pharmacological activities, including analgesic, antioxidant, anti-inflammatory, anticancer effects, largely attributed to glycyrrhizin.[32] Induction of inducible nitric oxide synthase (iNOS) expression is mediated by NF-kB, which plays a crucial role in inflammatory response. Glycyrrhizin inhibit thrombin-induced platelet aggregation without affecting collagen or platelet aggregating factor (PAF) agglutination.[33] In Ayurveda, licorice is recognized as "*Rasayana*" highlighting its nourishing and rejuvenating properties. Polysaccharide fractions from Licorice enhance immune responses by stimulating macrophages.[32]

2.2.3. *Valeriana wallichii* DC.

Valepotriates are the primary compounds in *Valeriana wallichii* DC. (*Tagara*) that induce

sedation by inhibiting GABA breakdown in the brain. Additionally, *Dashanga Ghana* shows significant anti-arthritic activity, beneficial for treating arthritis.[34] The roots and rhizomes of *V. wallichii* are rich in valepotriates, lignans, flavonoids, tannins, and phenolic acids, which enhance its central nervous system effects and aid in sleep initiation.[35]

2.2.4. *Pterocarpus santalinus* L.

Methanolic extracts of the leaves demonstrate radical-scavenging activity against DPPH, NO, and H2S, while the heartwood extract exhibits both Fe^{3+} reducing capacity. In Ayurveda, the heartwood of *P. santalinus* is utilized externally to treat inflammation, Diabetes, skin diseases and wounds.[36] Notable lignans such as savinin found in the heartwood are known to inhibit TNF-α.[37] Bark extract displays stronger antibacterial activity against gram-positive bacteria, including *S. aureus*, *S. epidermidis*, *E. coli*, and *Pseudomonas aeruginosa*.

2.2.5. *Elettaria cardamomum* L.

Extracts and essential oils possess strong antioxidant properties, helping to prevent oxidative damage and combat infections, due to compounds like gingerol, β-zingiberene and geraniol.[38] Known as the "queen of spices," cardamom not only enhances flavor but also offers numerous health benefits, acting as a nutraceutical that improves mood and lipid profiles by lowering cholesterol, triglycerides while raising HDL levels.[39] Green cardamom improves blood pressure control and exert anti-inflammatory effects which could help patients with unhealthy metabolic profile manage their health.

2.2.6. *Nardostachys jatamansi* DC.

Valued in traditional medicine for its sedative, anti-inflammatory, and cardiotonic effects, with roots also showing antiseptic and diuretic properties. It exhibits antioxidant and anticancer potential, particularly against estrogen receptor-negative breast carcinoma, primarily due to its main sesquiterpenoid, Jatamansone.[40]

2.2.7. *Curcuma longa* L.

Curcumin, the active compound in *C. longa*, is known for its unique flavor and antioxidant properties, which are optimized at low doses.[41] Induces apoptosis and inhibits telomerase in cancer cells[42] and reduces delayed onset muscle soreness (DOMS) by blocking the NF-κB inflammatory pathway, lowering inflammatory cytokines[43] Curcumin alleviates statin-induced myalgia through COX-2 inhibition and improves cholesterol ratios.[42] *C. longa* extract and curcumin have similar effects on joint pain, function and stiffness.[44]

2.2.8. *Berberis aristata* DC.

Pharmacological studies highlight its anticancer, analgesic, and antipyretic activities.[45] Plant contains key chemical constituents such as berbamine, berberine chloride, oxy-berberine, oxyacanthine, contributing to its antidiarrheal, cardiotonic, hepatoprotective, antidiabetic, and anticancer effects. Higher concentrations of phenolic compounds in *B. aristata* enhance its antioxidant activity, with the root containing more berberine than the bark.[45]

2.2.9. *Saussurea lappa* Falc. - No research articles were found for antioxidant, analgesic, anti-inflammatory and anti-swelling activity of *Saussurea lappa* Falc in PubMed Central database.

2.2.10. *Vetiveria zizanioides* L.

Vetiver oil is commonly used as a main odor contributor in perfumery industry and as a flavor agent in food industry. Antioxidant properties of extracts can be attributed to presence of phenolic acids. Vetiver oil is reported to possess a strong free radical scavenging activity when compared to standard antioxidants such as butylated hydroxytoluene (BHT) and α-tocopherol.[46]

3. Clinical Study

This section presents the findings from the data analysis of the study conducted to evaluate the efficacy of treatment protocol with *Balāsahacharādi kashāya* and *Dashāngalēpaya* in the management of Knee Osteoarthritis (*Jānusandhigatha vātha*) in comparison to the treatment protocol *Dashamul kvātha* and *Shūlahara thailaya* in the control group. Data were analyzed for a total of 60 patients, divided equally into test and control groups (n = 30 per group). Results are organized into the following categories: demographic data, clinical characteristics of KOA, Blood Pressure, Anthropometric data to analyze body mass index (BMI), Analysis of clinical features of KOA like pain, tenderness, crepitus, swelling, oedema, and range of motion (ROM). Statistical analyses were performed using paired sample t-tests, to determine the significance of differences between pre- and post-treatment measurements. Significance was determined at $p < 0.05$. Findings provide insight into the effectiveness of the treatment protocol in improving clinical symptoms associated with KOA.

Demographic data Analysis

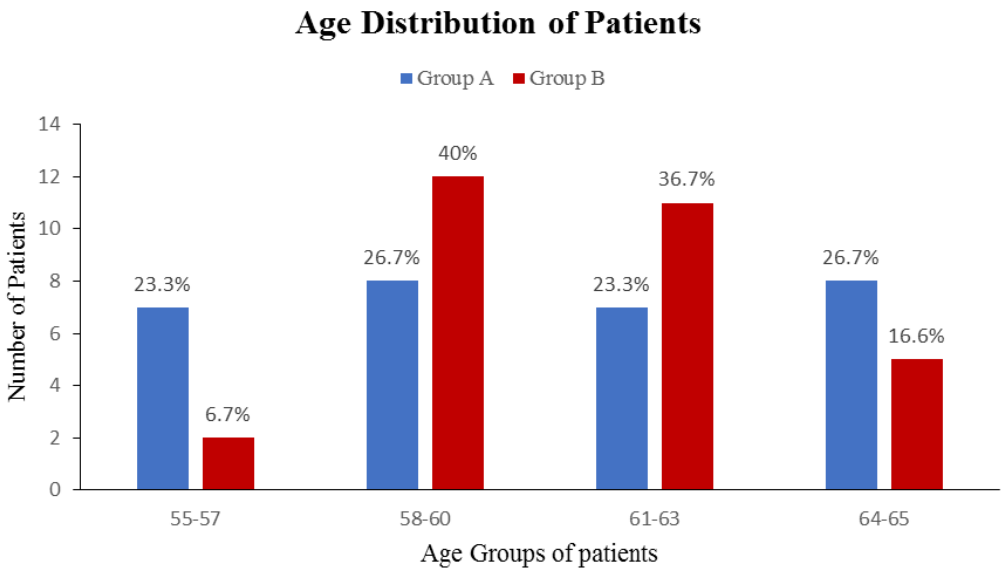

Figure 3: Age-wise Distribution of Patients in both Groups.

(Both groups exhibited a similar age distribution, and mean ages were comparable, indicating a consistent demographic profile across treatment and control groups)

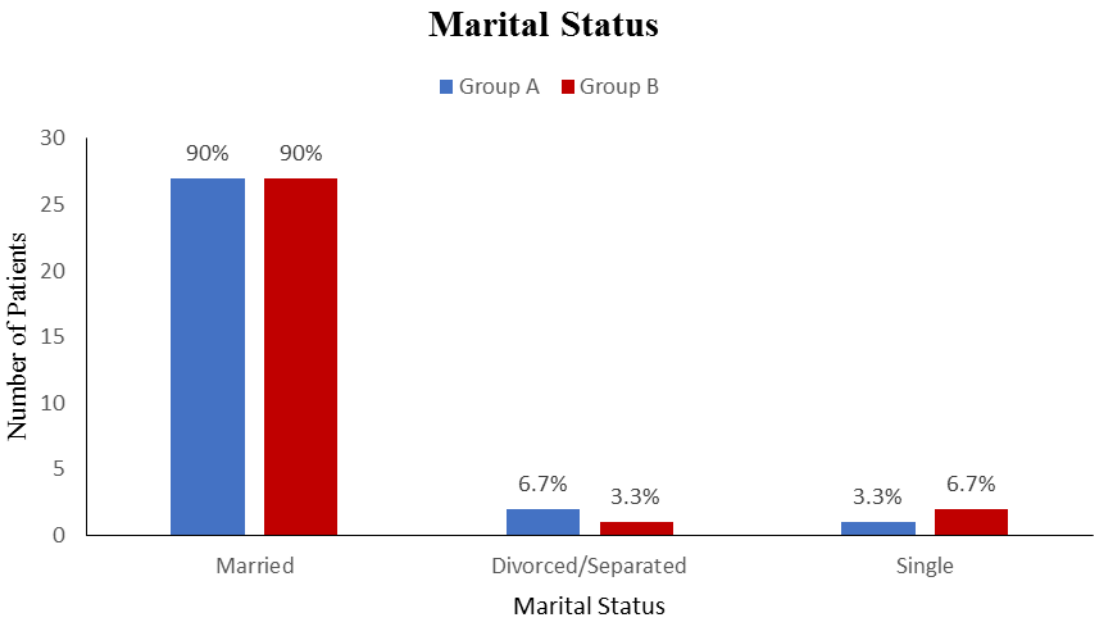

Figure 4: Marital status of Patients in both Groups.

(Marital status is not a confounding factor in the study as 90% of patients in both groups were married. The divorced/separated category is slightly higher in Group A (6.7%) compared to Group B (3.3%). More single patients were in Group B (6.7%) than in Group A (3.3%).

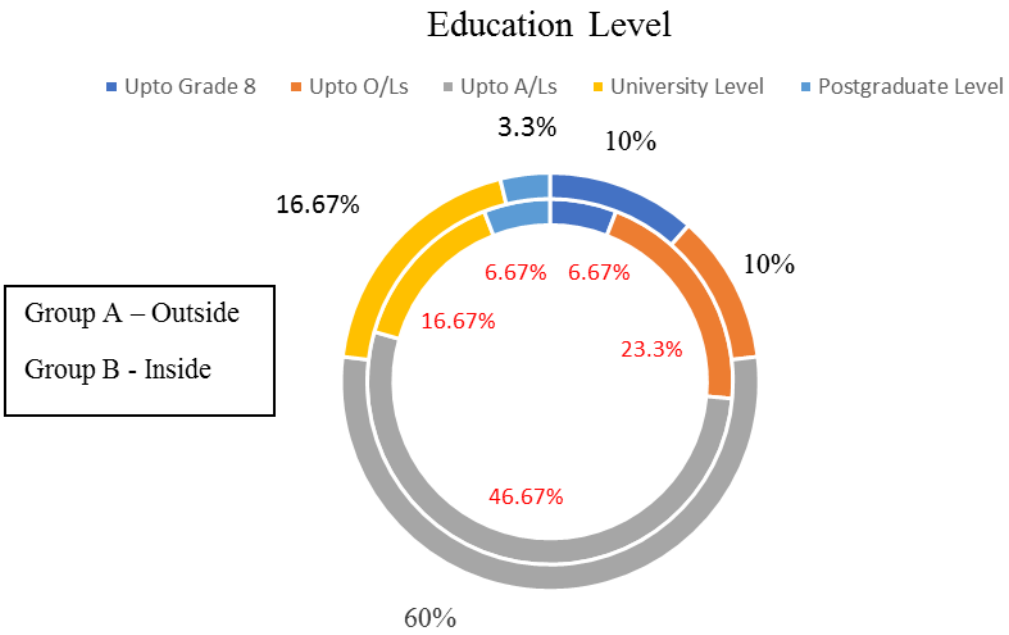

Figure 5: Education Level of patients in both groups.

(Both groups exhibited a similar educational pattern, with a majority of participants having completed education up to A/Ls)

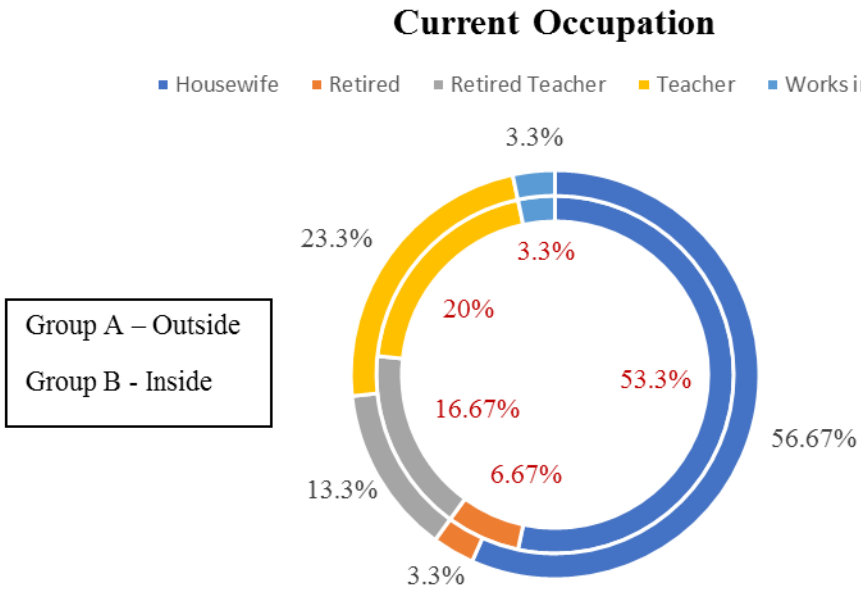

Figure 6: Current Occupation of patients in both groups.

(Majority of participants were housewives in both groups A- 56.67% and B- 53.3%)

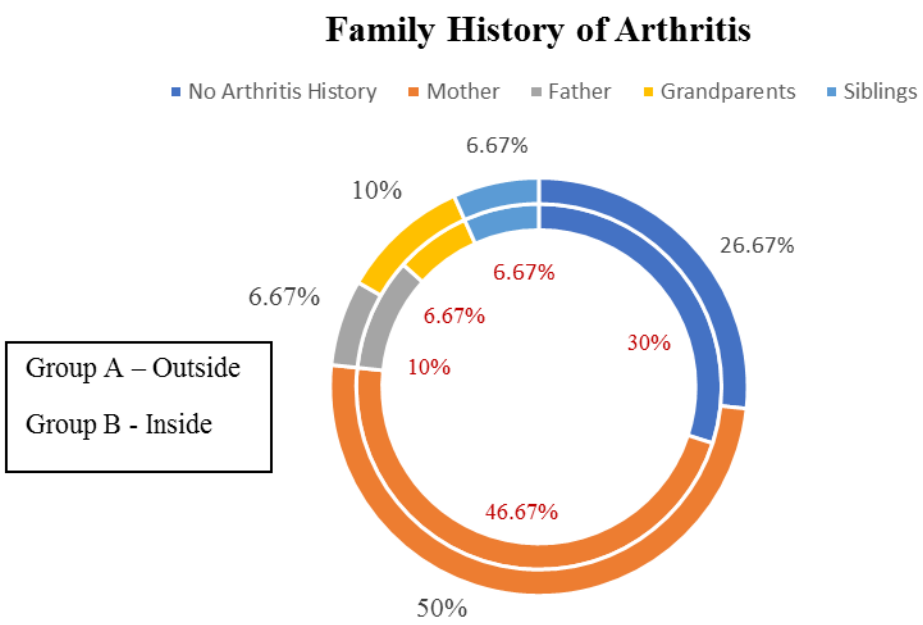

Figure 7: Family history of Arthritis in both Groups.

(A considerable proportion of participants reported a family history of arthritis, predominantly from their mothers, suggesting a possible hereditary association. Reports from fathers, grandparents, and siblings were comparatively lower and similar in frequency.)

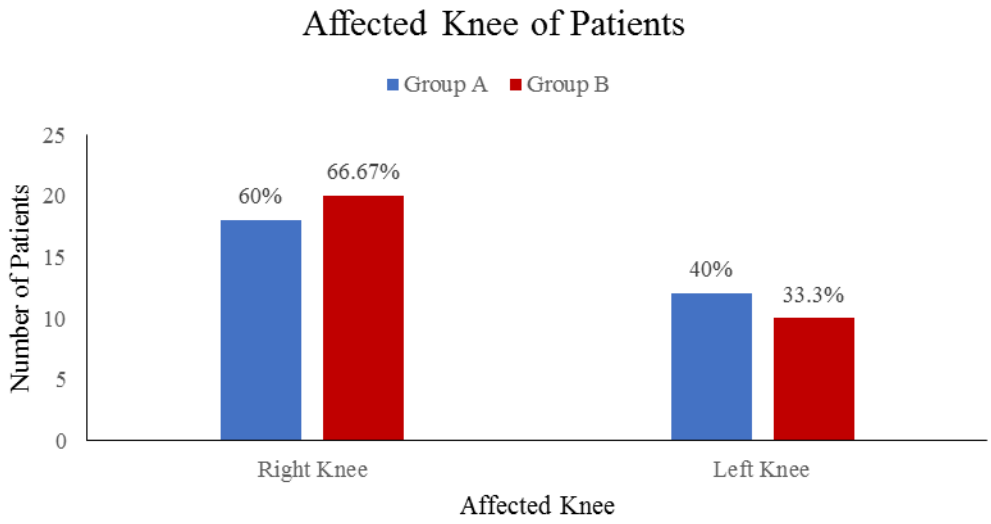

Figure 8: Distribution of affected Knees in both Group.

(Greater frequency of right knee joint pain was reported compared to left knee joint pain suggesting right knee pain was more prevalent among participants of the research)

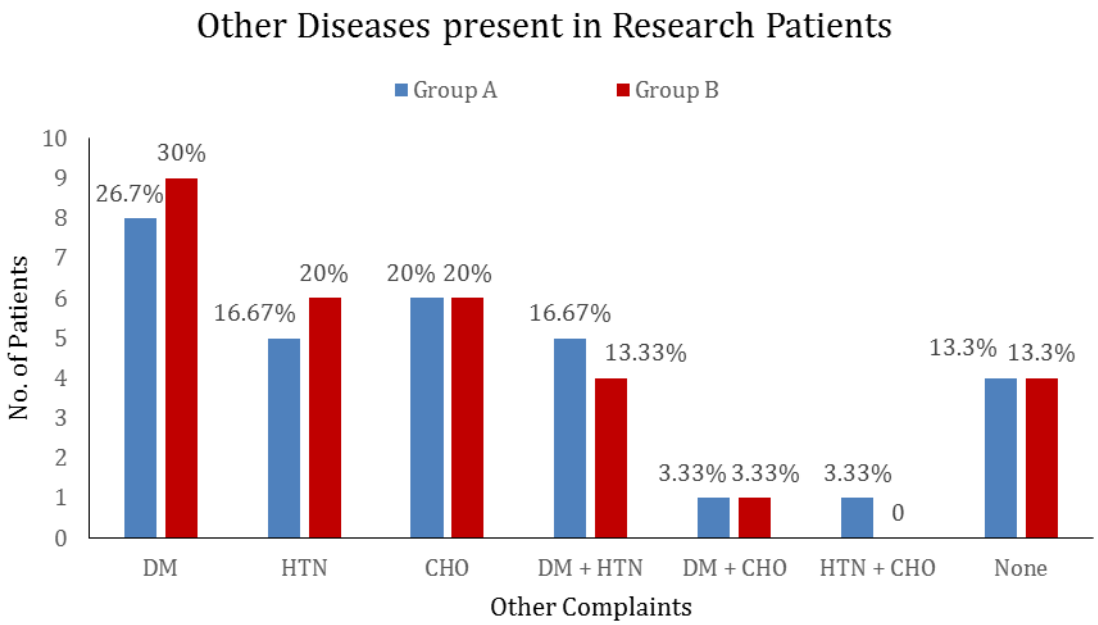

Figure 9: Other diseases present in Research Patients.

(Both Group A and positive control groups displayed comparable patterns in the prevalence of other diseases, with DM being the most frequently reported condition. Consistent distribution of these conditions suggests that they are unlikely to significantly influence the primary study outcomes).

Anthropometric Analysis

Weight, height of patients was recorded to test the effect of treatment in maintenance of Body Mass Index (BMI). BMI values were assessed before and after treatment in both groups. Comparison of pre and post treatment BMI values allowed to determine the potential impact of the treatment protocols on overall patient health and weight management.

- Paired Sample T-Test was carried out to check if the changes in BMI within each group (test and control) are statistically significant.
- Independent Samples T-Test was performed to compare the mean changes in BMI between the test and control groups, (BMI after treatment - BMI before treatment).

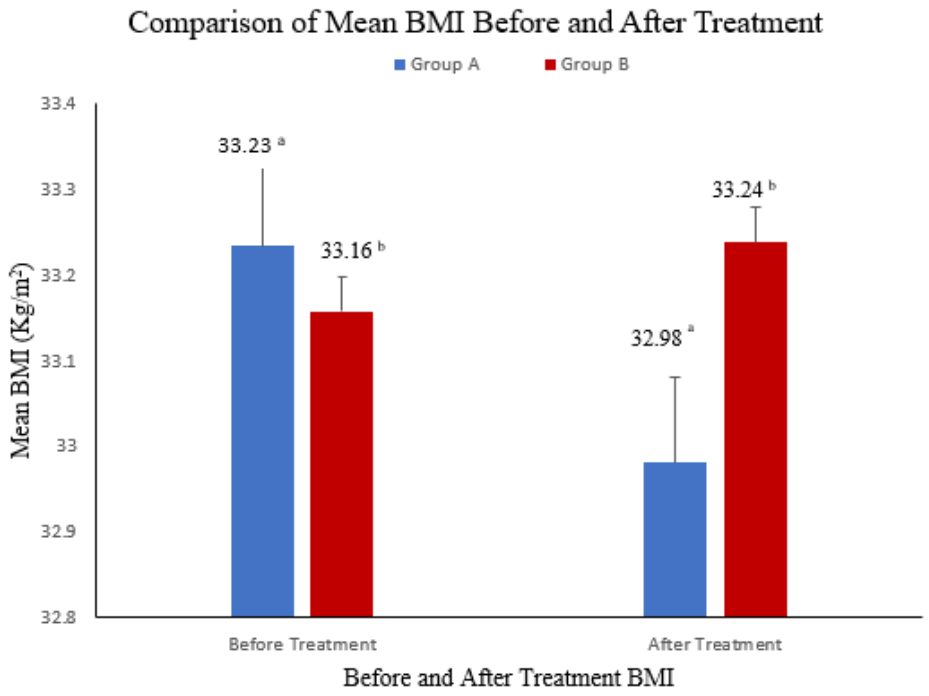

Figure 10: Comparison of mean BMI of both groups Before and After Treatment.

(Both groups showed minimal, non-significant changes in mean BMI ($p > 0.05$), indicating stable body weight during the study period. This suggests that the observed clinical improvements were independent of BMI changes.)

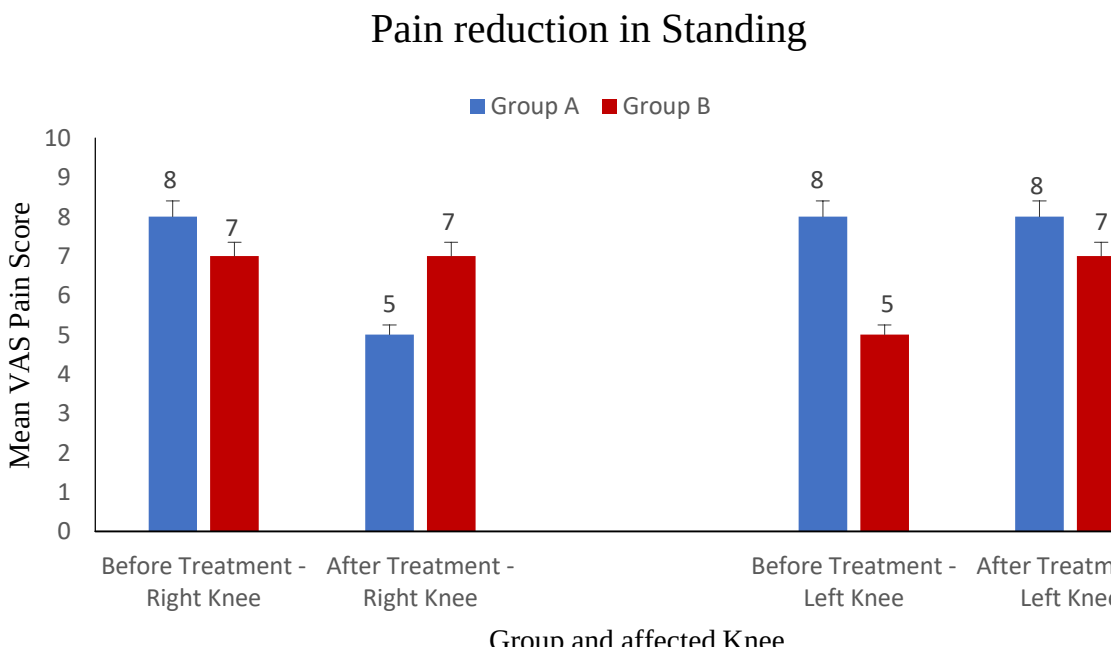

Figure 11: Pain reduction in Standing for Right and Left knees Before and After Treatment.

(The alternative hypothesis (1H1) proposes that BS and DL are effective in managing KOA-related pain, with the test group demonstrating greater efficacy than the control treatment.)

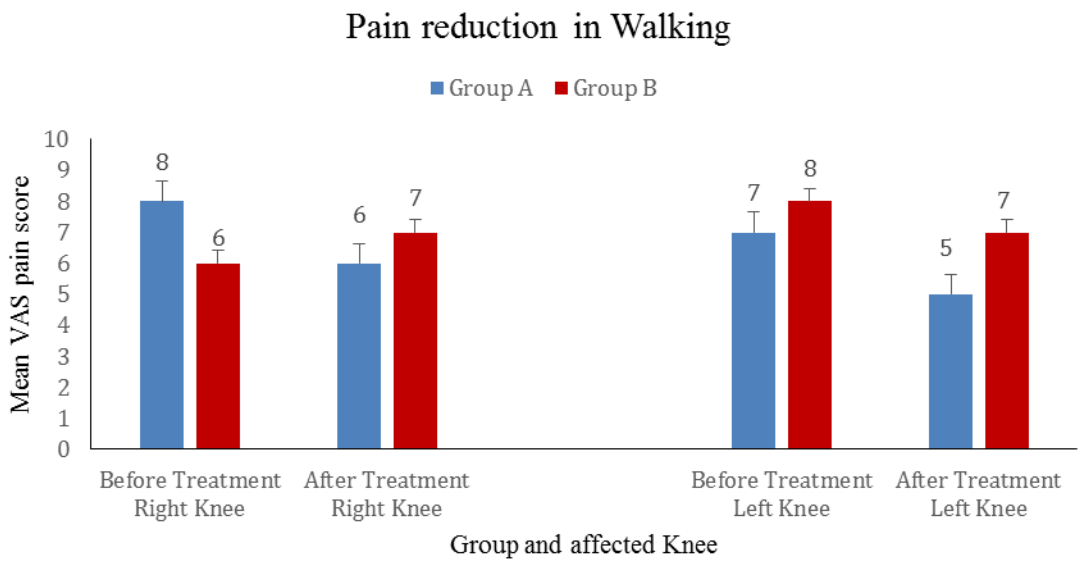

Figure 12: Pain reduction in Walking for Right and Left knees Before and After Treatment.

(Group A showed a reduction in pain during walking in both right and left knees, whereas the control group showed a mixed response. However, the observed changes were statistically significant ($p > 0.05$).

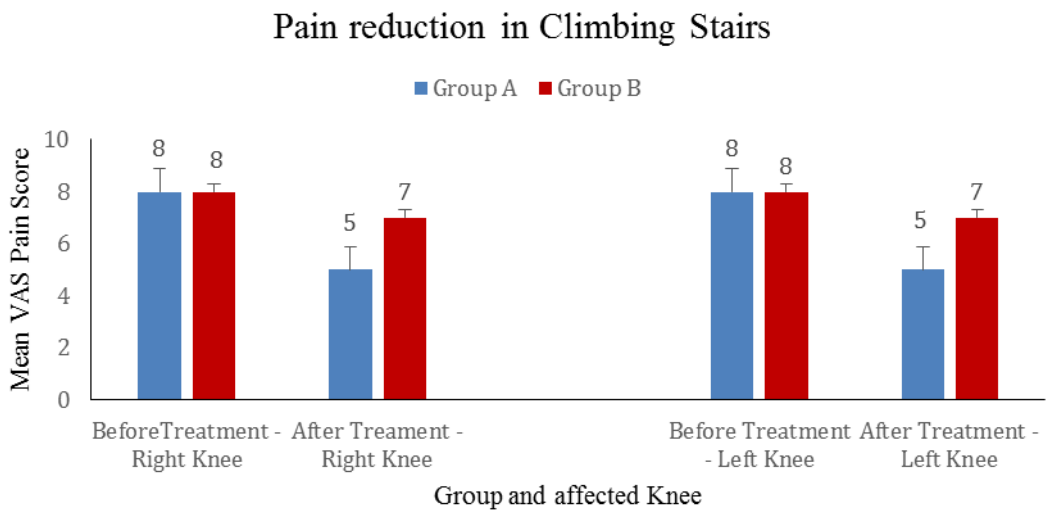

Figure 13: Pain reduction in Climbing Stairs for Right and Left knees Before and After Treatment.

(Results support 1H1 and 2H1, indicating that the treatment protocol in Group A was more effective and resulted in a significantly greater reduction in pain during stair climbing compared to Group B.)

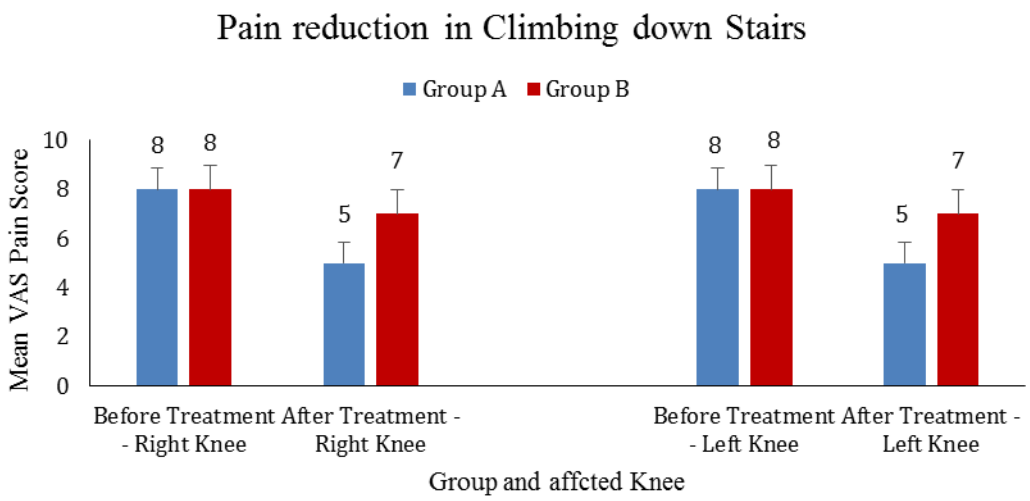

Figure 14: Pain reduction in Climbing down Stairs for Right and Left knees Before and After Treatment.

(Results support 1H1, indicating that treatment protocol in Group A was significantly more effective in reducing pain during climbing down stairs compared to Group B.)

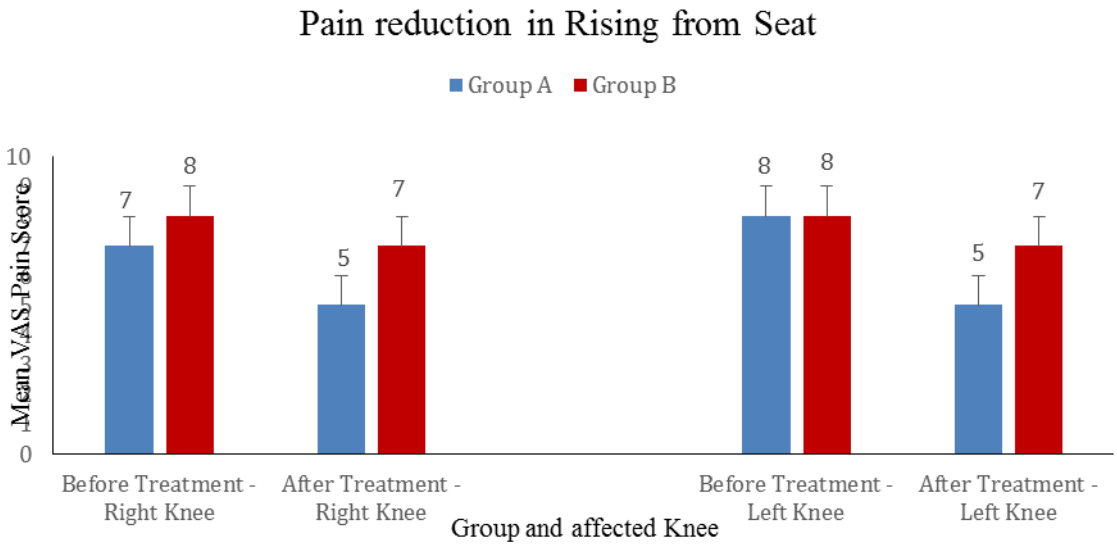

Figure 15: Pain reduction in Rising from Seat for Right and Left knees Before and After Treatment.

(Findings support 1H1, ($p < 0.05$). indicating that the treatment protocol in the Group A was

significantly more effective and suggests that the treatment has a strong impact on managing KOA during rising from seat)

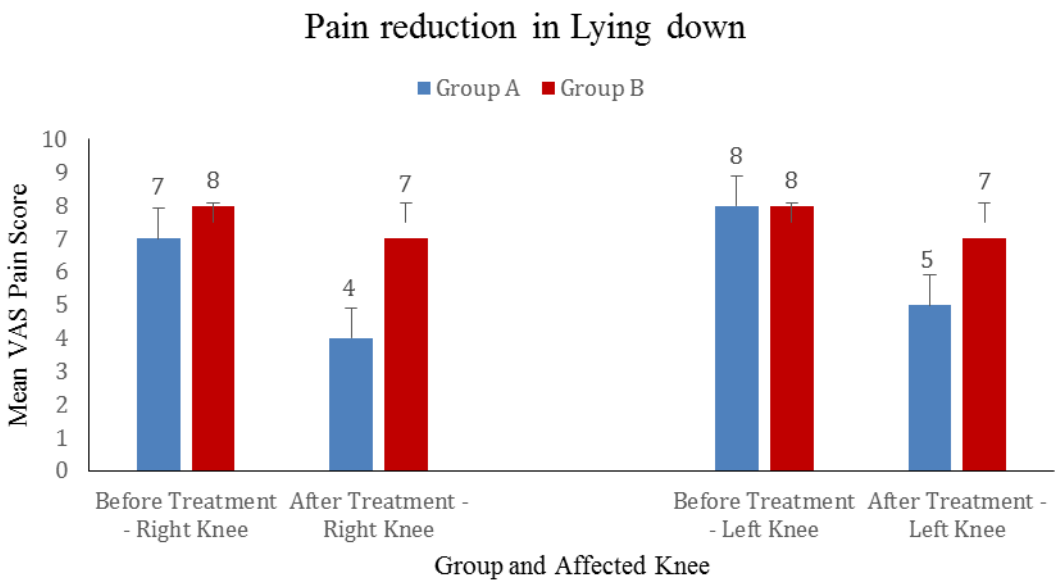

Figure 16: Pain reduction in Lying down for Right and Left knees Before and After Treatment.

(Bars represent Mean ± SD (n = 30). Both groups showed significant pain reduction ($p < 0.05$), with greater improvement in the test group. These findings support the effectiveness of BS and DL in managing KOA, consistent with Hypothesis 1H1.)

CONCLUSION ON PAIN REDUCTION

Significant pain reduction was observed in both the test and positive control groups across all six assessed activities (standing, walking, climbing stairs, climbing down stairs, rising from a seat, and lying down) following treatment. However, the test group (BS and DL) demonstrated comparatively greater improvement than the control group (*Dashamul kvātha* and *Shūlahara thailaya*). These results support both 1H1 and 2H1, confirming the effectiveness of the test treatment and its superiority in managing Knee Osteoarthritis (KOA).

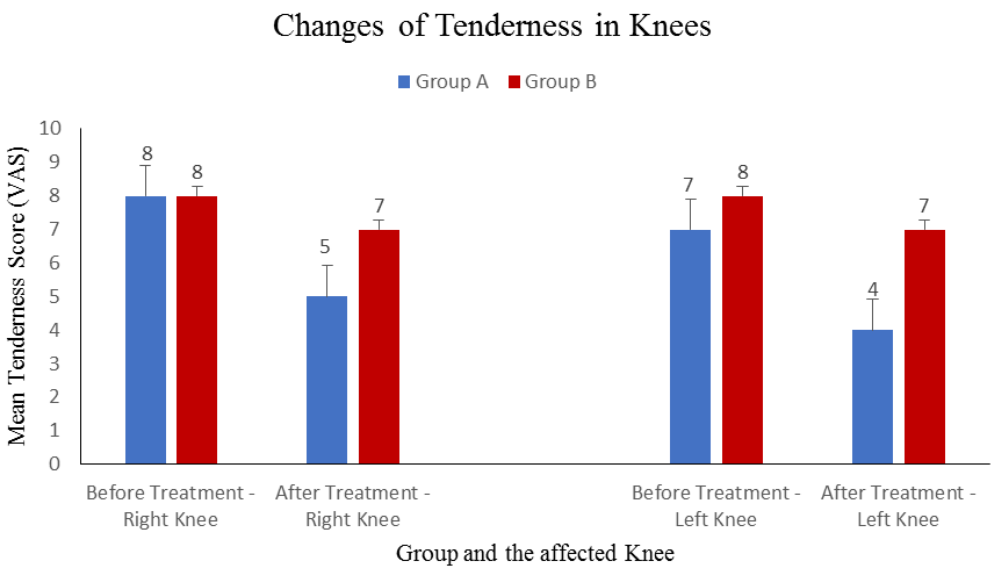

Figure 17: Tenderness reduction for Right and Left knees Before and After Treatment.

(Significant reduction in tenderness (VAS) was observed in both knees of the test group ($p < 0.05$), with comparatively smaller improvements in the positive control group. These results indicate that the treatment effectively reduces knee tenderness in KOA, supporting Hypothesis 1H1.)

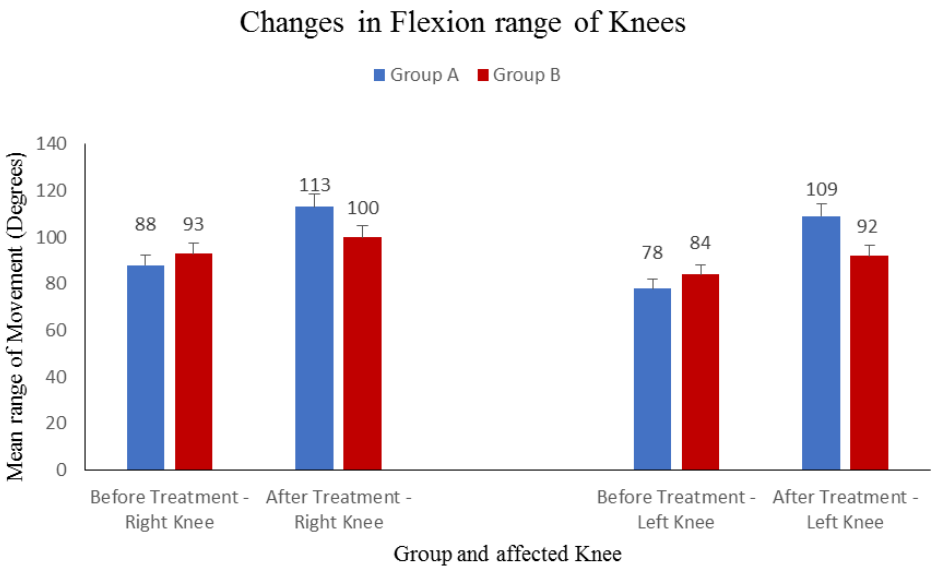

Figure 18: Comparison of Flexion range Before and After Treatment.

(Both groups showed improvement in range of motion, with Group A demonstrating significantly greater enhancement ($p < 0.05$). This indicates superior effectiveness of Group A treatment in improving knee flexion.)

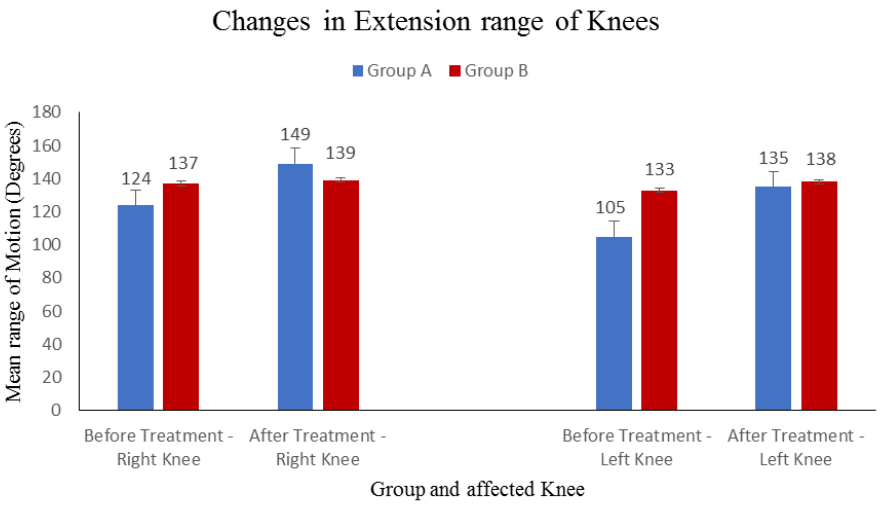

Figure 19: Comparison of Extension range Before and After Treatment.

(Group A showed a substantial improvement in left knee extension (35°), compared to a minor increase in Group B (5°). These results indicate that the test treatment was more effective in enhancing knee extension, with significant differences between groups ($p < 0.05$).

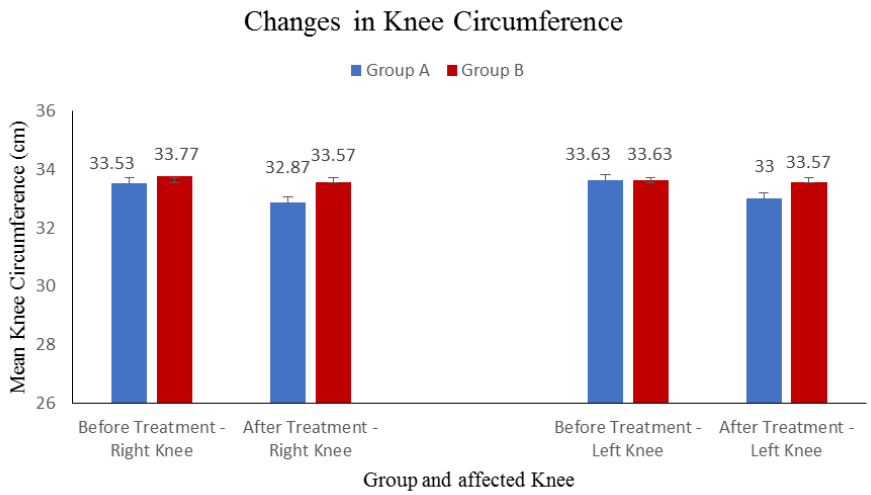

Figure 20: Changes in Knee Circumference Before and After Treatment.

(Group A showed a notable reduction in knee circumference (33.53 cm to 32.87 cm), while Group B had minimal change (33.77 cm to 33.57 cm). This indicates that the treatment in Group A was more effective in reducing knee swelling.)

The test group showed a significant reduction in knee circumference (33.63 cm to 33.00 cm, $p < 0.05$), while the positive control group exhibited minimal change (33.63 cm to 33.57 cm), indicating greater effectiveness of the test treatment in reducing swelling.

Joint Stiffness was a commonly reported symptom in participants with KOA. A non-parametric test, the Wilcoxon Signed Rank Test, was used for analyzing stiffness because non-parametric methods do not assume that the data follows a normal distribution.

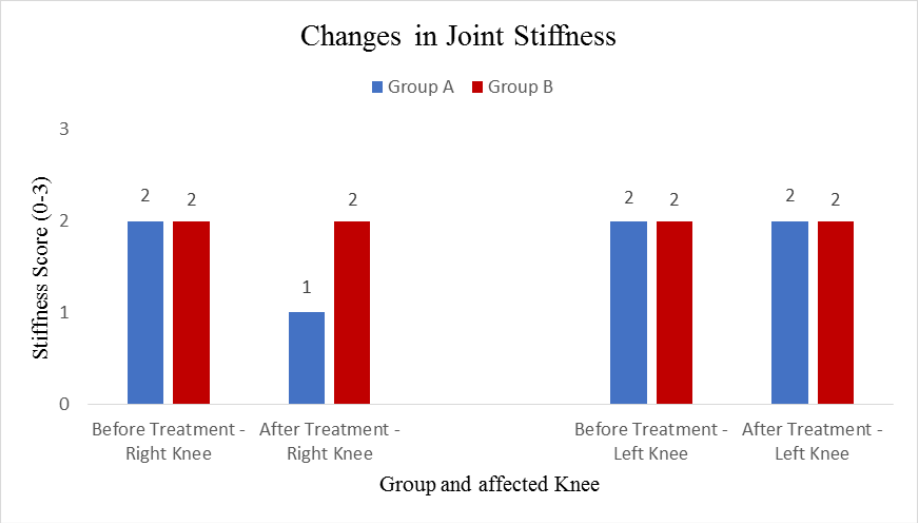

Figure 21: Changes in Joint Stiffness Before and After Treatment.

(Both groups showed significant improvement in stiffness after two weeks, with the treatment group showing a stronger level of statistical significance.)

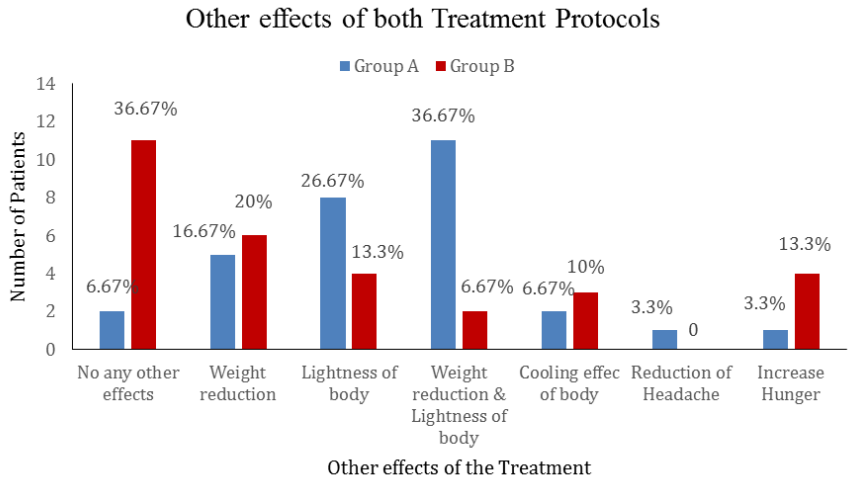

Figure 22: Distribution of other effects of both Treatment Protocols.

(Group A mainly reported weight reduction and lightness (36.7%), with minor side effects. Group B mostly reported no effect (36.7%), indicating greater positive outcomes in Group A).

DISCUSSION

Knee Osteoarthritis (KOA) is a common degenerative joint disease, especially in women over 50, characterized by pain, stiffness, swelling, crepitus, and reduced knee movement. It can be primary, due to age-related cartilage degeneration, or secondary, resulting from abnormal joint stress or conditions like rheumatoid arthritis. Risk factors include age, female gender, obesity, prior injuries, genetics, and metabolic disorders. Pathophysiology involves cartilage breakdown, bone remodeling, and joint space loss. Diagnosis combines medical history, physical examination, and imaging, with lab tests to rule out other conditions. Ayurvedic management includes therapies like *Abhyanga*, *Svēdana*, *Vasthi*, and medicinal formulations (*Kashāya*, *Guli*, *Kalka*, *Thaila*) to reduce *Vāta* vitiation, alleviate symptoms, and improve joint function. This study evaluated the efficacy of two Ayurvedic treatment protocols for KOA.

Pharmacological Aspect

Balāsahacarādi kashāya (BS) is an Ayurvedic decoction composed of *Sida cordifolia* (*Balā*) roots, *Barleria prionitis* (*Katukarōsana*) stems, *Ricinus communis* (*Ēranda*) stems, and *Zingiber officinale* (*Shunti*) rhizome. It primarily targets *Vāta* and *Kapha doshas* to alleviate pain and swelling associated with KOA. *Dashāngalēpaya* (DL) is a ten-ingredient poultice comprising *Albizia lebbeck* (*Shīreesha*) bark, *Glycyrrhiza glabra* (*Yashti*) roots, *Valeriana wallichi* (*Anatha*) leaves, *Pterocarpus santalinus* (*Chandana*) bark, *Elettaria cardamomum* (*Ēlā*) seeds, *Nardostachys jatamansi* (*Mānshi*) stem, *Curcuma longa* (*Haridrā*) rhizome, *Berberis aristata* (*Dāruharidrā*) stem, *Saussurea lappa* (*Kushta*) bark, and *Vetiveria zizanioides* (*Vālā*) roots, applied as a mild warm *Upanāha svēda* to reduce edema and nourish cartilage, often combined with *Tamarindus indica* L. juice and ghee and in this research ghee (*Sarpi*) was used.

Pharmacological analysis shows that BS ingredients are predominantly bitter/pungent (*Thiktha/Katu*), unctuous (*Snigdha*), and hot in potency (*Ushna veerya*), targeting pain and swelling via pacifying *Vāta* and *Kapha*. Evidence from systematic reviews and experimental studies supports the anti-inflammatory, analgesic, antioxidant, and cartilage-nourishing properties of key ingredients. DL ingredients, including *Albizia lebbeck, Glycyrrhiza glabra, Elettaria cardamomum*, and *Curcuma longa*, are documented to reduce inflammation, oxidative stress, and edema, while experimental evidence highlights the therapeutic potential of the remaining components. Together, BS and DL exhibit complementary anti-

inflammatory, analgesic, antioxidant, and swelling-reducing effects, addressing the pain, edema, and joint dysfunction characteristic of KOA, reflecting Ayurvedic principles of restoring *dōsha* balance and improving joint health.

Pharmacological Properties and Mechanism of Action

The therapeutic effects of Protocol 1 (*Balāsahacarādi kashāya* [BS] + *Dashāngalēpaya* [DL]) in KOA are mediated through anti-inflammatory, analgesic, antioxidant, and anti-oedema mechanisms.

- Anti-inflammatory: BS, particularly *Balā* (*Sida cordifolia*), inhibits prostaglandins, COX enzymes, and TNF-α, reducing systemic inflammation, while DL herbs provide local relief by suppressing COX-2 and pro-inflammatory cytokines.
- Analgesic: BS modulates pain pathways via opioid receptor activity. DL ingredients—including *Albizia lebbeck*, *Curcuma longa* (Turmeric), *Nardostachys jatamansi* (*Jatamansi*), *Pterocarpus santalinus* (Sandalwood), *Valeriana wallichi* (*Thvaralā*), and *Elettaria cardamomum* (*Ēlā*) offer potent analgesic effects, soothe inflamed tissues, and calm nociceptive signaling.
- Antioxidant: BS and DL components, especially *Balā*, *Curcuma longa*, and *Jatamansi*, scavenge free radicals and protect cells from oxidative damage, reducing joint degeneration and pain.
- Anti-swelling / Anti-oedema: BS promotes lymphatic drainage and fluid balance, while DL ingredients, including Turmeric and *Albizia lebbeck*, reduce edema through anti-inflammatory and diuretic actions, enhancing joint mobility.

The combined systemic and topical effects of Protocol 1 resulted in significantly greater reductions in pain, improved range of motion, and decreased swelling compared to Protocol 2, demonstrating a synergistic and targeted pharmacological approach to KOA management.

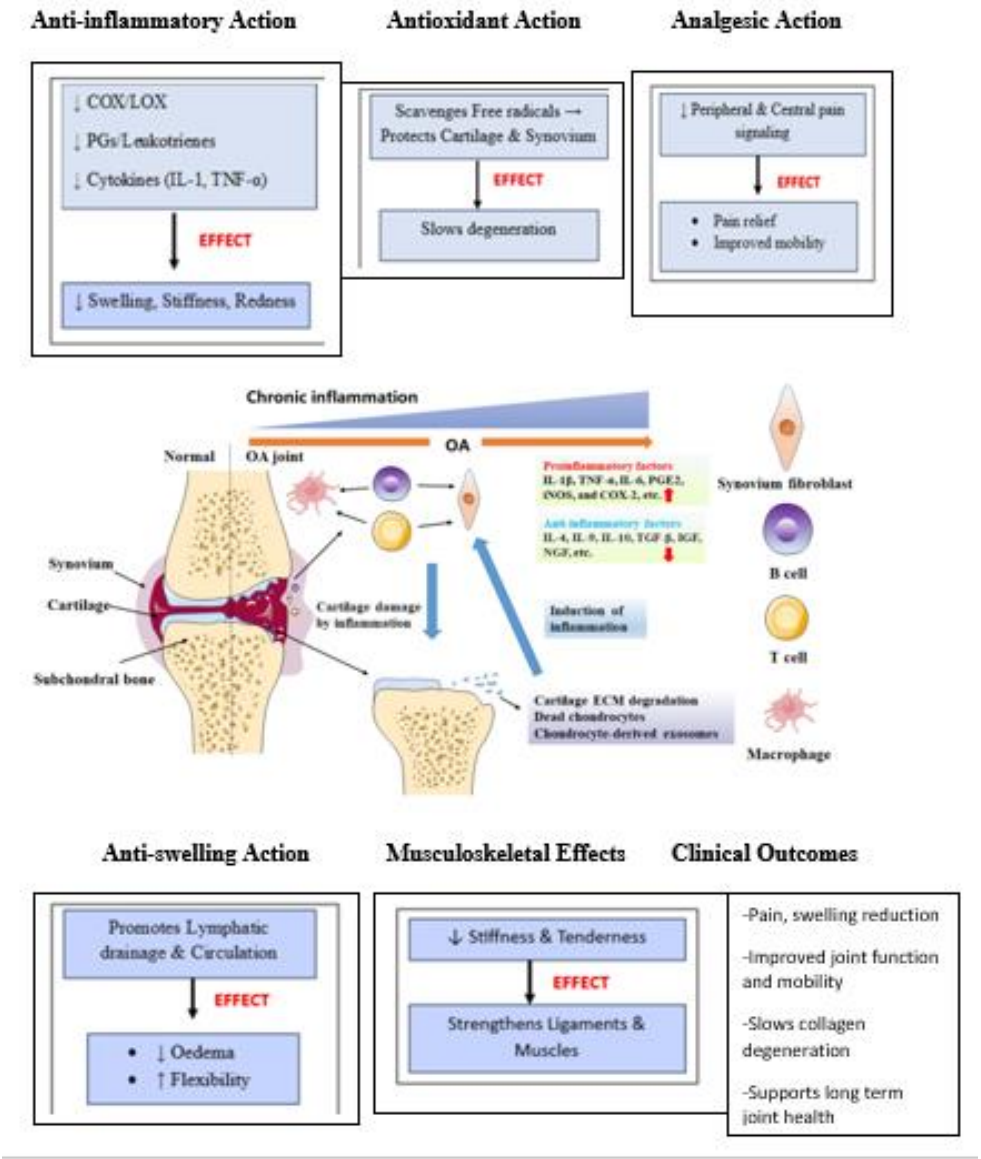

Figure 23: Pharmacological Mechanisms of BS & DL on KOA.

Comparative Analysis of Treatment Protocols

Protocol 1 (BS + DL) was more effective than Protocol 2 in reducing pain and improving joint function, with significant VAS improvements during activities such as standing, walking, and climbing stairs ($p < 0.05$). Enhanced range of motion was observed in Protocol 1, likely due to combined anti-inflammatory, analgesic, and circulatory effects of BS and DL. Edema reduction was also greater, improving mobility and comfort. Tenderness decreased more in Protocol 1, while crepitus remained largely unchanged, reflecting its association with structural joint changes. Patients in Protocol 1 additionally reported improved energy and body lightness, suggesting broader benefits for overall quality of life.

CONCLUSION

Knee Osteoarthritis (KOA) remains a pervasive public health concern, affecting millions globally. This degenerative joint disease is characterized by chronic pain, inflammation, and reduced mobility, which progressively diminishes the quality of life for affected individuals. Pharmacological treatments, though widely used, often come with limitations such as adverse side effects, high costs, and complications. As a result, there is a growing interest in exploring alternative therapeutic approaches, especially those rooted in traditional medicine systems like Ayurveda, which offer a holistic framework for managing chronic conditions like KOA. This study evaluated the efficacy of two Ayurvedic treatment protocols: *Balāsahacharādi kashāya* and *Dashāngalēpaya*, focusing on their impact on key clinical parameters such as pain, tenderness, range of motion (ROM), crepitus, and oedema. By comparing these protocols against a control group, this research aimed to determine which treatment was more effective in managing KOA symptoms and enhancing patients' quality of life.

Pharmacological Mechanisms of Action - The superior efficacy of the Ayurvedic treatment protocol combining *Balāsahacharādi kashāya* (BS) and *Dashāngalēpaya* (DL) is largely attributed to the pharmacological properties of its ingredients. BS, containing *Sida cordifolia*, *Barleria prionitis*, *Ricinus communis*, and *Zingiber officinale*, exhibits systemic anti-inflammatory, analgesic, and antioxidant effects, targeting *Vāta* and *Kapha doshas* to reduce pain, swelling, and oxidative stress. DL, comprising *Albizia lebbeck*, *Glycyrrhiza glabra*, *Valeriana wallichi*, *Pterocarpus santalinus*, *Elettaria cardamomum*, *Nardostachys jatamansi*, *Curcuma longa*, *Berberis aristata*, *Saussurea lappa*, and *Vetiveria zizanioides*, provides localized anti-inflammatory, analgesic, and anti-oedema effects through *Upanāha svēda* (mild warm poultice), enhancing circulation and lymphatic drainage. The combination of systemic internal therapy and targeted external application created a synergistic effect, addressing both underlying inflammatory mechanisms and symptomatic joint dysfunction in KOA. This multi-modal pharmacological approach aligns with Ayurvedic principles of pacifying vitiated *dōshas* while nourishing cartilage and improving joint health.

Pain, Stiffness Reduction, and Improved Mobility - Pain, the most debilitating symptom of KOA, was significantly reduced in participants receiving Protocol 1. Visual Analog Scale (VAS) assessments indicated substantial improvement during functional activities such as standing, walking, and climbing stairs ($p < 0.05$). Components of BS, including *Sida*

cordifolia, *Ricinus communis*, and *Berberis aristata*, modulate nociceptive pathways and reduce pain perception, while DL ingredients such as *Albizia lebbeck*, *Curcuma longa*, and *Nardostachys jatamansi* provided localized analgesic and anti-inflammatory effects. Stiffness reduction facilitated improved joint flexibility and movement, likely due to enhanced blood flow, reduced edema, and loosening of tissue congestion, enabling participants to perform daily activities with greater ease and comfort.

Tenderness and Range of Motion - Tenderness, a direct indicator of inflammation and joint sensitivity, was significantly alleviated in Protocol 1 participants, reflecting effective anti-inflammatory action. The internal administration of BS reduced systemic inflammation, while the external application of DL targeted localized joint tissues. Improved range of motion (ROM) was observed in both flexion and extension of the knees, with Protocol 1 participants showing greater enhancement than the control group. Herbs such as *Jatamansi* and Turmeric contributed to improved joint mobility by reducing pain sensitivity, protecting cartilage, and mitigating oxidative stress, thus facilitating functional recovery and improving overall quality of life.

Crepitus and Oedema Reduction - Crepitus, indicative of long-term cartilage deterioration, remained relatively unchanged in both groups, highlighting its association with structural joint changes less responsive to short-term interventions. In contrast, oedema showed significant reduction in the test group, attributed to systemic anti-inflammatory effects of BS (notably *Sida cordifolia* and *Barleria prionitis*) and the localized diuretic and anti-swelling properties of DL ingredients such as *Albizia lebbeck* and Curcuma longa. Reduction of joint swelling contributed to enhanced mobility, decreased discomfort, and improved joint function, reflecting the combined efficacy of internal and external treatments in addressing both symptoms and underlying inflammatory processes.

Overview on Clinical Analysis - Overall, Protocol 1 demonstrated superior clinical efficacy compared to the control, as evidenced by significant improvements in pain, tenderness, range of motion, and edema ($p < 0.05$). Participants also reported holistic benefits, including enhanced energy, body lightness, and overall well-being, suggesting that Ayurvedic therapy positively impacts both physical function and quality of life. These findings support the potential integration of Ayurvedic treatments as a safe, effective, and complementary approach in KOA management, offering an alternative to conventional pharmacological therapies, which often carry risks of side effects and limited long-term efficacy.

Limitations

Despite the robust results, the study was limited by the short duration and relatively small sample size, which may restrict generalizability. Extended studies with larger cohorts and longer follow-up periods, incorporating imaging techniques such as X-rays or MRI, would provide further insights into structural joint changes and long-term effectiveness. Future research should also explore biochemical markers of inflammation and cartilage metabolism to strengthen the mechanistic understanding of Ayurvedic interventions in KOA.

Recommendations

Future studies should investigate the long-term effects of these Ayurvedic treatments on joint health, incorporating advanced pharmacological analyses such as pH testing, moisture content, microscopic evaluation, HPTLC, and DNA-based authentication to ensure preparation quality and consistency. Toxicological assessments are recommended to evaluate safety over prolonged use. Integrating radiological techniques, including X-rays and MRIs, would provide valuable insights into cartilage regeneration and joint structural changes, enabling a more comprehensive understanding of the clinical and molecular mechanisms underlying these therapies.

In conclusion, the combination of *Balāsahacharādi kashāya* and *Dashāngalēpaya* offers a holistic, evidence-based, and effective approach for managing KOA. By addressing pain, tenderness, stiffness, and edema through synergistic pharmacological mechanisms, this protocol enhances joint function and overall quality of life, validating the potential of Ayurvedic medicine as a valuable adjunct or alternative to conventional treatment strategies in degenerative joint disorders.

REFERENCES

1. Palazzo C, Nguyen C, Lefevre-Colau MM, Rannou F, and Poiraudeau S. (2016). Risk factors and burden of osteoarthritis. Ann Phys Rehabil Med. https://pubmed.ncbi.nlm.nih.gov/26904959/
2. Center for Disease Control and Prevention. (2020). Osteoarthritis (OA) | Arthritis | CDC. https://www.cdc.gov/arthritis/basics/osteoarthritis.htm
3. Neogi, T. (2014). The Epidemiology and impact of pain in Osteoarthritis. HHS Public access. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3753584/
4. Shen, J., and Chen, D. (2014). Recent progress in Osteoarthritis research. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4124725/

5. Hettihewa, A. P., Gunawardena, N. S., Athukorala, I., Hassan, F., Lekamge, I. N. and Hunter, D. J. Prevalence of knee osteoarthritis in a suburban, Srilankan, adult female population: a population-based study. International Journal of Rheumatic Diseases, 2017; 21(2): 394-401. https://onlinelibrary.wiley.com/doi/10.1111/1756-185X.13225
6. Malemud, C. (2015). Biologic basis of osteoarthritis: state of the evidence. https://pubmed.ncbi.nlm.nih.gov/25784380/
7. Singhal, G. D. (2005). Susrutha Samhithā, Ancient Indian Surgery, Chaukhamba Sanskrit Prathishtham, Delhi, Nidāna sthāna - Sandhigatha vātha lakshana - 1/27.
8. Murthy, S. K. R. (2008). Vāghbata's Ashtāngahrdayam - Chikithsā sthāna (Vol. 2). Chowkhamba Krishnadas Academy - Varanasi, India.
9. Kumarasinghe, A. (1991). Charaka Samhithā - Sinhala translation. Department of Ayurveda – Sri Lanka, Chikithsā sthāna - Sandhigatha vātha samprāpthi - 28/37.
10. Chandra, S. R., and Aryadasa, K. (1984). Vaidyaka Sarasankshepaya (1st ed., Vol. 1). Department of Ayurveda-Sri Lanka.
11. Dasji, S. G. (2017). Bhaisajyarathnavali (Reprint ed., Vol. 03). Chaukhambha Sanskrit Sansthan - Varanasi, India.
12. Hawker, G. A., Mian, S., Kendszerska, T., and French, M. (2011). Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-. Arthritis Care Res (Hoboken). https://pubmed.ncbi.nlm.nih.gov/22588748/
13. Yu, S. P., and Hunter, D. J. (2015). Managing osteoarthritis. Australian Prescriber. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4653978/
14. Buckwalter, J., and Mankin, H. (2019). Articular cartilage: degeneration and osteoarthritis, repair, regeneration, and transplantation. https://pubmed.ncbi.nlm.nih.gov/9571450/
15. Rovati, L. C., Gregori, D., Giacovelli, G., Minto, C., Barbetta, B., Gualtieri, F., Azzolina, D., and Vaghi, P. (2018, December 21). Association of Pharmacological Treatments with Long-term Pain Control in Patients With Knee Osteoarthritis: A Systematic Review and Meta-analysis. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6583519/
16. Verma, V., and Chandra, N. (2014, October 30). Biochemical and Ultrastructural Changes in Sida cordifolia L. and Catharanthus roseus L. to Auto Pollution. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4897458/

17. Shantha, T. R., Pattanshetty, J. K., and Gopakumar, K. (1988, June 7). Pharmacognostical studies on the root of sahachara nilgirianthus heyneanus (nees) bremek – (Acanthaceae). NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3336645/
18. Su, B.-W., Lin, W.-C., Lin, L.-J., Huang, C.-M., Chuang, W.-Y., Wu, D.-J., Shih, C.-H., and Lee, T.-T. (2020, October 25). Laying diet supplementation with Ricinus communis L. leaves and Evaluation of Productive Performance and Potential Modulation of Antioxidative Status. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7596032/
19. Yeboah, A., Lu, J., Gu, S., Liu, H., Shi, Y., Amoanimaa-Dede, H., Agyenim-Boateng, K. G., Payne, J., and Yin, X. (2021, June 17). Evaluation of two wild castor (Ricinus communis L.) accessions for cadmium tolerance in relation to antioxidant systems and lipid peroxidation. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8494669/
20. Ziaei, A., Sahranavard, S., Gharagozlou, M. J., and Faizi, M. (2016, May 3). Preliminary investigation of the effects of topical mixture of Lawsonia inermis L. and Ricinus communis L. leaves extract in treatment of osteoarthritis using MIA model in rats. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4855329/
21. Mao, Q.-Q., Xu, X.-Y., Cao, S.-Y., Gan, R.-Y., Corke, H., Beta, T., and Li, H.-B. (2019, May 30). Bioactive Compounds and Bioactivities of Ginger (Zingiber officinale Roscoe). NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6616534/
22. Bischoff-Kont, I., and Fürst, R. (2021, June 15). Benefits of Ginger and Its Constituent 6-Shogaol in Inhibiting Inflammatory Processes. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8232759/
23. Hazra, S. K., Sarkar, T., Salauddin, M., Sheikh, H. I., Pati, S., and Chakraborty, R. (2020, October 30). Characterization of phytochemicals, minerals and in vitro medicinal activities of bael (Aegle marmelos L.) pulp and differently dried edible leathers. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7610326/
24. Rajaram, A., Vanaja, G. R., Vyakaranam, P., Rachamallu, A., Reddy, G. V., Anilkumar, K., Arunasree, K. M., Dhyani, A., Prasad, N. K., Sharma, S., Joshi, M. C., Kimoth, G. P., Brindavanam, N. B., and Reddanna, P. (2017, November 26). Anti-inflammatory profile of Aegle marmelos (L) Correa (Bilva) with special reference to young roots grown in different parts of India. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6034160/
25. Rastegari, A., Manayi, A., Akbarzadeh, T., Hojjatifard, R., Samadi, N., Khanavi, M., Niknam, S., and Saeedi, M. (2023, April 7). Cedrus deodara: In Vivo Investigation of Burn Wound Healing Properties. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10104737/

26. Khan, A., Naz, S., Farooq, U., Shahid, M., Ullah, I., Ali, I., Rauf, A., and Mabkhot, Y. N. (2017, December 28). Bioactive chromone constituents from Vitex negundo alleviate pain and inflammation. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5749391/
27. Saklani, S., Mishra, A. P., Chandra, H., Atanassova, M. S., Stankovic, M., Sati, B., Shariati, M. A., Nigam, M., Khan, M. U., Plygun, S., Elmsellem, H., and Suleria, H. A. R. (2017, September 27). Comparative evaluation of Polyphenol contents and Antioxidant activities between Ethanol extracts of Vitex negundo and Vitex trifolia L. leaves by different methods. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750621/
28. Choi, I. S., Cha, H. S., and Lee, Y. S. (2014, October 20). Physicochemical and Antioxidant Properties of Black Garlic. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6270986/
29. Huang, L., Liu, Z., Wang, J., Fu, J., Jia, Y., Ji, L., and Wang, T. (2023, February 7). Bioactivity and health effects of garlic essential oil: A review. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10261769/
30. Shang, A., Cao, S.-Y., Xu, X.-Y., Gan, R.-Y., Tang, G.-Y., Corke, H., Mavumengwana, V., and Li, H.-B. (2019, July 5). Bioactive Compounds and Biological Functions of Garlic (Allium sativum L.). NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6678835/
31. Saleem, U., Raza, Z., Anwar, F., Ahmad, B., Hira, S., and Ali, T. (2019, May 21). Experimental and Computational Studies to Characterize and Evaluate the Therapeutic Effect of Albizia lebbeck (L.) Seeds in Alzheimer's Disease. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6572470 /
32. Batiha, G. E.-S., Beshbishy, A. M., El-Mleeh, A., Abdel-Daim, M. M., and Devkota, H. P. (2020, February 25). Traditional Uses, Bioactive Chemical Constituents, and Pharmacological and Toxicological Activities of Glycyrrhiza glabra L. (Fabaceae). NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7175350/
33. Frattaruolo, L., Carullo, G., Brindisi, M., Mazzotta, S., Bellissimo, L., Rago, V., Curcio, R., Dolce, V., Aiello, F., and Cappello, A. R. (2019, June 20). Antioxidant and Anti-Inflammatory Activities of Flavanones from Glycyrrhiza glabra L. (licorice) Leaf Phytocomplexes: Identification of Licoflavanone as a Modulator of NF-kB/MAPK Pathway. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6616548/
34. Gu, R.-R., Meng, X.-H., Zhang, Y., Xu, H.-Y., Zhan, L., Gao, Z.-B., Yang, J.-L., and Zheng, Y.-M. (2022, March 7). (−)-Naringenin 4′,7-dimethyl Ether isolated from

Nardostachys jatamansi relieves pain through inhibition of multiple channels. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8911579/

35. Pandey, M. M., Katara, A., Pandey, G., Rastogi, S., and Rawat, A. K. S. (2013, February 7). An Important Indian Traditional Drug of Ayurveda Jatamansi and Its Substitute Bhootkeshi: Chemical Profiling and Antioxidant Activity. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3618914/
36. Bulle, S., Reddyvari, H., Nallanchakravarthula, V., and Vaddi, D. R. (2016). Therapeutic Potential of Pterocarpus santalinus L.: An Update. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4791987/
37. Natalia, P., Zwirchmayr, J., Rudžionytė, I., Pulsinger, A., Breuss, J. M., Uhrin, P., Rollinger, J. M., and de Martin, R. (2022, January 18). Pterocarpus santalinus selectively inhibits a subset of Pro-Inflammatory Genes in Interleukin-1 stimulated endothelial cells. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8804362/
38. Delgadillo-Puga, C., Torre-Villalvazo, I., Cariño-Cervantes, Y. Y., García-Luna, C., Soberanes-Chávez, P., de Gortari, P., Noriega, L. G., Bautista, C. J., and Cisneros-Zevallos, L. (2023, February 15). Cardamom (Elettaria cardamomum (L.) Maton) Seeds Intake Increases Energy Expenditure and Reduces Fat Mass in Mice by Modulating Neural Circuits That Regulate Adipose Tissue Lipolysis and Mitochondrial Oxidative Metabolism in Liver and Skeletal. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9960522/
39. Delgadillo-Puga, C., Torre-Villalvazo, I., Cariño-Cervantes, Y. Y., García-Luna, C., Soberanes-Chávez, P., de Gortari, P., Noriega, L. G., Bautista, C. J., and Cisneros-Zevallos, L. (2023, February 15). Cardamom (Elettaria cardamomum (L.) Maton) Seeds Intake Increases Energy Expenditure and Reduces Fat Mass in Mice by Modulating Neural Circuits That Regulate Adipose Tissue Lipolysis and Mitochondrial Oxidative Metabolism in Liver and Skeletal. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9960522/
40. Razack, S., Kumar, K. H., Nallamuthu, I., Naika, M., and Khanum, F. (2015, March 12). Antioxidant, Biomolecule oxidation protective activities of Nardostachys jatamansi DC and its Phytochemical analysis by RP-HPLC and GC-MS. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4665568/
41. Choi, Y., Ban, I., Lee, H., Baik, M.-Y., and Kim, W. (2019, October 23). Puffing as a novel process to enhance the Antioxidant and Anti-Inflammatory properties of Curcuma longa L. (Turmeric). NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6912485/

42. Kim, H., Ban, I., Choi, Y., Yu, S., Youn, S. J., Baik, M.-Y., Lee, H., and Kim, W. (2020, September 29). Puffing of Turmeric (Curcuma longa L.) Enhances its Anti-Inflammatory Effects by Upregulating Macrophage Oxidative Phosphorylation. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7600901/
43. Kim, H., Ban, I., Choi, Y., Yu, S., Youn, S. J., Baik, M.-Y., Lee, H., and Kim, W. (2020, September 29). Puffing of Turmeric (Curcuma longa L.) Enhances its Anti-Inflammatory Effects by Upregulating Macrophage Oxidative Phosphorylation. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7600901/
44. Singh, K., Srichairatanakool, S., Chewonarin, T., Prommaban, A., Samakradhamrongthai, R. S., Brennan, M. A., Brennan, C. S., and Utama-ang, N. (2022, November 14). Impact of Green Extraction on Curcuminoid Content, Antioxidant Activities and Anti-Cancer Efficiency (In Vitro) from Turmeric Rhizomes (Curcuma longa L.). Foods. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9689051/
45. Rathi, B., Sahu, J., Koul, S., and Kosha, R. L. (2013, April). Detailed pharmacognostical studies on Berberis aristata DC plant. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4078475/
46. David, A., Wang, F., Sun, X., Li, H., Lin, J., Li, P., and Deng, G. (2019, May 17) Chemical composition, Antioxidant, and Antimicrobial activities of Vetiveria zizanioides (L.) Nash essential oil extracted by Carbon Dioxide expanded Ethanol. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6572508/