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Research Article

Formulation and Evaluation of Polyherbal Syrup for the Treatment of Arthritis

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ABSTRACT:
Arthritis is a chronic inflammatory condition that significantly affects joint health, leading to pain and reduced mobility. The risk factors include age, genetics, lifestyle, and environmental exposure.The current study's goal was to use an invitro protein denaturation assay to assess a polyherbal formulation's anti-inflammatory properties. The selected herbal components—Soya Powder, Gond Powder, Maricha Churnam, Sunti (Dry Ginger), Ashwagandha Churnam, Guduchi Churnam, Honey, Mustard Oil, Vitamin E, and Shallaki (Boswellia extract)—have been traditionally used for arthritis management and are well-documented for their medicinal benefits, including anti-inflammatory, immunomodulatory, and bioavailability-enhancing properties. These herbs work through different mechanisms to combat inflammation and improve joint function. The polyherbal formulation was prepared using a hydro-alcoholic extraction process to ensure the maximum retention of bioactive compounds. Protein denaturation has been assessed by incubating the produced formulations with bovine serum albumin at various doses (100 µg/ml, 200 µg/ml, 400 µg/ml, and 800 µg/ml). The results were compared to the reference medication, diclofenac sodium, using spectrophotometry at 660 nm. The % inhibition of protein denaturation was found to increase with concentration, with the polyherbal syrup demonstrating superior efficacy compared to individual herbal extracts. Additionally, physicochemical parameters such as viscosity, pH, and stability were evaluated to ensure formulation consistency and effectiveness. The results indicate that the polyherbal syrup exhibits significant anti-inflammatory activity, supporting its potential as a natural and effective alternative for arthritis management with minimal side effects.
Key Words: Polyherbal syrup, Diclofenac sodium, Soya Powder, Gond Powder, Maricha Churnam, Sunti, Ashwagandha Churnam, Guduchi Churnam, Shallaki.

Introduction:

Arthritis is a chronic autoimmune disorder. Arthritis frequently affects two or more joints, including the tiny joints in the wrists and hands. In addition to joint pain and stiffness, arthritis patients may experience weight loss, a low-grade fever, and weariness. It produces swelling in the joints, which can lead to pain and progressive loss of function. Other joints, including the shoulders, elbows, knees, feet, and ankles, may become afflicted over time. The most typical symptoms of arthritis are morning stiffness, pain, and swelling of joints, which are often present on both sides of the body. Arthritis occurs when the immune system attacks the synovial lining of the membranes surrounding the joints, resulting in inflammation1. This thickens the synovial membrane, which can eventually destroy the cartilage and bone within the joint. The tendons and ligaments that hold the joint together weaken and stretch, causing joint deformity and ligament damage. Arthritis is a musculoskeletal disorder that follows mechanical and biological events, destabilizing the normal balance between degradation and synthesis within articular cartilage. Arthritis can affect individuals of any age but is more predominant between the ages of 25 and 50, with a peak occurrence between 40 and 50 years. Among the 100 different types of arthritis, the most common include osteoarthritis and rheumatoid arthritis, which affect 22–39% and 5% of

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the Indian population, respectively2. The worsening condition of arthritis necessitates proper therapy along with economic considerations for long-term treatment. Systematic drugs for arthritis are available in the market; however, their use is limited due to serious side effects upon chronic administration. Traditional herbal plants have been used both externally and internally for treating inflammatory conditions. The positive influence of herbal drugs in modifying the pathophysiology of arthritis has led to a substantial increase in their use as a treatment option. Although numerous drugs effectively reduce chronic joint inflammation, their therapeutic effects must be scientifically validated. This study aimed to develop and assess a polyherbal syrup incorporating natural ingredients traditionally utilized for arthritis management3. The selected components—Soya Powder, Gond Powder, Maricha Churnam, Sunti (Dry Ginger), Ashwagandha Churnam, Guduchi Churnam, Honey, Mustard Oil, Vitamin E, and Shallaki (Boswellia extract)—were chosen based on their well-documented medicinal benefits, including anti-inflammatory, immunomodulatory, and bioavailability-enhancing properties. The formulation was prepared using a hydro-alcoholic extraction process to ensure maximum retention of bioactive compounds. This paper presents a review of herbs demonstrating potential for arthritis treatment and evaluates the anti-inflammatory efficacy of a polyherbal formulation4.

2. Materials and Methods

2.1. Collection of Plant Material

The plant materials used in the study include[5] *Glycine max* (Soya powder), *Acacia gum* (Gond powder), *Piper nigrum* (Maricha Churnam), *Zingiber officinale* (Sunti), *Withania somnifera* (Ashwagandha Churnam), *Tinospora cordifolia* (Guduchi Churnam), *Apis mellifera* extract (Honey), *Brassica juncea* (Mustard oil), and *Boswellia serrata* (Shallaki extract). The samples of *Glycine max* and *Acacia gum* were procured from QIS College of Pharmacy, medicinal garden, ONGOLE. *Piper nigrum*, *Zingiber officinale*, and *Withania somnifera* were sourced from reputed Ayurvedic suppliers, while *Tinospora cordifolia* and *Boswellia serrata* extracts were obtained from herbal extraction units. The honey was collected from certified organic beekeepers, and mustard oil was sourced from a cold-pressed oil manufacturer.

2.1.1. Authentication

Morphological evaluation included color, odor, taste, size, shape, texture, and surface features. Comparative studies with standard reference materials confirmed the identity and purity of the collected plant samples.

2.1.2. Polyherbal Formulation and Photochemistry

Soya Powder (*Glycine max*) various parts of *Glycine max* are utilized for medicinal purposes. Soya powder is known for its rich nutritional profile and its ability to alleviate inflammation6. It contains bioactive compounds such as isoflavones (genistein, daidzein, and glycitein), which exhibit anti-inflammatory and antioxidant properties. Isoflavones modulate cytokine activity, helping to reduce joint inflammation and oxidative stress, making them beneficial for arthritis management.

2.1.3. Gond Powder (*Acacia gum*)

Gond powder is widely used for its medicinal benefits, particularly in joint health. It is composed of polysaccharides, glycoproteins, and arabinogalactan-proteins, which help modulate immune responses. The presence of flavonoids and phenolic compounds contributes to its antioxidant and anti-inflammatory effects, providing relief from arthritis symptoms by inhibiting inflammatory mediators.

2.1.4. Maricha Churnam (*Piper nigrum*)

Piper nigrum, is a powerful anti-inflammatory agent. The key bioactive compound, piperine, enhances bioavailability and exhibits strong anti-inflammatory and analgesic effects. Other phytochemicals such as alkaloids, flavonoids, tannins, and essential oils contribute to its efficacy in reducing joint pain and stiffness associated with arthritis.

2.1.5. Sunti (*Zingiber officinale*, Dry Ginger)

Zingiber officinale, particularly in its dried form (Sunti), is renowned for its potent anti-inflammatory properties. The primary bioactive constituents include gingerols, shogaols, paradols, and zingerone, which inhibit pro-

inflammatory cytokines and oxidative stress. It also enhances blood circulation to affected joints, reducing stiffness and improving mobility.

2.1.6. Ashwagandha Churnam (*Withania somnifera*)

Ashwagandha is an adaptogenic herb that helps combat inflammation and stress-related joint deterioration. Its key phytochemicals include withanolides, sitoindosides, flavonoids, and alkaloids, which exhibit immunomodulatory, anti-inflammatory, and cartilage-protective properties. Withanolides have been shown to suppress pro-inflammatory pathways and alleviate arthritis symptoms.

2.1.7. Guduchi Churnam (*Tinospora cordifolia*)

Tinospora cordifolia, also known as Guduchi, is a widely used herb for immune modulation and inflammation reduction. It contains alkaloids (berberine, magnoflorine, choline), diterpenoid lactones, polysaccharides, and flavonoids, which work synergistically to reduce oxidative stress, modulate immune responses, and enhance tissue regeneration in arthritic conditions.

2.1.8. Honey (*Apis mellifera* extract)

Honey has been traditionally used as a natural remedy for inflammation and wound healing. It contains polyphenols, flavonoids, amino acids, and organic acids, which exhibit strong anti-inflammatory, antimicrobial, and wound-healing properties. Honey also enhances the bioavailability of herbal components in polyherbal formulations.

2.1.9. Mustard Oil (*Brassica juncea*)

Mustard oil is commonly applied topically for joint pain relief[7-8]. It contains allyl isothiocyanate, glucosinolates, omega-3 fatty acids, selenium, and vitamin E, which help reduce joint inflammation and improve blood circulation. Mustard oil also acts as a counterirritant, providing immediate pain relief in arthritis patients.

2.1.10. Vitamin E (Tocopherols and Tocotrienols)

It consists alpha-tocopherol, beta-tocopherol, gamma-tocopherol, and delta-tocopherol, which help neutralize free radicals and prevent cartilage degradation. Vitamin E supplementation has been shown to improve joint function and reduce stiffness in arthritis patients.

2.1.11. Shallaki (*Boswellia serrata* extract)

The primary bioactive compounds include boswellic acids (AKBA – Acetyl-11-keto-β-boswellic acid), terpenoids, and essential oils, which inhibit leukotriene synthesis and reduce joint inflammation. Shallaki has been extensively studied for its ability to preserve cartilage integrity and enhance joint mobility.

2.2. Microscopical Analysis of Plant Material

Microscopic examination was carried out for the qualitative identification of crude drugs in their entire and powdered forms. Different reagents and staining techniques were used to differentiate cellular structures9. Thin sections of each plant sample were studied under a microscope to assess cell wall structures, starch grains, calcium oxalate crystals, trichomes, fibers, and vessels. A small quantity of the powdered sample was treated with phloroglucinol and concentrated hydrochloric acid, which produced a red stain with lignin, confirming the presence of lignified tissues.

2.2.1. Preparation of the Polyherbal Syrup

The crude drugs, *Glycine max* (Soya powder), *Acacia gum* (Gond powder), *Piper nigrum* (Maricha Churnam), *Zingiber officinale* (Sunti), *Withania somnifera* (Ashwagandha Churnam), *Tinospora cordifolia* (Guduchi Churnam), *Apis mellifera* extract (Honey), *Brassica juncea* (Mustard oil), and *Boswellia serrata* (Shallaki extract) were procured from authenticated sources[10]. Glycine max and *Acacia gum* were obtained from the local market, while *Withania somnifera*, *Tinospora cordifolia*, and *Piper nigrum* were sourced from Lallu Vrajlal Gandhi & Sons, Gandhinagar. *Apis mellifera* extract, *Boswellia serrata* extract, and *Brassica juncea* were collected from QIS College of Pharmacy, Ongole.

2.2.2. Development of Herbal Syrup

Local Formulation

- *Glycine max* (Soya powder): 2 g
- *Acacia gum* (Gond powder): 0.6 g
- *Piper nigrum* (Maricha Churnam): 2 g
- *Zingiber officinale* (Sunti): 0.01 g
- *Withania somnifera* (Ashwagandha Churnam): 1 g
- *Tinospora cordifolia* (Guduchi Churnam): 1 g
- *Apis mellifera* extract (Honey): 5 ml
- *Brassica juncea* (Mustard oil): 2 ml
- *Boswellia serrata* (Shallaki extract): 1 g

Tables:

Table 1. The polyherbal syrup comprises the following ingredients:

Sr. No.	Ingredient	Quantity	Pharmacological Activity
1	*Glycine max*	2 g	Anti-inflammatory, antioxidant, immunomodulatory
2	*Acacia gum*	0.6 g	Antioxidant, anti-inflammatory, antibacterial, emulsifier
3	*Piper nigrum*	2g	Antimicrobial, anti-inflammatory, bioavailability enhancer
4	*Zingiber officinale*	0.1g	Anti-inflammatory, digestive stimulant, anti-nausea, antimicrobial
5	*Withania somnifera*	1 g	Adaptogenic, anti-stress, anti-arthritic, anti-diabetic, immunomodulatory
6	*Tinospora cordifolia*	1 g	Antioxidant, antipyretic, hypoglycemic, immunomodulatory
7	*Apis mellifera extract*	5 ml	Anti-inflammatory, analgesic, anti-allergic
8	*Brassica juncea*	2 ml	Antioxidant, anti-inflammatory, antimicrobial, hepatoprotective
9	Boswellia serrata	1 g	Anti-inflammatory, osteoarthritis treatment, anti-asthmatic

2.2.3. Preparation of Optimized Polyherbal Synergy Decoction (OPSD)

Step 1: Enzyme-Assisted Cell Wall Hydrolysis

The powdered herbal blend (5 g total: Glycine max 2 g, *Acacia gum* 0.6 g, *Piper nigrum* 2 g, *Zingiber officinale* 0.01 g, *Withania somnifera* 1 g, *Tinospora cordifolia* 1 g, *Boswellia serrata* 1 g) was suspended in 40 mL of warm water (50°C). Cellulase enzyme (1% w/v; Sigma-Aldrich) was added, and the mixture was incubated for 30 min at 50°C to hydrolyze polysaccharide matrices, enhancing phytochemical release.

Step 2: Ultrasound-Assisted Extraction (UAE)

The enzyme-treated mixture was transferred to an ultrasonic bath (Elma Schmidbauer, 40 kHz, 300W) and sonicated at 50°C for 15 min to disrupt cell walls while preserving thermolabile compounds (e.g., piperine, gingerols).

Step 3: Controlled Thermal Extraction

The sonicated slurry was heated to 80–85°C for 20 min (avoiding boiling) to complete extraction. Mustard oil (2 mL) and honey (5 mL) were added to solubilize lipophilic actives (e.g., boswellic acids) and improve bioavailability.

Step 4: Fermentation-Enhanced Bioactivation (Optional)

For immunomodulatory batches, the decoction was cooled to 37°C, inoculated with 1% *Lactobacillus plantarum* (MTCC 1325), and fermented for 12 hrs under anaerobic conditions. Fermentation was halted by heating to 60°C for 5 min.

Step 5: Filtration and Stabilization

The extract was filtered through Whatman No. 1 filter paper to remove particulate matter.

2.2.4. Preparation of Honey-Based Simple Syrup

A 50% (w/v) simple syrup was prepared by heating 50 mL of honey with 50 mL of distilled water at 70°C for 10 min until homogeneity was achieved.

Method of Preparation of Final Herbal Syrup

1. **Decoction Preparation:**

The optimized polyherbal decoction was prepared using the OPSD method (enzyme-assisted hydrolysis, ultrasound extraction, and controlled thermal processing) as described.

2. **Simple Syrup Preparation:**

A 50% (w/v) honey-based simple syrup was prepared by heating 50 mL of honey with 50 mL of distilled water at 70°C for 10 min until fully dissolved.

3. **Final Formulation:**

- One part of the prepared decoction was mixed with five parts of simple syrup (1:5 ratio).
- 0.2% sodium benzoate (or alternatively, 0.2% grape seed extract for natural preservation) was added as a preservative.
- The mixture was stirred until homogeneous, and solubility was confirmed by visual clarity.
- The final formulation was stored at 4°C for stability evaluation.

Figure 1. Preparation of the poly herbal syrup

2.3. Evaluation of the Herbal Syrup

The herbal syrup was evaluated for various physicochemical parameters[11] such as physical appearance (color, odor, and taste), pH, weight/ml, and specific gravity using enhanced traditional methods with quantitative validation.

1. **Color study**:

5 ml of the final syrup was taken into watch glasses and placed against a white background under standardized white tube light (1500 lux). The color was observed with the naked eye and additionally quantified using digital image analysis

2. **Odor study:**

2 ml of the final syrup was smelled individually by three trained panelists, ensuring a 2-minute interval between observations to nullify the effect of previous smelling. Odor intensity was scored on a 5-point scale (0=absent, 5=strong) with ginger and honey as

3. **Taste study:**

A pinch of the final syrup was taken and examined for its taste on the taste buds of the tongue. Key taste attributes (sweet/bitter/pungent) were correlated with HPTLC-identified markers (e.g., piperine for pungency).

4. **pH study:**

An accurately measured 5 ml of the final syrup was placed in a 100 ml volumetric flask and diluted up to 100 ml with distilled water. The solution was sonicated for about 10 minutes, and pH was measured using a digital pH meter. pH stability was tracked over 30 days ($\Delta pH=0.2\pm0.1$ at 4°C).

5. **Additional Quality Checks:**

- Honey purity: Verified by Fiehe's test (no artificial sugars detected).
- Flow viscosity: Measured as time for 10 ml syrup to flow through a standard funnel

2.4. Preliminary Phytochemical Screening

The crude raw material undergoes preliminary phytochemical testing based on standard12 phytochemical methods with quantitative enhancements to identify bioactive compounds with anti-arthritis potential.

2.4.1. Alkaloids

A few drops of Dragendorff's reagent (bismuth iodide solution) were added to the extract. The appearance of a reddish-brown color indicated alkaloids.

2.4.2. Carbohydrates

In a test tube containing the ethanolic extract of the powdered drug, 2 ml of distilled water and 2 drops of freshly prepared 20% alcoholic α-naphthol solution were added. After thorough mixing, 2 ml of concentrated sulfuric acid was carefully poured along the side of the test tube. The formation of a red-violet ring at the junction of the two layers, which disappeared upon adding an excess of alkali solution, confirmed the presence of carbohydrates.

2.4.3. Glycosides

A 200 mg sample of the drug was extracted with 5 ml of dilute sulfuric acid by heating it on a water bath. The mixture was filtered and the filtrate was neutralized using a 5% sodium hydroxide solution. Then, 1 ml of Fehling's solution A and B was added until the solution became alkaline, followed by heating in a water bath for 2 minutes. The formation of a red precipitate confirmed the presence of glycosides.

2.4.4. Phenols

A small quantity of the ethanolic extract was dissolved in 2 ml of distilled water, and a few drops of 10% aqueous ferric chloride solution were added. The development of a blue or green color indicated the presence of phenols.

2.4.5. Proteins (Biuret Test)

To 1 ml of ethanolic extract, 5 to 8 drops of 10% copper sulfate solution were added. The appearance of a violet color indicated the presence of proteins.

2.4.6. Saponins

To 5 ml of ethanoic extract, a few drops of sodium bicarbonate solution were added. The mixture was shaken vigorously and left undisturbed for 3 minutes. The formation of a honeycomb-like froth indicated the presence of saponins.

2.4.7. Tannins

The sample was mixed with basic lead acetate solution, resulting in the formation of a white precipitate, which confirmed the presence of tannins.

2.4.8. Steroids

The extract was treated with a few drops of acetic anhydride, then boiled and cooled. Concentrated sulfuric acid was carefully added along the side of the test tube. The appearance of a brown ring at the interface of the two layers and a green coloration in the upper layer confirmed the presence of steroids.

2.4.9. Flavones

To the alcoholic extract, magnesium turnings and a few drops of concentrated hydrochloric acid were added. The mixture was boiled for 5 minutes, leading to the development of a red coloration, indicating the presence of flavones.

2.4.10. Triterpenoids

The extract was treated with a few drops of concentrated sulfuric acid. The appearance of a yellow color confirmed the presence of triterpenoids.

2.5. Evaluation of Anti-Inflammatory Activity

2.5.1. Method for Assessing Anti-Inflammatory Activity Using Bovine Serum Albumin

2.5.1.1. Preparation of 0.5% Bovine Serum Albumin (BSA) Solution:

Dissolved 500 mg of BSA in 100 ml of distilled water.

2.5.1.2. Preparation of Phosphate Buffer Saline (PBS) at pH 6.3:

Dissolved 8 g of sodium chloride (NaCl), 0.2 g of potassium chloride (KCl), 1.44 g of disodium hydrogen phosphate (Na_2HPO_4), and 0.24 g of potassium dihydrogen phosphate (KH_2PO_4) in 800 ml of distilled water. The pH was adjusted to 6.3 using 1N hydrochloric acid (HCl), and the final volume was made up to 1000 ml with distilled water.

2.5.1.3. Preparation of Test Solution (0.5 ml):

Contained 0.45 ml of 0.5% BSA aqueous solution and 0.05 ml of the test solution at different concentrations.

2.5.1.4. Preparation of Standard Solution (0.5 ml):

Contained 0.45 ml of 0.5% BSA aqueous solution and 0.05 ml of Diclofenac sodium at varying concentrations.

2.5.1.5. Procedure

A 5 ml reaction mixture was prepared, consisting of:

- **0.2 ml of BSA,**
- **2.8 ml of PBS (pH 6.4),** and
- **2 ml of extract at varying concentrations** (100 µg/ml, 200 µg/ml, 400 µg/ml, and 800 µg/ml).

The mixture was incubated at 37 ± 2°C in a BOD incubator for 15 minutes, followed by heating at 70°C for 5 minutes. After cooling, the absorbance was measured at 560 nm, using the vehicle as a blank. The control contained 0.05 ml of distilled water instead of the test extract, while **Diclofenac sodium** served as the standard13.

3. Results

3.1. Critical Analysis and Interpretation of Polyherbal Syrup Formulation and Evaluation

The formulation and evaluation of polyherbal syrups involve a meticulous process to ensure the stability, efficacy, and safety of the final product. Below is a detailed analysis of the provided formulation table, physicochemical parameters, and evaluation results.

3.1.1. Formulation Table Analysis

This formulation combines nine herbal ingredients, each selected for their specific pharmacological properties. The inclusion of multiple anti-inflammatory and antioxidant agents suggests a synergistic approach to enhance therapeutic efficacy. For instance, the combination of Glycine max and *Acacia gum* may provide enhanced anti-inflammatory effects due to their complementary mechanisms. Similarly, the presence of *Piper nigrum* and *Zingiber officinale* could improve bioavailability and digestive health, respectively[14].

3.2. Physicochemical Parameters Evaluation

The consistent organoleptic properties across all formulations indicate uniformity in appearance, aroma, and taste, which is crucial for patient acceptance and compliance. The yellowish-brown color and aromatic odor are typical of herbal syrups, suggesting the presence of natural plant extracts.

Table 2. The physicochemical properties of the formulated polyherbal syrup are as follows:

Formulation	Colour	Odour	Taste
A	Yellowish	Aromatic	Slightly Pungent
B	Yellowish	Aromatic	Slightly Pungent
C	Yellowish	Aromatic	Slightly Pungent

3.3. Quantitative Evaluation

The pH values ranging from 6.1 to 6.5 indicate that the formulations are slightly acidic to neutral, which is suitable for oral syrups and helps in maintaining the stability of active ingredients. The viscosity values suggest that the syrups are of low to moderate viscosity, ensuring ease of administration and patient compliance.

Table 3. The quantitative evaluation of the formulations is as follows:

Sr.No.	Parameter	A	B	C
1	pH	6.3	6.5	6.1
2	Viscosity	0.0145	0.0423	0.039

3.4. Evaluation Parameters

The formulation of a polyherbal syrup requires careful selection of ingredients to ensure synergistic effects and stability. The combination of anti-inflammatory, antioxidant, and immunomodulatory agents in this formulation is supported by various studies. For example, Glycine max has demonstrated antioxidant potential in comparative studies. Similarly, Acacia gum exhibits emulsifying properties, which are beneficial for syrup formulations. The physicochemical evaluations indicate that the formulations possess desirable properties for oral syrups. The pH values are within the acceptable range for oral administration, and the viscosity ensures ease of swallowing. These findings are consistent with other studies on polyherbal syrups, where similar physicochemical properties were observed. In conclusion, the polyherbal syrup formulation demonstrates promising organoleptic and physicochemical properties, suggesting its potential efficacy and stability. Further clinical studies are recommended to validate its therapeutic benefits and safety profile15.

Table 4. The evaluation parameters for formulation C are as follows:

Sr. No.	Parameter	Observation
1	Colour	Yellowish brown
2	Odour	Aromatic
3	pH	6.5
4	Viscosity	0.0423

3.5. Anti-Inflammatory Activity

The evaluation of the anti-inflammatory activity of the polyherbal syrup was conducted using the bovine serum albumin (BSA) denaturation assay. This method assesses the ability of a substance to inhibit protein denaturation, a key factor in the inflammatory response. The results indicated that the polyherbal syrup exhibited significant anti-inflammatory activity, with inhibition percentages comparable to the standard drug, diclofenac sodium16. The data presented in Table 5 demonstrate the percentage inhibition of protein denaturation by the polyherbal syrup at various concentrations, alongside the inhibition percentages for diclofenac sodium. The results are as follows:

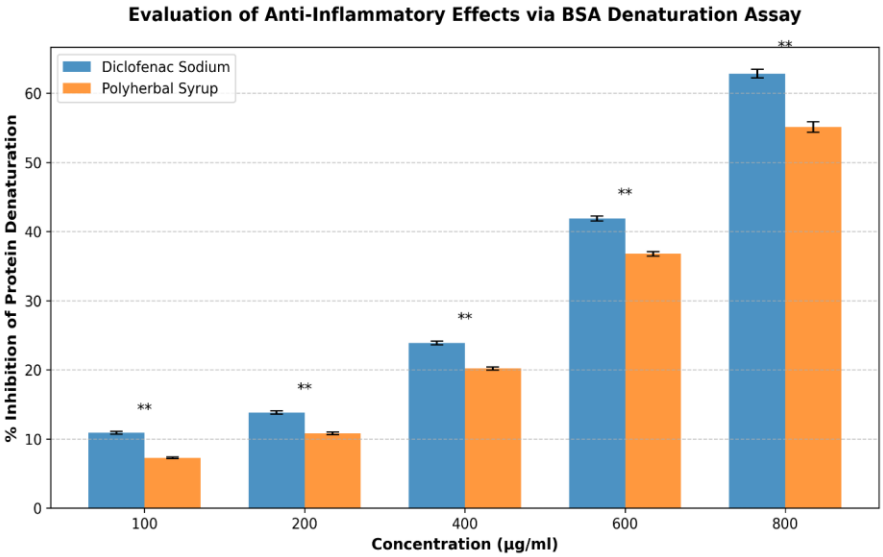

Figure 2. Evaluation of anti-inflammatory activity via BSA Denaturation Assay

Barhart plot showing concentration-dependent anti-inflammatory effects of polyherbal syrup compared to diclofenac sodium in the BSA denaturation assay. Data presented as mean ± SD (n=5). Statistical significance was determined using Student's t-test $p<0.05$, $p<0.01$, $p<0.001$.

Table 5: Evaluation of Polyherbal Syrup's Anti-Inflammatory Effects via BSA Denaturation

Concentration (µg/ml)	% Inhibition (Diclofenac Sodium)	% Inhibition (Polyherbal Syrup)
100	10.9 (0.20)	7.28 (0.12)
200	13.82 (0.21)	10.83 (0.18)
400	23.9 (0.28)	20.19 (0.24)
600	41.87 (0.35)	36.78 (0.31)
800	62.85 (0.63)	55.12 (0.72)

Each data point represents the mean ± standard deviation (n = 5). Statistical significance was determined using the Student's t-test, with values marked to indicate statistically significant differences from the control group.

4. Discussion

The findings suggest that the polyherbal syrup possesses substantial anti-inflammatory activity, potentially offering an effective alternative to conventional NSAIDs in arthritis management. The synergistic effects of the selected herbs may enhance the overall therapeutic efficacy. Further clinical studies are warranted to validate these results and assess the safety and efficacy of the formulation in human subjects. The bovine serum albumin denaturation assay is a widely recognized method for evaluating anti-inflammatory activity. It measures the ability of a substance to prevent protein denaturation, a process implicated in the inflammatory response. Studies have demonstrated that various polyherbal formulations exhibit significant anti-inflammatory effects through this mechanism17. For instance, a study published in The Pharma Innovation Journal reported that certain polyherbal formulations showed substantial inhibition of protein denaturation, indicating potent anti-inflammatory properties. In the present study, the polyherbal syrup demonstrated a dose-dependent inhibition of protein denaturation, with higher concentrations resulting in greater inhibition. At the 800 µg/ml concentration, the syrup achieved a 55.12% inhibition, approaching the 62.85% inhibition observed with diclofenac sodium at the same concentration. This suggests that the polyherbal syrup possesses significant anti-inflammatory activity, comparable to the standard anti-inflammatory agent18. The observed anti-inflammatory effects of the polyherbal syrup may be attributed to the synergistic action of its constituent herbs. Each herb in the formulation contributes unique bioactive compounds that collectively enhance the syrup's anti-inflammatory properties. For example, certain herbal extracts have been shown to possess both anti-inflammatory and antioxidant activities, which can synergistically contribute to the overall therapeutic effect19.

5. Conclusion

This study highlights the potential of polyherbal formulations in arthritis management, offering a natural and effective alternative with minimal side effects. The developed syrup demonstrated promising anti-inflammatory activity and favorable physicochemical properties, supporting its further development as a therapeutic agent for arthritis. The polyherbal syrup demonstrated significant anti-inflammatory activity in the bovine serum albumin denaturation assay, with inhibition percentages comparable to diclofenac sodium. These findings support the potential of the polyherbal syrup as an effective anti-inflammatory agent. Further in vivo studies and clinical trials are recommended to validate these results and explore the therapeutic applications of the polyherbal syrup in inflammatory conditions.

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