RESEARCH ARTICLE

Formulation and Evaluation of Herbal Capsules Containing Gum Resin of *Boswellia serrata*

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ABSTRACT

Boswellia serrata (Sallaki) is one of the most popular herbs, belonging to the family Burseraceae, whose dietary and therapeutic potential has been practiced since ancient days mainly for the treatment of arthritis and other inflammatory disorders. The therapeutic activity of oleo gum resin is typically due to the presence of active constituents such as 11-keto-β-boswellic acid and 3-o-acetyl-11-keto-β-boswellic acid. The main objective of the present research work was to formulate and evaluate the *Boswellia* capsule. The plant *B. serrata* is the best traditional medicine for the treatment of rheumatoid arthritis without causing any side-effects when compared to synthetic drugs (NSAIDs). The herbal capsules were formulated and evaluated. The prepared formulation was subjected to evaluations like physical appearance, pH, dissolution, disintegration and phytochemical screening.

Keywords: *Boswellia serrata*, *Curcuma longa*, Sallaki, Boswellic acid, Rheumatoid arthritis, Herbal capsule.

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INTRODUCTION

Every year, millions of individuals worldwide suffer from joint discomfort and arthritis. According to the CDC (Centers for Disease Control and Prevention), roughly one out of every four persons in the United States suffers from joint discomfort or arthritis in which persistent pain affects over half of people suffering from joint arthritis.[1] Arthritis is an age-related, debilitating, degenerative joint condition that affects people all over the globe. It is characterized by joint discomfort, limited mobility, and a poor effect on the quality of life. In 2013-2015, an estimated 43.5% of people were afflicted with arthritis, representing a net rise of nearly 1 million each year. By 2040, that figure is estimated to rise to roughly 78.4 million, accounting for over half of the projected total adult population.[2]

The primary goal of the treatment is to subside the pain. Hence, NSAIDs and acetaminophen are presently the backbones of arthritis treatment. NSAIDs have been linked to cardiovascular, renal, and gastrointestinal risks. The quest for herbal preparations with anti-inflammatory qualities but no negative side effects for the management of arthritis is increasing.[3] The gum resin is derived from the well-known herb *Boswellia serrata* Roxb. Ex Colebr (Figure 1) is an effective treatment for chronic inflammatory diseases such as arthritis.[4]

Between 2021 and 2027, the extract of *B. serrata* is predicted to expand at a CAGR of 7.7%.[5] Plant-derived goods have seen increased demand in both developed and developing nations in recent years, and these items are increasingly being sought after as pharmaceutical products, nutraceuticals, and cosmetics.[6] There are over 6000 herbal factories in India, with approximately 4000 units producing Ayurvedic medicines. Due to a lack of infrastructure, severe regulatory rules, and trained labor-dependent procedures, the production of these items is exceedingly tentative.[7]

Increased population, poor drug supply chain, increased cost for treatments, adverse effects of synthetic molecules, battling resistance against disease, and new untreatable diseases have established the use of herbal medicines for different diseases in human beings. *B. serrata* has long been used to treat arthritis and related inflammatory diseases. Methotrexate, on the other hand, is the most commonly used synthetic drug (DMARD) used as an antirheumatic medicine worldwide. Though it is helpful against the ailment, it also causes major life-threatening side effects such as cardiac arrest, bloody vomit, black, tarry stools, mouth and lip sores, GI issues, rashes, reddening of the skin, swelling of the eyelids, and other body parts. To prevent these adverse effects and promote healthy well-being, the demand for natural

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Figure 1: *B. serrata*

goods is increasing. They are now extensively utilized as an alternative for many illness problems, and some have also been demonstrated to be superior to synthetic pharmaceuticals.[8] The present study is to develop and evaluate a solid oral dosage form of *B. serrata*.

Plant Profile

Synonym: Sallaki, Indian frankincense, Kundur
Biological source: Dried gum resin of *B. serrata*
Family: Burseraceae
Geographical source: India (Andhra Pradesh, Odisha, Bihar, Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, and Western Himalayas), the Middle East, and Northern Africa.
Chemical constituents:
Active constituents – Keto derivatives of β-Boswellic acid
The resin includes higher terpenoids (25–35%), essential oil (12%), and polysaccharides (45–60%) depending on the origin and time of harvest.
Uses: Anti-inflammatory, anti-fungal, anti-arthritic activity, anti-cancer, analgesic, anti-anemic, CNS Depressant, hepatotonic, anti-asthmatic, sedative, stomachic, tonic, and stimulant.[9]

MATERIALS AND METHODS

Collection of Plant material

The dried gum resin of *B. serrata* was collected from the raw material manufacturing site – Amsar Private Ltd. located in No.47 Laxmibai Nagar, Industrial Estate, Fort, Indore – 452006. The plant material obtained was disease-free and devoid of contamination from other plants.

Formulation of *Boswellia* Capsule (Table 1)

- About 9 g *B. serrata* resin powdered drug and 1.5 g *Curcuma longa* powdered drug were taken and passed through S.S Sieve 20# using a mechanical sifter and was transferred to a double cone blender.
- About 4 g Silicon dioxide was also passed through S.S Sieve 30# using a mechanical sifter and transferred to the same double cone blender for 10 minutes.
- Then, 6 g Microcrystalline Cellulose 102 (E460(i), 2 g Cross-linked carboxy methyl cellulose sodium (E468) were passed through S.S Sieve 20 # using a mechanical sifter and was transferred to a double cone blender with granules and the blender was operated for 10 minutes.
- Finally, 1 g of Talc (E553b), 1 g Magnesium stearate(E470b) extract was passed through S.S Sieve 40 # using a mechanical sifter and the sifted powder was transferred to double cone blender with granules and the blender was again operated for 5 minutes.

Capsule Filling

The Automatic Capsule filling machine was set for ”0” Size Capsule with desired Dosing Disc. The final granules obtained from the stage I was filled using Transparent “0” Size Transparent HPMC Plain Capsule Shells. The approved blend of Stage II was transferred to capsule filling area. The granules were then loaded and the filling was initiated. The filled Capsules were collected and verified.

Evaluation of *Boswellia* capsule

Organoleptic characters

Color, odor, taste and texture were observed.

Description

About 20 Capsules were taken, the content were removed from the shell and was spread evenly on petri dish and the observation was recorded.

Average net weight

About 20 filled capsule weights were taken and noted individually in milligrams up to one decimal. The filled powder was removed from the capsules, then accurately 20 empty capsules weight was taken and the weight was noted down orderly in milligrams up to one decimal. The average mass of the filled weight was determined and reported in terms of milligrams.

Weight variation

About 20 Filled capsules were weighed and the weight of each capsule was noted individually in milligrams up to one decimal. The filled powder was removed from the capsules. Accurately 20 empty capsules were weighed and the weight of each capsule was noted individually in milligrams up to one decimal. The percentage variation of the highest and lowest weight of the Capsules with maximum and minimum weight was calculated and reported in terms of milligrams.

Determination of pH

1.0009 g of Capsule powder was macerated with 100 mL of water in a closed container. Shaken frequently to about 15 minutes once and left undisturbed for one hour. A rapid filtration was performed, the filtrate was collected and the pH was measured.

Loss on drying

A clean, empty petri dish was taken and pre-heated for 10 minutess at 105°C. Then it was allowed to cool at room temperature in a desiccator. First the empty petri dish weight was noted (W_1). 1 g of sample was then added to the petri dish

Table 1: Composition of herbal capsules

Ingredients	*Quantity for 30 capsules (gm)*
B. serrata	9
Curcuma longa	1.5
Silicon dioxide	4
Microcrystalline cellulose	6
Cross linked carboxy methyl cellulose sodium	2
Talc	1
Magnesium stearate	1

and the weight was noted(W_2). The petri dish containing the sample was then kept in hot air oven for 3 hours at 105°C and, after which the samples were cooled at room temperature and the weight was recorded (W_3). The LoD was thus calculated.

Disintegration test

The disintegration test was performed by placing the capsule inside the 6 tubes of the testing apparatus along with a disc. The basket rack assembly was suspended in water maintained at 37 ± 1°C. Then, the apparatus was operated till the Capsules get disintegrated and their residue passes through the mesh. The time was noted down. If the Capsules adhere to the disc, then the test should be repeated without the discs added to the tube.

Dissolution test

The capsule's dissolution was tested using a USP dissolution device type I. (basket type). The capsule was put in a tiny wire mesh which is attached to the bottom of the shaft suspending in the basket, which was linked to a variable speed motor. 900 mL of 6.8 pH phosphate buffer was taken as the dissolution medium, and the basket was submerged in a dissolving medium. A continuous temperature bath was used to keep the flask at 37 ± 2°C. The shaft was spun at 50 revolutions per minute. The time was set for 1 hr. At every 15-minute of interval, the 10mL of the sample was withdrawn from the bath and the sink condition was maintained by replacing it with 10 mL of buffer solution. The withdrawn sample was moved to a flask (100 mL) and the volume was increased with the buffer solution. Then 1 mL of sample was withdrawn from the flask (100 mL) and shifted to the 10 mL flask and the volume was increased with buffer to 10 mL and the absorbance was measured at 251nm. The procedure was repeated for various samples collected at a different time intervals (15, 30, 45, 60) and the absorbance was measured by UV-spectrometer.[10]

Qualitative Phyto-chemical Evaluation

Test for alkaloids

Dragendroff's test : 2 mL of dragendroff's reagent was added to the powdered drug and shaken well

Mayer's test : 2 to 3 mL of Mayer's reagent was added to the powdered drug and shaken well

Wagner's test : 2 mL of Wagner's reagent was added to the powdered drug and shaken well.

Hager's test : 2 mL of Hager's reagent was added to the powdered drug and shaken well.

Test for phenolic compound

To the concentrated alcoholic extract of powdered gum resin, a few drops of alcoholic $Fecl_3$ was added.

Test for flavonoids

Shinoda test: Add conc. HCl dropwise to the powdered drug.

Test for glycosides

Dilute 200 mg of powdered drug in H_2SO_4 in warm water bath. Filter and neutralize using 5% NaOH solution. After which 0.1 mL of Fehling's solution A and B were added and made alkaline by heating in the water bath. Red precipitate mass for tests A and B were compared.

Test for triterpenoids

To the powdered drug, 2 mL of $CHCl_3$ and 1 mL of $(CH_3CO)_20$ were added. Conc.H_2SO_4 was added drop-wise to the mixture.

Test for anthraquinone glycosides

Borntrager's test: Heat the powdered drug with sulphuric acid for 5 minutes. Filter the solution, add 2-3 mL of dichloromethane, and shake it in a dilute solution of NH_3.

Test for saponins

Foam test: The powdered drug was shaken well for a few minutes with 10-20 mL of water.

Test for steroids

Libermann-Burchard test: To the powdered drug, add 2-3 mL of $(CH_3CO)_20$. Boil it for 2 minutes and cool it down to room temperature. Then, add conc.H_2SO_4 dropwise to the solution.[11]

Identification by HPTLC Fingerprinting Profile

Standard preparation

A dry 100 mL volumetric flask was filled with accurately weighed 300 mg of *B.serrata* dry extract working standard. To the flask, methanol (60 mL) was added and further subjected to sonication for period of 15 mins. The remaining volume was further made with methanol, shaken well, and filtered thoroughly.

Sample preparation

Totally 10 capsules were weighed and triturated and the content for 1 capsule was re-weighed and added to a 100 mL volumetric flask. Then methanol (60 mL) was added, sonicated, and heated gently for 10 minutes. The final volume was adjusted

Procedure

The mobile phase solvent (10 mL) was poured over the paper, and chambers were allowed to equilibrate with the solvents. The chamber was then saturated for around 20 minutes. The samples were applied in such a manner that each band (8 mm) has a spacing of 2 mm between them, 15 mm on each side of the edge, and 8 mm from the plate's lower edge.

Then the plate was dried using cold air for 2 mins and the developing distance of 70 mm was marked from the lower edge of the plate. Finally, the plate was placed inside the saturated

chamber, facing the layer inside, and allowed the solvent to reach the mark before being removed.

The plate was dried again with cold air (hair dryer) for 5 minutes. The plate was then examined under Ultraviolet light at 254 nm. Derivatized with 10 % Methanolic sulphuric acid and dried at 105°C for 5 minutes. The plate was also examined under Ultraviolet light at 366 nm and white light.

Assay of Keto Derivatives of β- Boswellic Acid by HPLC

Preparation of standard solution

To a 100 mL volumetric flask, 300.0 mg of *B.serrata* dry extract was accurately weighed and added. Then 60 mL of diluent was added, sonicated, and heated gently for 10 minutes. The final volume was adjusted with the same diluent and shaken well. After which, the entire solution was filtered using a PVDF syringe filter (0.45 µm).

Preparation of sample solution

About 20 capsules were weighed, triturated, and 1 capsule content weight was placed into a volumetric flask of 100 mL. The diluents were then added in 60 mL increments and sonicated for 10 minutes. The volume was adjusted with diluent and well shaken. Filtered with a 0.45 µm PVDF syringe filter.

The following sequence was injected into the chromatograph and the chromatogram was recorded. The system suitability was found out and the response of major peak was measured.

RESULTS AND DISCUSSION

Organoleptic Characters

Color, odor, taste and texture of capsule were cream colored powder, Characteristic, bitter and smooth respectively.

Description

Size '0' HPMC Transparent capsules, containing cream colored granular powder were observed.

Weight variation of net content

As per the API specification, the percentage deviation is 10% if the average weight of the capsule is less than 300 mg. The percentage deviation for the formulated herbal capsules was not more than ± 2.88%

Determination of pH

The pH of the sample was found to be 5.67

Table 2: Phyto-chemical screening

S. No.	*Phyto-constituents*	*Inference*
1.	Alkaloids	-
2.	Phenolic compounds	+
3.	Flavonoids	+
4.	Glycosides	+
5.	Triterpenoids	+
6.	Anthraquinone glycosides	-
7.	Saponins	+
8 .	Steroids	-

Loss of drying

The loss on drying (LOD) was obtained as 6.12% w/w

Disintegration time

The herbal capsule passed the test as no residue of drug was remained. The capsule complies with the test according to API. The disintegration time was noted for the herbal capsules as 11 minutes 14 seconds.

Dissolution test

The dissolution test for the herbal capsule (USP Dissolution apparatus type 1 – Basket type) was performed and the absorbance was measure using UV spectrometer at 251

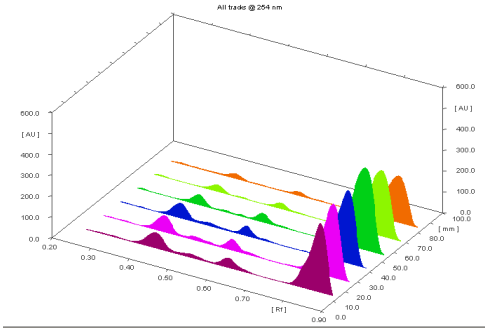

Figure 2: The chromatographic profile of *Boswellia* capsules by HPTLC method

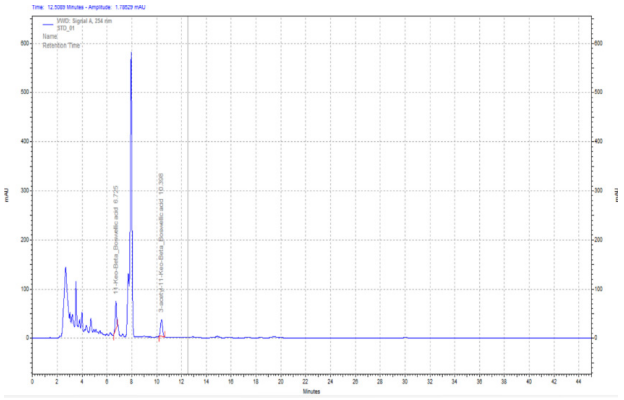

Figure 3: The chromatographic profile of reference standard (*B. serrata*) by HPLC method

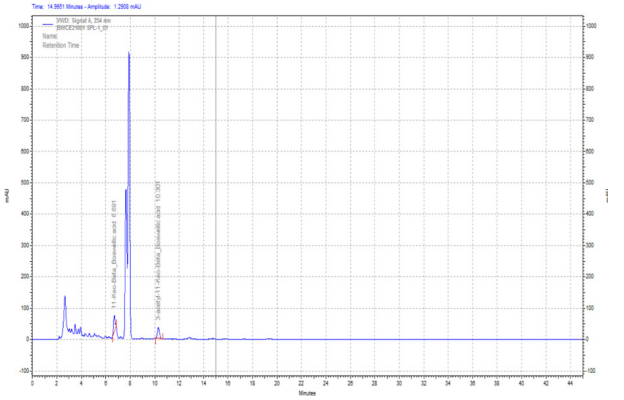

Figure 4: The chromatographic profile of sample (*Boswellia capsule*) by HPLC method

nm. API defines a medicine as highly soluble if it dissolves quickly in the gastrointestinal system. Typical acceptability requirements for the quantity of medication dissolved vary from 70 to 88%. These criteria, which include test periods, are often set based on a review of the dissolution profile data. As indicated below, the capsule components may dissolve 87.70% in the phosphate buffer medium in 60 minutes. As a result, the capsule under consideration may give the required information to determine its bioavailability.[12] 87.70% of drug released in 60 minutes indicating an acceptable time for conventional dosage forms.

Phyto-chemical Screening

The results are shown in Table 2.

Test for alkaloids

Dragendroff's test : 2 mL of dragendroff's reagent was added to the powdered drug and shaken well

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Test for phenolic compound

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Test for flavonoids

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Test for glycosides

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Test for triterpenoids

To the powdered drug, 2 mL of $CHCl_3$ and 1-mL of $(CH_3CO)_20$ were added. Conc.H_2SO_4 was added drop-wise to the mixture.

Test for anthraquinone glycosides

Borntrager's test: Heat the powdered drug with sulphuric acid for 5 minutes. Filter the solution, add 2 to 3 mL of dichloromethane, and shake it in a dilute solution of NH_3.

Test for saponins

Foam test: The powdered drug was shaken well for a few minutes with 10-20 mL of water.

Test for steroids

Libermann-Burchard test: To the powdered drug, add 2-3 mL of $(CH_3CO)_20$. Boil it for 2 minutes and cool it down to room temperature. Then, add conc.H_2SO_4 dropwise to the solution.[11]

Identification by HPTLC Fingerprinting Profile

HPTLC was optimized and the n-Hexane: Ethyl acetate (6:4) solvent system was found most suitable for separation of the compounds.

The chromatogram representing the presence of boswellic acid in the sample (*Boswellia* capsule) was found to be similar when compared with the chromatogram of the reference standard (Figures 2-4). As a result, the developed mobile phase provided higher, sharper, and more defined peak resolution for both standards and samples. With the use of a chromatogram of the reference compound and an HPTLC plate at 254 nm, the spot at R_f 0.45 was confirmed as KBA and the spot at R_f 0.49 as AKBA. After 30 minutes of total saturation of the solvent chamber, the well-defined spots were achieved.

Assay of Keto Derivatives of β - Boswellic acid by HPLC

CONCLUSION

The Physico-chemical parameters and the phyto-chemical screening of the formulated capsule have been studied. The qualitative and quantitative determination of the formulated capsule have been performed. The principle constituents were found to be responsible for the antirheumatic activity. The prepared herbal formulation was proven to be a safer alternative for the existing antirheumatic drugs [Allopathy]. This may also be useful for the development of newer antirheumatic agents as a single formulation / as well as a poly herbal formulation thereby enhancing the antirheumatic activity more effectively.

AUTHOR CONTRIBUTIONS

Design – Vikram J , Sangeetha M , Sonel Gurjar M

Acquisition of data- Sangeetha M , Vikram J , Sonel Gurjar M , Gopinath S

Analysis of data- Sangeetha M , Sonel Gurjar M , Gopinath S

Drafting of the manuscript- Sangeetha M , Sonel Gurjar M , Gopinath S , Anantharaj V

Critical revision of manuscript- Sangeetha M, Vikram J, Sonel Gurjar M

Statistical analysis- Sonel Gurjar M , Gopinath S , Sangeetha M

Technical or financial support- Sangeetha M , Vikram J , Sonel Gurjar M

Supervision- Sangeetha M , Vikram J

Others – Literature search – Anantharaj V , Sonel Gurjar M

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REFERENCES

1. Gaware Rutuja, Gaikwad V, et al., formulation and evaluation of *Boswellia serrata* resin gel by using different gelling agents. International Journal of Bio-Pharma Research: 2019; 8 (8), 2763-2768.
2. Josef S Smolen , Robert B M Landewé,Johannes W J Bijlsma, Et al., EULAR recommendations for the management of rheumatoid arthritis with synthetic and biological disease-modifying antirheumatic drugs Ann Rheum Dis: 2020; 0, 1–15.
3. Singh JA, Saag KG, Bridges SL Jr, Akl EA, Bannuru RR,

Sullivan MC, et al. American College of Rheumatology guideline for the treatment of rheumatoid arthritis. Arthritis Rheumatol: 2016; 68, 1–26.

4. Umar S, Umar K, et al. *Boswellia serrata* extract attenuates anti-inflammatory mediators and ox idative stress in collagen induced arthritis. Phytomedicine: 2014; 21 (6), 847-856.
5. Abdel-Tawab M, Werz O, et al. *Boswellia serrata*. Clinical Pharmacokinetics: 2011; 50 (6), 349-369.
6. Kameda H, Fujii T, Nakajima A, et al. Japan College of rheumatology guideline for the use of methotrexate in patients with rheumatoid arthritis. Mod Rheumatol: 2019; 29, 31–40.
7. Sailer E R, Subramaniam L R, et al. Acetyl-11-keto-β-boswellic acid (AKBA): Structure requirements for binding and 5-lipoxygenase inhibitory activity. British Journal of Pharmacology 1996; 117 (4), 615-618.
8. Yoshiya, Tanaka, et al., A Review on Rheumatoid arthritis Tanaka Inflammation and Regeneration: 2020; 40, 2 0.
9. Bhutani, K K, et al., Herbal medicines an enigma and challenge to science and directions for new initiatives. *Indian Journal of Natural Products*: 2003, 19 (1), 3-8.
10. Neha Sharma, Vikram Bhardwaj, et al., Simultaneous quantification of triterpenoic acids by high performance liquid chromatography method in the extracts of gum resin of *Boswellia serrata* obtained by different extraction techniques. Chem Cent Journal: 2016; 10 (49).
11. Mina Khajehdehi, Mohammad Khalaj-Kondori, et al., Molecular evidences on anti-inflammatory, anti-cancer and memory-boosting effects of frankincense. Phytotherapy Research: 2022; 36 (3), 1194-1215.
12. The Ayurvedic Pharmacopoeia of India, Ministry of AYUSH. Pharmacopoeia Commission for Indian medicine & Homeopathy, Ghaziabad: 2016; 1 (9), 113-117, 122-124, 127-129.