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Comprehensive Comparative Quality Assessment and In-Vitro Quality Evaluation of Marketed *Boswellia Serrata* Herbal Capsule by Using Double Beam UV-Visible Spectroscopy

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Abstract:

Boswellia serrata is a medicinal plant known for its anti-inflammatory properties due to the presence of boswellic acids. The present study was carried out to evaluate the quality, stability, and anti-inflammatory activity of *Boswellia serrata* capsules using a double-beam UV-Visible spectrophotometer. Various tests were performed, including dissolution, disintegration, protein denaturation (egg albumin) assay, and heavy metal complexation studies. The dissolution and disintegration tests were used to evaluate drug release and capsule breakdown. The protein denaturation test was used to determine the anti-inflammatory activity of the capsules. Photodegradation studies evaluated the stability of the capsules under light exposure, while heavy metal complexation studies assessed their metal-chelating ability. The results showed satisfactory dissolution and disintegration, significant inhibition of protein denaturation, acceptable photostability, and measurable metal-complexing activity. These findings suggest that *Boswellia serrata* capsules have good pharmaceutical quality, stability, and promising anti-inflammatory activity. UV-Visible spectroscopy was found to be a simple, rapid, accurate, and cost-effective method for evaluating the quality of *Boswellia serrata* capsules.

Key Words: *Boswellia serrata*, Comparative Quality Assessment, Double-Beam UV-Visible Spectrophotometer, Physicochemical Evaluation, In-vitro Tests, Anti-inflammatory Activity.

1. INTRODUCTION:

Herbal medicines are natural medicines made from plants containing active compounds like alkaloids, flavonoids and tannins. Although different companies may sell products with the same herb, their quality, purity and effectiveness can vary due to different manufacturing processes. Therefore, comparative analysis is done to compare different brands using physical, chemical and biological tests to check their quality and consistency. For this study, *Boswellia serrata* (Indian Frankincense), a tree from the Burseraceae family, was selected. Its oleo-gum resin contains active boswellic acids, especially AKBA, which has strong anti-inflammatory activity and is traditionally used for arthritis, asthma, and joint pain. The study compares three marketed brands - Pure Nutrition, Inlife, and HealthyHey - which are widely available for joint health, to evaluate their quality differences.

The evaluation is done by pharmaceutical tests and UV-Visible spectroscopy. UV-Visible spectroscopy is an analytical technique that measures absorption of light in the 200-800 nm range to identify and quantify compounds. It works on the Beer-Lambert Law ($A = \epsilon cl$), where absorbance is proportional to concentration. The main parts of the instrument are the light source (Deuterium lamp for UV, Tungsten lamp for visible), monochromator (to select wavelength), cuvette (to hold sample), and detector (PMT or PDA). This technique helps to compare the active constituent content and quality of the three *Boswellia* brands.

2. AIM AND OBJECTIVE:

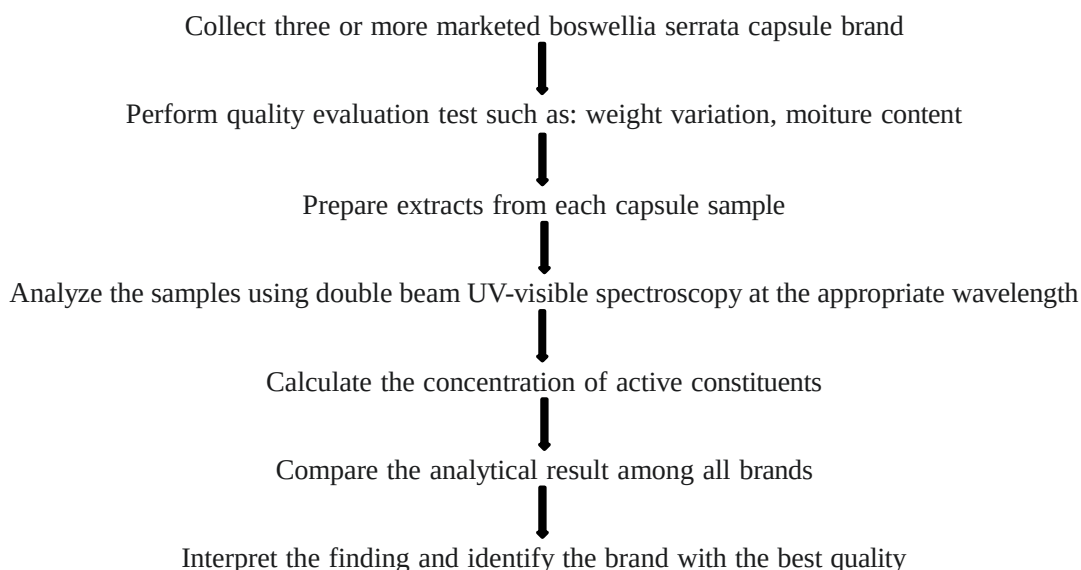
2.1 AIM:

To compare different marketed *Boswellia serrata* herbal capsule brands and evaluate their **quality, consistency, safety, and overall performance** using different pharmaceutical, physicochemical, and in-vitro tests.

2.2 OBJECTIVES:

1. To collect three marketed brands of *Boswellia serrata* capsules for comparison.
2. To evaluate the anti-inflammatory activity using the egg albumin protein denaturation method.
3. To compare the anti-inflammatory activity of the three brands.
4. To assess the quality and consistency of the selected capsules using different evaluation tests.
5. To identify differences in the quality parameters among the three brands.
6. To compare the overall in-vitro performance of the three *Boswellia serrata* capsule brands.
7. To identify the brand showing better overall quality and activity based on the study results.

3. PLAN OF WORK:



4. MATERIALS AND METHODOLOGY:

4.1 QUALITY ASSESSMENT TESTS:

4.1.1 Weight Variation Test:

Ten capsules from each brand were weighed individually for gross weight. Then each capsule was opened, powder removed, and empty shell weighed. Net powder weight = Gross weight - Empty shell weight. Average net weight of 10 capsules was calculated and % variation for each capsule was found using $\% \text{ Variation} = (\text{Individual} - \text{Average}) / \text{Average} \times 100$. This test checks filling uniformity and consistency.

4.1.2 Loss on Drying (LOD):

Capsule powder was mixed well and about 10g was weighed in a pre-weighed clean drying bottle. The bottle was heated in a hot-air oven at 105°C for 5 hours with lid open, then cooled in a desiccator and

weighed. Drying was repeated till constant weight. % LOD = (Loss in weight / Initial weight) x 100. Test was done in triplicate. It checks moisture/volatile matter content.

4.1.3 Foam Test:

About 300 mg powder was boiled with 30 mL distilled water for 10 min, cooled and filtered. 10 mL filtrate was taken in a test tube, shaken vigorously for 15 seconds and left undisturbed for 15 min. Foam height was measured in cm. More stable foam indicates presence of saponins.

4.2 IN-VITRO STUDIES:

4.2.1 Assay:

Test for Boswellic Acid: Standard solution of 100 µg/mL boswellic acid was prepared in ethanol. Sample powder was extracted with ethanol and diluted to 100 µg/mL. Both were scanned by UV-Visible spectrophotometer to find λ_{max} and absorbance was measured using ethanol as blank. Boswellic acid content was calculated by comparing sample absorbance with standard absorbance. This shows active ingredient content.

4.2.2 Egg Albumin Protein Denaturation Test:

This test checks anti-inflammatory activity. 100 mg ibuprofen standard and 100 mg capsule powder were dissolved separately in phosphate buffer pH 7.0 and filtered. Reaction mixture contained 0.2 mL egg albumin + 2.0 mL sample/standard + 0.8 mL buffer (3 mL total). Control had albumin + buffer only. Mixtures were incubated at 37°C for 15 min, then heated at 70°C for 5 min to denature protein, cooled, and absorbance measured at 660 nm. Lower absorbance than control indicates inhibition of protein denaturation.

4.2.3 Ferrous Ion Chelation Test:

This test checks metal chelating ability. Ferrous sulphate + 1,10-phenanthroline forms a coloured complex. If extract chelates Fe^{2+} , colour decreases. Sample was extracted in methanol (20 µg/mL). Solutions of 1,10-phenanthroline (0.1g/100mL), ferrous sulphate (0.02g/100mL) and EDTA standard (0.03g/100mL) were prepared. Reaction mixture (5 mL) contained 1 mL sample/EDTA/methanol + 0.5 mL ferrous sulphate + 1 mL phenanthroline + 2.5 mL water. After incubation, absorbance was measured at 510 nm. Reduction in absorbance vs control shows chelating activity, compared with EDTA standard.

5. RESULTS:

5.1 Weight Variation Test

The weight variation test was performed on 10 capsules of each marketed brand. The average capsule weights and standard deviations were calculated.

Brand	Average Weight $\pm$ SD (mg)	Minimum Variation	Maximum Variation
Healthy Hey	550 $\pm$ 2.58	-0.73%	+0.73%
Pure Nutrition	545 $\pm$ 8.50	-2.75%	+2.75%
Inlife	553 $\pm$ 1.83	-0.54%	+0.54%





Result: Healthy Hey and Inlife showed lower weight variation, indicating better uniformity of capsule fill weight. Pure Nutrition showed comparatively higher variation.

5.2 Loss on Drying (LOD)

Loss on drying was determined to estimate the moisture/volatile content of the samples.

Sample	Initial Weight (g)	Weight After Drying (g)	% LOD
1	52.18	51.85	99.36%
2	52.36	52.00	99.31%
3	50.90	50.55	99.31%

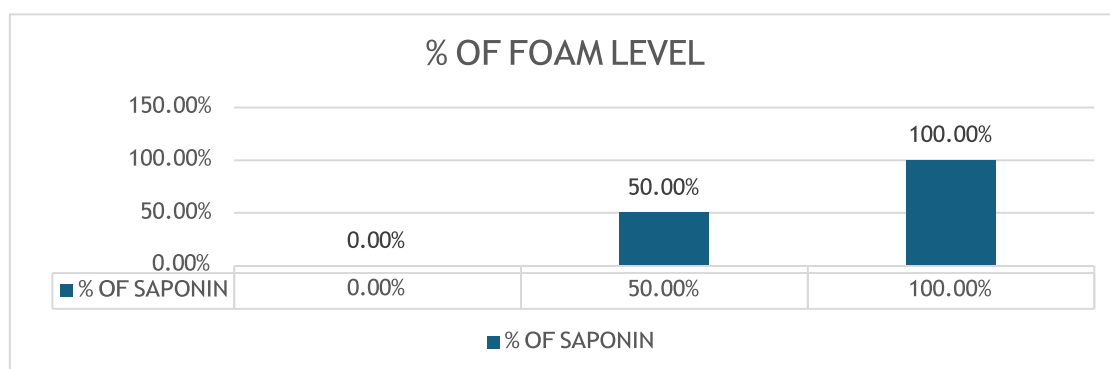
Mean $\pm$ SD = 99.33 $\pm$ 0.03% (n = 3).

Result: The three samples showed very similar LOD values under the experimental conditions.

5.3 Foam Test (Saponin Test)

The foam test was performed to compare the foam-forming ability of the three marketed formulations.

Brand	Foam Height (cm)	% Increase
Healthy Hey	1.00	0%
Pure Nutrition	1.50	50%
Inlife	2.00	100%



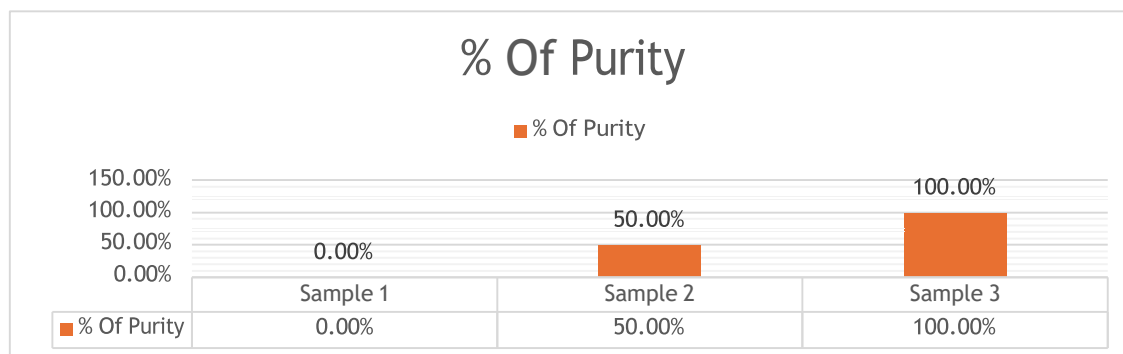
Result: Inlife produced the highest foam height (2.00 cm), followed by Pure Nutrition (1.50 cm) and Healthy Hey (1.00 cm). Thus, Inlife showed the highest foam-forming response.

5.4 Assay Test

The percentage assay/content of Boswellic acid was determined using UV–Visible spectrophotometry.

Brand	Sample Absorbance	Assay (% Purity)
Healthy Hey	0.458	93.4%
Pure Nutrition	0.446	90.1%
Inlife	0.480	98.4%

Mean $\pm$ SD = 93.97 $\pm$ 4.16% (n = 3).

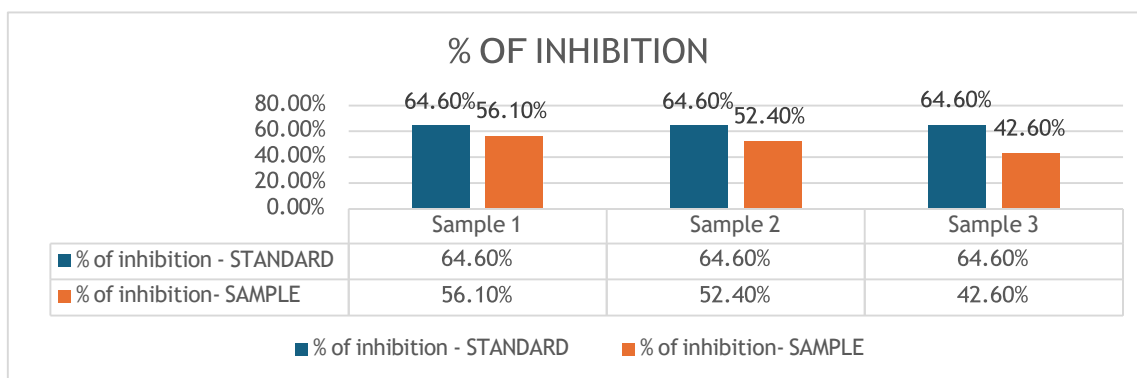


Result: Inlife showed the highest assay value (98.4%), followed by Healthy Hey (93.4%) and Pure Nutrition (90.1%). Therefore, Inlife showed the highest Boswellic acid content among the tested samples.

5.5 Egg Albumin Test (Protein Denaturation)

The anti-inflammatory activity was evaluated by the inhibition of heat-induced protein denaturation using egg albumin. Ibuprofen was used as the standard.

Sample	Absorbance	% Inhibition
Control	0.820	—
Ibuprofen	0.290	64.6%
Healthy Hey	0.360	56.1%
Pure Nutrition	0.390	52.4%
Inlife	0.470	42.6%



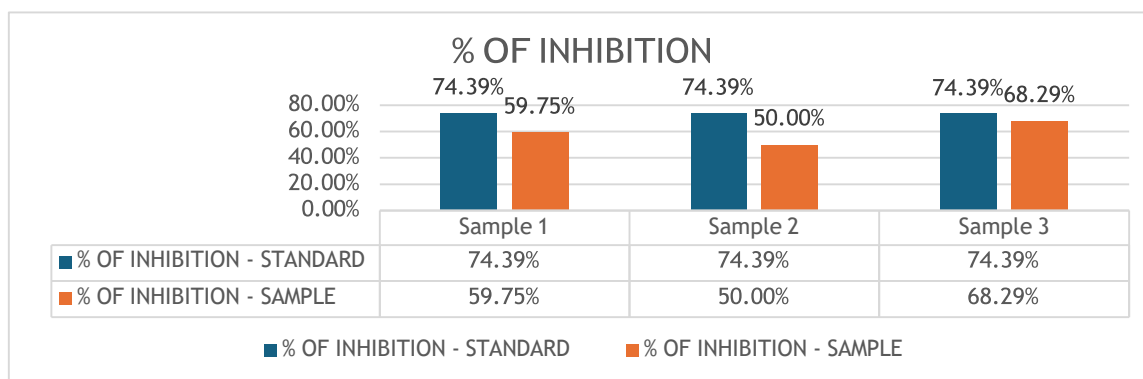
Result: Healthy Hey showed the highest inhibition of protein denaturation among the three Boswellia formulations (56.1%), followed by Pure Nutrition (52.4%) and Inlife (42.6%). Ibuprofen showed 64.6% inhibition.

Therefore, Healthy Hey showed the highest anti-inflammatory activity in this test.

5.6 Ferrous Ion Chelation Test

The ferrous ion chelation test was performed to evaluate the metal-chelating ability of the marketed Boswellia formulations. EDTA was used as the standard.

Sample	Absorbance	% Inhibition
Control	0.820	—
EDTA	0.210	74.39 %
Healthy Hey	0.330	59.75 %
Pure Nutrition	0.410	50.00 %
Inlife	0.280	68.29%



Result: Inlife showed the highest ferrous ion chelating activity (**68.29%**), followed by Healthy Hey (**59.75%**) and Pure Nutrition (**50.00%**). EDTA showed the highest activity (**74.39%**) as the reference standard.

6. DISCUSSION:

This study compared the quality and in-vitro performance of three *Boswellia serrata* capsule brands: Healthy Hey, Pure Nutrition, and Inlife using weight variation, LOD, foam test, assay, protein denaturation, and ferrous chelation tests with UV-Visible spectroscopy. For weight variation, Inlife showed best uniformity (-0.54% to $+0.54\%$), followed by Healthy Hey (-0.73% to $+0.73\%$) and Pure Nutrition (-2.75% to $+2.75\%$), which may be due to differences in powder flow and filling efficiency. Loss on drying was almost similar (~ 0.63 - 0.69%) for all brands, showing comparable moisture content. In the foam test, Inlife showed highest foam (2.0 cm), followed by Pure Nutrition (1.5 cm) and Healthy Hey (1.0 cm), which may be related to saponin content. For assay, Inlife had the highest content (98.4%), followed by Healthy Hey (93.4%) and Pure Nutrition (90.1%), likely due to variation in raw material and extraction process. In egg albumin denaturation test, Ibuprofen showed 64.6% inhibition as standard, while among samples Healthy Hey showed highest activity (56.1%), followed by Pure Nutrition (52.4%) and Inlife (42.7%). In ferrous ion chelation test, EDTA showed 74.39% as standard, while Inlife showed highest chelation (65.85%) among samples, followed by Healthy Hey (59.75%) and Pure Nutrition (50%). Overall, Inlife showed better uniformity, content and chelation activity, while Healthy Hey showed better anti-denaturation activity.

7. CONCLUSION:

This study compared three *Boswellia serrata* capsule brands: Healthy Hey, Pure Nutrition, and Inlife. Overall, Inlife showed the best performance with lowest weight variation ($\pm 0.54\%$) indicating better filling uniformity, highest foam formation (2.00 cm), highest assay value (98.4%), and highest ferrous-ion chelation (65.85%). However, Healthy Hey showed highest protein-denaturation inhibition (56.1%) in the egg albumin test. Pure Nutrition showed higher weight variation and lower assay and chelation values. These results show that even with the same herbal ingredient, marketed brands can differ in quality and in-vitro performance. So, under the tested conditions, Inlife was considered the best brand, but this does not prove clinical superiority and further studies using advanced chromatographic and stability testing are needed.

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