



Phytochemical Profiling And Bioactive Potential Of Camellia Sinensis Seed Oil Infused With Ayurvedic Herbs For Hair Growth:A Research

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Abstract: In order to encourage hair growth, the current study examines the phytochemical makeup and bioactive potential of *Camellia sinensis* (green tea) seed oil infused with particular Ayurvedic herbs. *Camellia sinensis* seed oil, known for its antibacterial, anti-inflammatory, and antioxidant qualities, is a promising vehicle for herbal bioactives. In order to preserve phytoconstituents, Ayurvedic herbs like Bhringraj (*Eclipta alba*), Amla (*Emblica officinalis*), Brahmi (*Bacopa monnieri*), and Neem (*Azadirachta indica*) were infused into the oil using cold maceration and gentle heating techniques. Essential compounds like flavonoids, terpenoids, phenolics, and fatty acids were found through phytochemical profiling using GC-MS analysis and qualitative screening. The infused oil's antimicrobial effectiveness against scalp pathogens, antioxidant activity (DPPH assay), and in vitro hair follicle stimulation using keratinocyte assays for cell culture. Compared to plain seed oil, the results showed significant hair growth-promoting potential and increased antioxidant activity, confirming the synergistic benefits of combining Ayurvedic botanicals with *Camellia sinensis* seed oil. The development of safe and efficient herbal-based cosmeceuticals is aided by this study, which offers a natural, therapeutic substitute for hair care formulations

Keywords – *Camellia sinensis* seed oil, Ayurvedic herbs, Phytochemical profiling, Hair growth promotion, Bioactive compounds, Herbal infusion, Antioxidant activity, GC-MS analysis, Natural hair care, Cosmeceuticals

I. INTRODUCTION

In Ayurveda, where plant-based formulations are used to strengthen hair roots, nourish the scalp, and improve hair health, herbal hair oils have long been an essential component of traditional hair care. As people's desire for natural and chemical-free hair care products grows, the introduction of adding bioactive-rich herbs to carrier oils has drawn a lot of interest. The high concentration of essential fatty acids, tocopherols, squalene, and polyphenols in *Camellia sinensis* (tea seed) oil makes it stand out among other plant-based oils. These compounds help to hydrate the scalp, condition hair, and provide antioxidant protection (Zhao et al., 2020).

Ayurvedic herbs have long been used to enhance their therapeutic effects by infusing them into base oils. Herbs that have long been known to reduce hair loss, treat dandruff, promote hair growth, and improve scalp health include Amla (*Phyllanthus emblica*), Bhringraj (*Eclipta alba*), Brahmi (*Bacopa monnieri*), and Neem (*Azadirachta indica*) (Gupta et al., 2022). These botanicals may improve the bioactive qualities of *C. sinensis* seed oil, providing a safe and efficient substitute for artificial hair care treatments.

A popular Ayurvedic herb, bhringraj has long been used to prevent hair loss and encourage hair growth. It is abundant in triterpenoids, alkaloids, and flavonoids, which nourish hair follicles, increase scalp circulation, and delay the onset of greying. Research indicates that Bhringraj extracts can extend the anagen phase to promote hair development (Sharma et al., 2021).

Hibiscus helps to promote hair development and decrease hair loss. It activates dormant hair follicles, increases blood flow to the scalp, and aids in nourishing the hair roots. Indicating a favourable impact on hair regeneration, it also raises the quantity of hair follicles in the anagen (growth) phase (Rathi V et al., 2021).

The highly prized medicinal fruit amla (*Emblica officinalis*) is abundant in antioxidants, phenolic compounds, and vitamin C. It is well-known for strengthening the immune system, preventing ageing, reducing inflammation, and nourishing hair. Amla aids with digestion, regulates blood sugar, and provides cancer and heart disease prevention. Because of its medicinal advantages, it is frequently employed in Ayurveda and contemporary nutraceuticals. (Baliga and others, 2011).

Bioactive substances such as azadirachtin, nimbin, and nimbolide are abundant in neem (*Azadirachta indica*), a multipurpose medicinal plant. Its strong antibacterial, antioxidant, and anti-inflammatory qualities have been highlighted by recent research. A complex composition that contributes to its medicinal properties is revealed by phytochemical investigations. Neem has long been used to treat diseases and promote health, and its effectiveness against a variety of pathogens has been established by neem extracts. Its potential for creating natural therapies is highlighted by its varied pharmacological actions. Rai (2024).

II. AIM:

This study aims to evaluate the phytochemical profile and bioactive potential of *Camellia sinensis* seed oil infused with ayurvedic herbs, focusing on its physicochemical properties, antimicrobial activity and suitability for hair care application.

III.METHODOLOGY:

1. SAMPLE COLLECTION:

In January 2025, the organic field was used to gather the seeds and leaves of *Camellia sinensis*, the fruit of *Phyllanthus emblica*, the leaves and stem of *Eclipta alba*, the leaves of *Bacopa monnieri*, and the leaves of *Azadirachta indica*.

2. EXTRACTION OF CAMELLIA SINENSIS SEED OIL USING SOXHLET APPARATUS:

Hexane was used as the solvent in the Soxhlet extraction of *Camellia sinensis* seeds, which was derived from Muoki et al. (2012). A Wiley mill was used first to grind the dried seeds into a coarse powder, and a mixer grinder was used to refine them into a fine powder further. About 20 grams of this powder were put in a Soxhlet thimble, and the extraction process was run for 14 hours at 40°C until the solvent in the siphon tube

turned colorless. Following the removal of the solvent with a Liebig condenser, the hexane was evaporated to produce pure *C. sinensis* seed oil, which was then preserved for additional examination in a sterile, airtight container.

3. PREPARATION OF HERBAL INFUSED OIL:

A few chosen Ayurvedic herbs were dried, ground into a fine powder, and weighed precisely. In a predetermined ratio (such as 1:1 or 1:2), camellia sinensis seed oil was combined with coconut oil and properly mixed. After adding the herbal powders, the oil mixture was heated to between 40 and 60°C for many hours while being constantly stirred to extract the active ingredients. Following cooling, the mixture was filtered to get rid of any leftovers, and the infused oil was kept for later examination in a sterile, sealed container.

4. PHYSICOCHEMICAL ANALYSIS:

4.1. SAPONIFICATION VALUE:

In a conical flask, 2 mL of herbal hair oil and 25 mL of alcoholic KOH were combined, and the mixture was heated for 30 minutes in a water bath. Phenolphthalein was added once the solution had cooled, and 0.5 M HCl was used to titrate it until the pink hue vanished. To find out how much KOH was initially present, a blank titration was also carried out.

4.2 ACID VALUE:

50 mL of a neutralized ethanol-ether (1:1 v/v) combination was used to dissolve 1 g of oil. After adding phenolphthalein, 0.1N KOH was used to titrate the solution until a persistent pink hue developed.

4.3. PEROXIDE VALUE:

30 mL of chloroform–acetic acid (2:3), 0.5 mL of 5% KI, and 1 g of oil were combined. Thirty milliliters of distilled water were added after five minutes of standing in the dark. After adding 1 mL of starch indicator and titrating the mixture with 0.01N sodium thiosulfate until it turned pale yellow, the blue hue was eliminated.

4.4. TOTAL FLAVONOID CONTENT (TFC):

Quercetin was utilized to create a calibration curve. The sample was prepared by mixing 1 mL of oil extract with 4 mL of distilled water, then adding 0.3 mL of 5% NaNO₂ for 5 minutes, 0.3 mL of 10% AlCl₃ for 5 minutes, and lastly, 2 mL of 1M NaOH. At 510 nm, absorbance was measured after the volume was increased to 10 mL. The findings were reported as mg QE/g, or mg of quercetin equivalent per gram of oil.

4.5. TOTAL PHENOLIC CONTENT:

Gallic acid was used to create a calibration curve. 2.5 mL of 10% Folin–Ciocalteu reagent was combined with 0.5 mL of oil extract to create the sample. Five minutes later, two milliliters of 7.5% sodium carbonate were added, and the mixture was left to sit in the dark for half an hour. Results were reported as milligrams of gallic acid equivalent per gram of oil (mg GAE/g), with absorbance measured at 765 nm.

4.6 IRRITATION AND SENSITIVITY TEST:

PATCH TEST:

On a clean skin patch, a tiny bit of oil was applied, and it was left for four to five hours. We looked for any indications of redness, swelling, itching, or discomfort.

SENSORY EVALUATION:

For seven days, volunteers applied the oil to their scalps every day while their comfort, itching, irritation, and allergic reactions were tracked. Feedback on absorption and skin feel was gathered

5. PHYTOCHEMICAL ANALYSIS:

Standard phytochemical screening was applied to the oil extract. Mayer's and Wagner's reagents were used to test alkaloids. When an alkaline reagent was added, flavonoids were identified by the development of a yellow hue. When ferric chloride was added, a blue-black or greenish hue appeared, confirming the presence of tannins. When saponins were shaken with water, a stable froth formed, allowing for their identification. Using the Salkowski test, terpenoids were identified by their reddish-brown appearance. Phenols were identified by their interaction with ferric chloride, which produced a deep blue or black color.

6. GC-MS ANALYSIS:

Before 1 μL was injected into the GC-MS, 1 mL of oil was diluted with 5 mL of hexane, combined, and filtered through a 0.22 μm membrane filter. Helium was used as the carrier gas (1.0 mL/min), a DB-5 or HP-5 column, and an oven temperature program that ranged from 50°C to 300°C at a rate of 10°C/min. With electron ionization (70 eV) in the mass range of 50–600 m/z, the injector temperature was set to 250°C. The NIST or Wiley databases were used to identify compounds, and the peak area was used to quantify the bioactive components.

IV.RESULTS AND DISCUSSION

1.PHYTOCHEMICAL ANALYSIS:

Camellia sinensis seed oil infused with Ayurvedic herbs for hair growth was found to have many phytochemicals, which are phenols, tannins, flavonoids, and terpenoids. However, the extract was determined to be devoid of phytochemicals such as alkaloids and saponins.

PHYTOCHEMICAL	PRESENCE (+)/ ABSENCE (-)
Alkaloids	–
Saponins	–
Phenols	+
Tannins	+
Flavonoids	+
Terpenoids	–

2.PHYSICOCHEMICAL ANALYSIS:

2.1.SAPONIFICATION VALUE :

The saponification value of Camellia sinensis seed oil that was inhaled was found to be 25.25 mg KOH/g. The saponification value is consistent with earlier research on tea seed oil, indicating possible uses in cosmetic formulations, including herbal lotions, creams, and hair oils.

3.ACID VALUE:

The acid value of the herbal hair oil was determined to be 1.683. This finding suggests good quality and stability because there aren't many free fatty acids in the oil. Because of its low acidity, the oil is less likely to oxidise and can be used for extended periods of time in hair care products.

4. PEROXIDE VALUE:

The infused herbal oil had a peroxide value of 12 meq O₂/kg, indicating a minimal degree of lipid oxidation. This indicates strong oxidative stability, which reduces the likelihood of rancidity in the oil. Its antioxidant power has been enhanced by the incorporated Ayurvedic herbs, which have stopped lipid peroxidation. The outcomes are consistent with those of other stable cosmetic oils.

5. TOTAL FLAVOROID CONTENT:

The infused oil's potent antioxidant qualities were confirmed by the total flavonoid concentration (TFC), which was 3.91 mg GAE/g.

6. TOTAL PHENOL CONTENT:

It was found that the *Camellia sinensis* seed oil infused with Ayurvedic herbs had a total phenolic content (TPC) of 0.08 mg GAE/g. Phenolic components give the oil its antibacterial, anti-inflammatory, and antioxidant qualities, which are good for the health of the scalp and the nourishing of hair. Increased phenolic concentration indicates improved oxidative stability, which prolongs shelf life and avoids rancidity.

7. PHYSICOCHEMICAL ANALYSIS:

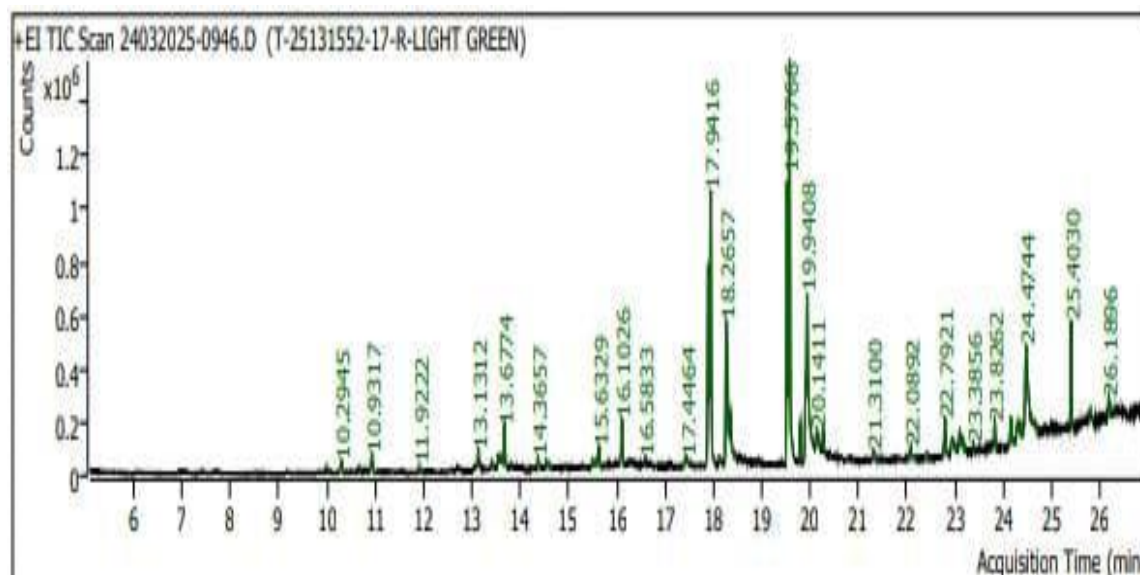
1. Acid value	1.683 mg KOH/g
2. Saponification value	25.25 mg KOH/g
3. Peroxide value	11 meq O ₂ /kg
4. The total flavonoid content	3.91 mg GAE/g
5. Phenolic content	0.08 mg GAE/g

8. TESTING FOR IRRITABILITY AND SENSITIVITY:

Eight individuals in a patch test reported no redness, itching, or irritation after 48 hours, indicating that the oil is compatible with their skin. All types of scalps can be safely applied thanks to a moderate formulation. There were no signs of allergic responses.

9. FEATURES OF THE GAS CHROMATOGRAPHY–MASS (GC–MS) SPECTROSCOPIC ANALYSIS OF CAMELLIA SINENSIS SEED:

The extract of *camellia sinensis* seed in hexane was analyzed using gas chromatography mass spectrometry (GC-MS). Squalene, methyl stearate, methyl linoleate, octadecanoic acid (stearic acid), 1, 6, 10, 14, 18, 22, and 22-Tetracosahexaen-3-ol were among the biochemical components discovered during the investigation to identify the kind of compounds present in the leaf extract GC-MS analysis. The GC-MS chromatography showed that the compounds were present based on their abundance.



PHYTOCHEMICALS COMPOUNDS PRESENT IN CAMELLIA SINENSIS SEED EXTRACT

10.FINAL PRODUCT:



HERBAL OIL

CONCLUSION:

This study examined the phytochemical profile and preliminary bioactive properties of Camellia sinensis seed oil (CSSO) infused with specific Ayurvedic herbs. The herbal infusion included traditional medicinal plants including Amla, Ashwagandha, Neem, Bhringraj, and turmeric that are known for their therapeutic benefits in hair and scalp care. Evaluating the oil's physicochemical quality and bioactive component content.

According to physicochemical investigations, the infused oil's saponification value of 25.25 showed the presence of long-chain fatty acids, which are beneficial for hair nourishment. The acid value of 1.63 indicated

minimal levels of free fatty acids and good oil quality. The peroxide value, as determined by this experiment, was 12meq O₂/kg of oil.

The existence of phytochemical analysis, which revealed a Total Flavonoid Content

After conducting phytochemical analysis, it was determined that the Total Flavonoid Content (TFC) was 3.91 mg QE/g and the Total Phenolic Content (TPC) was 0.08 mg GAE/g. These bioactive substances enhance the oil's capacity to lessen oxidative damage to the hair follicles and scalp. The herbal hair oil's GC-MS study discovered significant bioactive ingredients such as squalene, methyl stearate, and methyl linoleate that help with hair growth, hair strengthening, and scalp nourishment. The traditional application of *Camellia sinensis* seed oil in hair treatment is supported by these substances

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