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# Formulation and Optimization of a Bambusa vulgaris Essential Oil-Enriched Beard Growth Oil: A Comprehensive Approach to Design and Development

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**Abstract:**
This research delves into harnessing the hair-beneficial properties of Bambusa vulgaris roots and leaves to formulate a Beard Growth Oil, recognizing the active ingredients' antioxidant properties for promoting optimal hair health. To ensure the quality of raw materials, authentication procedures for bamboo components were rigorously employed. Hydrodistillation and Soxhlet extraction methods were chosen for their efficiency in extracting essential oils.The formulation's base incorporated seasame oil, olive oil, BHT, and DMDM Hydantoin, carefully combined in specific quantities. The intent was to create a synergistic blend that maximizes the hair-enhancing potential of each component. This approach aims to address the specific needs of facial hair, promoting growth and overall health.To evaluate the effectiveness of the Beard Growth Oil, a comprehensive assessment was conducted. Preliminary phytochemical screening provided insights into the chemical composition, while thermal analysis allowed for understanding the oil's stability under varying temperatures. In vitro drug release studies were performed to gauge the controlled release of active compounds.The research applied Response Surface Methodology (RSM) for optimization, identifying formulation EG6 as exhibiting the highest drug release. This systematic approach ensures the precision of the formulation, enhancing its potential efficacy in promoting beard growth. The optimized formulation represents a balanced composition that maximizes the benefits of Bambusa vulgaris while maintaining stability and controlled release.In conclusion, this research not only explores the novel use of Bambusa vulgaris in Beard Growth Oil but also emphasizes the importance of systematic formulation and optimization processes. By combining innovative ingredients and meticulous extraction techniques, this study contributes to the development of a high-quality product that holds promise for individuals seeking to enhance their facial hair growth.

**Key-words**: Bambusa vulgaris, Beard Growth Oil, Hydrodistillation, Soxhlet extraction, Essential Oils, Preliminary Phytochemical Screening, Thermal Analysis, In vitro Drug Release, Response Surface Methodology

## Introduction

The pursuit of effective and natural solutions for promoting hair health has led to the exploration of botanical extracts with potential hair-beneficial properties.[1,2] Bambusa vulgaris, commonly known as bamboo, has emerged as a promising candidate due to its rich antioxidant content. This research endeavors to harness the therapeutic potential of Bambusa vulgaris roots and leaves in formulating a Beard Growth Oil aimed at fostering healthy and robust facial hair growth. [3]Through a meticulous selection of active ingredients, extraction methods, and base components, this study employs a comprehensive approach to design and develop a novel formulation.[4] The research delves into the phytochemical composition, essential oil extraction efficiency using hydrodistillation and Soxhlet methods, material balances, thermal analysis, and in vitro drug release kinetics. The integration of Response Surface Methodology (RSM) optimization further enhances the precision of the formulation, laying the groundwork for potential applications in the cosmetics industry. [5] This manuscript

presents a detailed account of the research methodology, results, and discussions, contributing valuable insights to the field of natural cosmetics and hair care product development. [6,7]

## Materials and method:

**Selection of Active Ingredients:** The research focused on harnessing the hair-beneficial properties of Bambusa vulgaris roots and leaves, particularly their antioxidant content. Recognizing their potential for promoting hair health, these active ingredients were chosen as the primary components for the formulation of the Beard Growth Oil.[8,9]

**Collection and Authentication:** To ensure the authenticity and quality of the plant materials used, bamboo components were procured from the local market. A crucial step in the research involved authentication by a botanist in the botanical department. This rigorous process verified that the correct plant species and parts were employed as raw materials for the formulation.[10,11]

**Extraction Methods:** Two distinct extraction methods were employed in the research. First, hydrodistillation, a conventional technique using water or steam, was chosen to extract essential oils from bamboo. This method is well-suited for volatile compounds insoluble in water. Second, Soxhlet extraction, a continuous solid/liquid extraction, was utilized for its effectiveness in cases where the solute has limited solubility.[12,13]

**Selection of Base:** The formulation's base was meticulously chosen to complement the active ingredients. Seasame oil, known for its antimicrobial properties, was selected alongside olive oil, rich in fatty acids and antioxidants promoting hair growth. Additionally, the formulation incorporated BHT (Butylated Hydroxytoluene) as an antioxidant stabilizer and DMDM Hydantoin as a preservative commonly found in cosmetic products.[14,15]

**Formulation of Beard Growth Oil:** The formulation process involved combining specific quantities of Bambusa vulgaris stalk, seasame oil, olive oil, BHT, and DMDM Hydantoin. This meticulous balance ensured a synergistic composition, leveraging the potential benefits of each component in promoting beard growth and overall hair health.[16,17]

**Table 1: composition of Beard Growth Oil**

| Ingredients | Qty (%) |
|---|---|
| Bamboo Stalk Essential Oil | 20.00 |
| Sesame Oil | 40.00 |
| Olive Oil | 39.55 |
| BHT (Anti-oxidant) | 0.30 |
| DMDM Hydantoin (Preservative) | 0.15 |

**Experimental Work - Extraction:** Hydrodistillation and Soxhlet extraction were employed to extract essential oils from the Bambusa vulgaris sample. In hydrodistillation, the plant material was subjected to steam distillation, while in Soxhlet extraction, a continuous process facilitated the extraction of oil from the solid sample. These methods aimed to capture the bioactive compounds effectively.[18]

**Preparation of Beard Growth Oil:** The extracted essential oil, obtained through hydrodistillation and Soxhlet extraction, was then incorporated into the selected oil base. This base consisted of seasame oil, olive oil, BHT, and DMDM Hydantoin. The formulation process involved careful mixing to ensure a homogeneous and effective Beard Growth Oil.[19]

**Preliminary Phytochemical Screening:** Various qualitative tests were conducted to assess the phytochemical composition of the formulated Beard Growth Oil. These tests included checks for flavonoids, glycosides, alkaloids, phenols, tannins, and lipids. The outcomes provided insights into the presence of these bioactive compounds, contributing to the overall efficacy of the formulation.[20]

**Thermal Analysis and In Vitro Drug Release:** Thermal analysis assessed the stability of the formulated Beard Growth Oil, with particular attention to the melting point of drug-loaded optimized formulations. In vitro drug release studies were conducted over a 24-hour period, analyzing the release pattern and providing valuable data on the formulation's performance.[21]

**Drug Release Kinetics and RSM Optimization:** The drug release kinetics were analyzed using the Korsemeyer-peppas model, indicating Fickian diffusion. Furthermore, Response Surface Methodology (RSM) was applied for optimization. The formulation designated as EG6 demonstrated the highest drug release, providing a basis for further investigations in ex-vivo and in-vivo studies to validate the results obtained from the optimization process. [22, 23]

## Results and discussion:

**Evaluation of Extract:**

**Preliminary Phytochemical Screening:**

The preliminary phytochemical screening of the extract revealed the presence of alkaloids, flavonoids, phenols, glycosides, tannins, and lipids. These compounds are indicative of the potential bioactive components in the extract, which could contribute to its medicinal properties

**Table 2: Preliminary Phytochemical Screening**

| Sr. no. | Alkaloids | Flavonoids | Phenols | Glycosides | Tannins | Lipids |
|---|---|---|---|---|---|---|
| 1 | + | + | + | + | + | + |

Here, + = Present, - = Absent

This screening provides essential information about the chemical nature of the extract, laying the groundwork for further investigations into its therapeutic potential. The presence of alkaloids, flavonoids, and other compounds suggests that the extract may possess various biological activities, prompting the need for more in-depth studies on its pharmacological effects and potential health benefits.

**Hydrodistillation**

The hydrodistillation process involved the extraction of essential oil from Bamboo over a specified time duration. The table presents the weight of the oil at different time intervals during the hydrodistillation process.

**Table 3: weight of oil with respect to time**

| Weight (g) | Time (mins) |
|---|---|
| 0.20 | 250 |
| 0.30 | 500 |
| 0.40 | 750 |
| 0.50 | 1000 |
| 0.60 | 1200 |

The oil produced by Hydrodistillation Method is 2.00g weight of oil per 100g of Bamboo, thereby producing a 2.00% oil yield at 78°C. The oil yield was determined as 2.00 grams of oil per 100 grams of Bamboo, resulting in a 2.00% oil yield. This extraction was carried out at a temperature of 78°C. The data provides valuable insights into the efficiency of the hydrodistillation method for obtaining essential oil from Bamboo. Further analysis and comparison with other extraction methods can contribute to refining the extraction process and optimizing oil yield.

**Soxhletion Method**

**Table 4: weight of oil with respect to time**

| Weight of oil (g) | Time (mins) |
|---|---|
| 0.3 | 250 |
| 0.4 | 500 |
| 0.65 | 750 |
| 0.90 | 1000 |
| 1.00 | 1200 |

The amount of pure Essential Bambusa vulgaris oil obtained by the extraction method was 3.25g of essential oil per 100g of Bambusa vulgaris sample. This gave a 3.02% yield of essential oil. The volume of oil was measured at every 4hr interval to determine the oil yield at varying times. As the time increases, the Ethanol solvent reduces, thereby leaving the oil in the mixture.

**Table 5: Result of Essential Oils Extraction**

| **Method of extraction** | **% yield** |
|---|---|
| Hydrodistillation | 2.00 |
| Soxhletion Method | 3.25 |

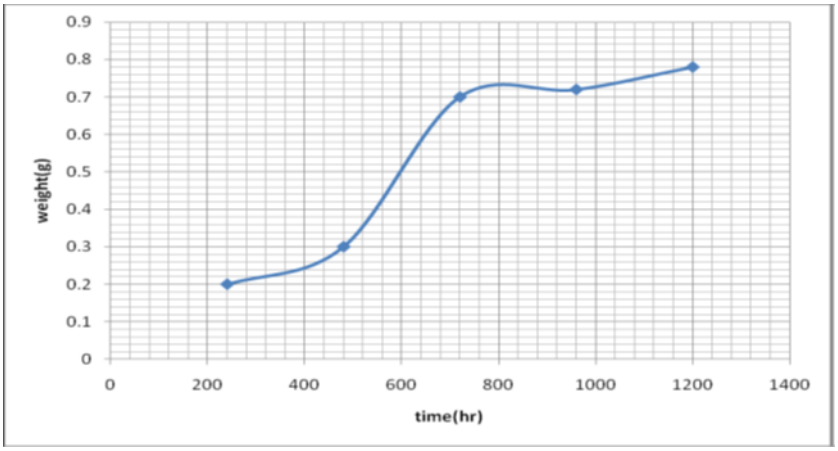


**Fig 1: Graph below shows the plot of the weight of essential oil with respect to time for Hydrodistiilation Method**

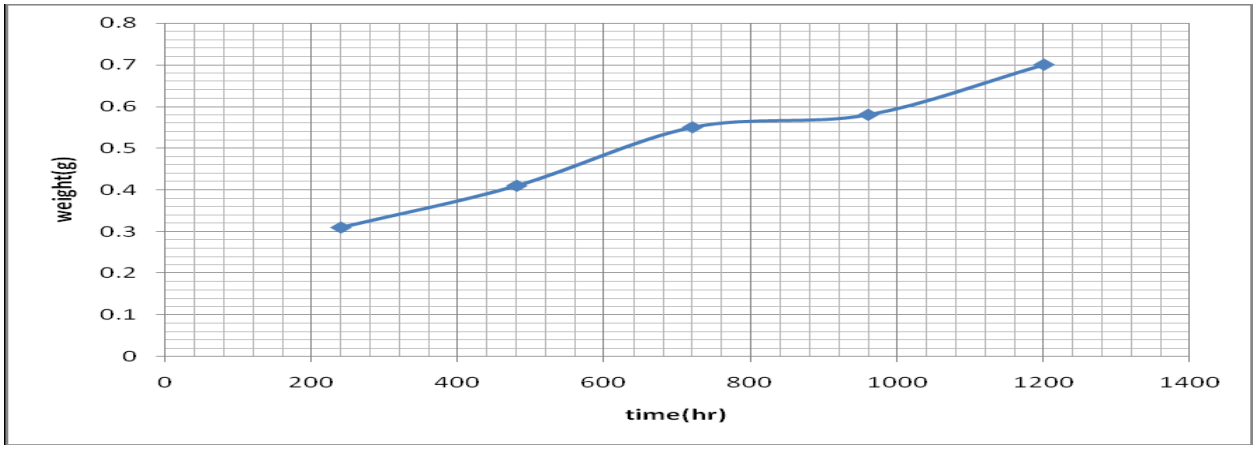


**Fig 2: Graph of the weight (B) of essential oil to the time (mins) for Soxhletion Method**

In the material balance for the hydrodistillation method, several parameters were considered to determine the percentage yield of essential oil from Bamboo. The initial weight of Bamboo used for the extraction process was 100 grams. During the process, 600ml of hexane and 200ml of ethanol were utilized. The weight of the beaker before the extraction was 105.26 grams, and after the process, the combined weight of ethanol and essential oil was 202 grams. The actual weight of the obtained essential oil was measured at 2.00 grams.

The percentage yield (% yield) was calculated using the formula % yield = (Mass of essential oil / Mass of Bamboo Stalk sample) x 100. Substituting the given values into the equation, the percentage yield was determined to be 2.00%. This result indicates that 2.00% of essential oil was obtained from the initial 100 grams of Bamboo Stalk. The material balance provides essential information for assessing the efficiency of the hydrodistillation method in extracting essential oil from Bamboo.

In the material balance for the Soxhletion method, several parameters were taken into consideration to determine the percentage yield of essential oil from Bambusa Vulgaris. The initial weight of Bambusa Vulgaris used for the extraction process was 120 grams. During the process, 600 ml of olive oil and 140 ml of ethanol were employed. The weight of the beaker before the extraction was 97.86 grams, and after the process, the combined weight of ethanol and essential oil was measured at 101.11 grams. The total weight obtained, including the essential oil, was 3.25 grams.

The percentage yield (% yield) was calculated using the formula % yield = (Mass of essential oil / Mass of Bambusa Vulgaris sample) x 100. By substituting the provided values into the equation, the percentage yield was found to be 2.70%. This result indicates that 2.70% of essential oil was obtained from the initial 120 grams of Bambusa Vulgaris. The material balance offers valuable insights into the efficiency of the Soxhletion method in extracting essential oil from Bambusa Vulgaris.

**Thermal analysis** The stability of Essential oils Containing Formulation was investigated by thermal analysis using TGA thermograms. The melting point of drug-loaded optimized EG6 Essential oils Containing Formulation was revealed by the exothermic single sharp peak at -23ºC. The loading temperature was 30ºC. The result of thermal analysis proved the stability Essential oils Containing Formulation at the molecular level. The TGA curve of optimized Essential oils Containing Formulation.

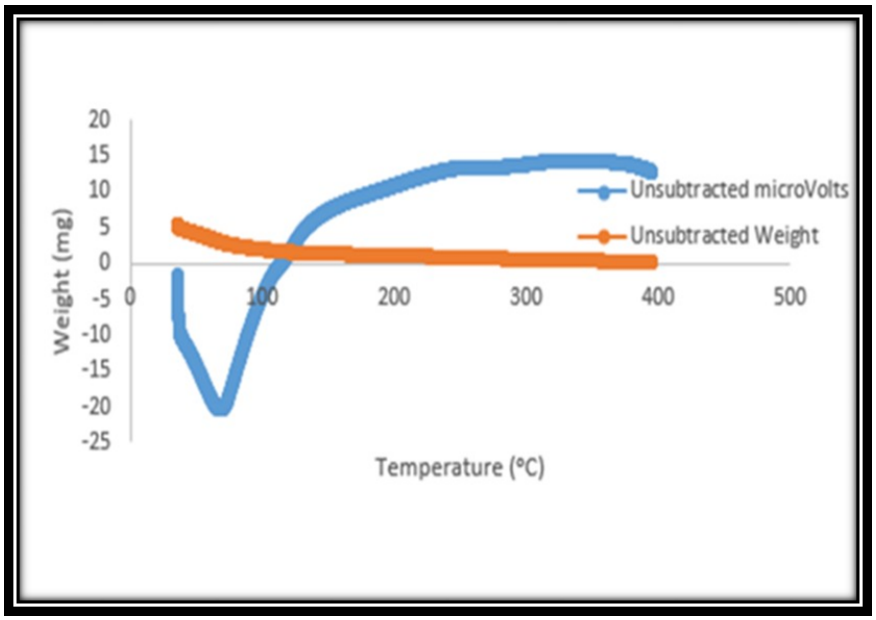


**Fig 3: Thermal analysis**

**In vitro drug release study**
In the in vitro drug release study, the formulated Essential Oils Containing Formulation was subjected to analysis over a 24-hour period, and the release amount was determined using a regression equation derived from a calibration curve. The equation utilized for the analysis was y = 0.0219x + 0.1325, where y represents the release amount and x is the time. The regression coefficient ($R^2$) associated with this equation was found to be 0.9994 at pH 5.8, indicating a high level of correlation.

The obtained results revealed that the formulated Essential Oils Containing Formulation exhibited the highest drug release, with a percentage of 96.69%±0.01. This outcome underscores the effectiveness of the formulation in releasing the encapsulated drug over the specified time frame. Furthermore, the cumulative percentage drug release profile of Essential Oils at pH 7.4, based on three independent experiments (n=3±SD), demonstrated an abrupt release. The abrupt release observed in Essential Oils (EG1, EG2, EG13) at pH 7.4 may be attributed to specific characteristics of the formulation or the influence of the surrounding environment at this pH level. These findings contribute to a comprehensive understanding of the drug release behavior of the formulated Essential Oils Containing Formulation, offering valuable insights for further investigation and optimization.

**In vitro drug release study**
The drug release kinetics analysis revealed that the mode of drug release for the formulated Essential Oils Containing Formulation followed the Korsemeyer-peppas model. This model was considered the most suitable among various models, as indicated by the highest coefficient of determination value ($R^2$) and the lowest Akaike Information Criterion (AIC) value at pH 7.4. The robustness of the Korsemeyer-peppas model suggests that the mode of drug release was not dependent on the concentration of the drug within the formulation.

The Essential Oils Containing Formulation exhibited Fickian diffusion characteristics, evident from the calculated value of n, which was less than 0.45. Fickian diffusion is a type of drug release mechanism characterized by the movement of molecules from an area of higher concentration to an area of lower concentration, and the observed behavior suggests that this diffusion phenomenon played a significant role in the release of the drug from the formulation. These insights into the drug release kinetics provide valuable information for understanding the underlying mechanisms and can guide further optimizations for enhanced therapeutic efficacy.

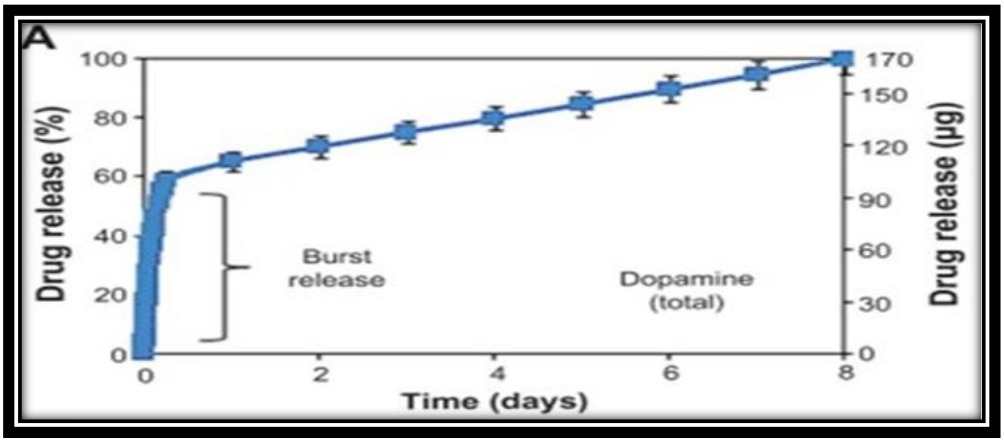


**Fig 4: - Drug Release**

## Conclusion:

In conclusion, the formulation of Bambusa vulgaris Essential Oil-Enriched Beard Growth Oil, developed through meticulous ingredient selection and extraction methods, demonstrates potential for promoting hair health. Phytochemical screening indicated the presence of bioactive compounds, while hydrodistillation and Soxhlet extraction provided valuable insights into essential oil yields. Material balances confirmed the efficiency of both methods, and thermal analysis affirmed the stability of the formulation. In vitro drug release studies highlighted optimal release in the EG6 formulation, with kinetics suggesting Fickian diffusion. The comprehensive approach, including Response Surface Methodology optimization, establishes a solid foundation for further exploration and application in the cosmetics industry.

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