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FORMULATION AND EVALUATION OF TAMARIND (TAMARINDUS INDICA) LEAVES CAPSULE FOR MALARIA TREATMENT.

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Abstract:

Malaria remains a significant global health challenge, particularly in tropical and subtropical regions, where resistance to conventional antimalarial drugs is increasing. Herbal medicines have gained attention as alternative therapeutic agents due to their safety, affordability, and accessibility. Tamarindus indica (tamarind) leaves are traditionally used for their medicinal properties, including antipyretic, anti-inflammatory, and antimicrobial activities. This study focuses on the formulation and evaluation of tablets prepared from tamarind leaf extract for potential antimalarial activity. Tamarind leaves were collected, dried, and subjected to extraction using suitable solvents. The obtained extract was formulated into tablets using standard excipients and compression techniques. The prepared tablets were evaluated for physicochemical parameters such as hardness, friability, weight variation, disintegration time, and dissolution profile. Additionally, preliminary phytochemical screening and in vitro antimalarial activity were assessed. The results indicated that the formulated tablets met pharmacopoeial standards for tablet quality and showed promising antimalarial potential. The study suggests that tamarind leaf-based tablets could serve as a cost-effective and natural alternative for malaria treatment, warranting further in vivo and clinical investigations.

Keywords: Tamarindus indica, Tamarind leaves Capsule, malarial activity, antimalaria, flavonoids.

Introduction:

Malaria is a life-threatening infectious disease caused by Plasmodium parasites, transmitted through the bite of infected female Anopheles mosquitoes. Despite significant advancements in treatment and prevention, malaria continues to pose a major public health burden, particularly in developing countries. The emergence of drug-resistant strains of Plasmodium falciparum has reduced the effectiveness of commonly used antimalarial drugs, creating an urgent need for new therapeutic agents. Medicinal plants have long been used in traditional systems of medicine for the treatment of various diseases, including malaria. Plant-derived compounds have played a crucial role in antimalarial drug discovery, as evidenced by drugs like artemisinin and quinine. In this context, Tamarindus indica, commonly known as tamarind, has attracted scientific interest due to its rich phytochemical composition, including flavonoids, alkaloids, tannins, and phenolic compounds, which exhibit diverse pharmacological activities. Tamarind leaves, in particular, have been reported to possess antipyretic, antioxidant, antimicrobial, and anti-inflammatory properties.¹ Traditional practices in several regions utilize tamarind leaves for the management of fever and infections, suggesting their potential role in malaria treatment. However, there is limited scientific data on the formulation of tamarind leaves into a standardized dosage form such as tablets. Tablet formulation offers advantages such as accurate dosing, improved stability, ease of administration, and patient compliance. Therefore, the present study aims to develop and evaluate tamarind leaf-based tablets for their physicochemical properties and potential antimalarial activity. This research seeks to bridge the gap between traditional knowledge and modern pharmaceutical formulation, contributing to the development of effective herbal antimalarial therapies.²

PHARMACOLOGY OF TAMARIND (TAMARINDUS INDICA) LEAVES

1. Plant profile³

Botanical Name:- Tamarindus indica L.

Common Name:- Tamarind, Imli , Chinch , Tamarindo

Synonyms:-Imli ke patte

Family:-Fabaceae (Leguminosae)

2. Taxonomic hierarchy⁴

Kingdom:- Plantae

Phylum:- Angiosperms

Order:-Fabales

Subfamily:- Caesalpinioideae

Genus:- Tamarindus

Species:-Tamarindus indica L.

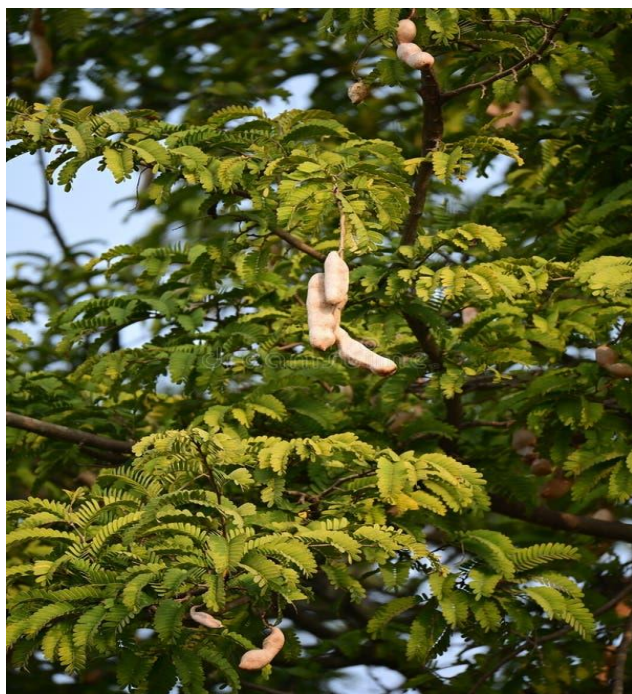


Fig 1: Tamarind tree.



Fig 2: tamarind leaves

ADVANTAGES OF TAMARIND LEAVES ⁵

1. Antimalarial Activity

Tamarind leaves have shown potential antimalarial effects in preliminary studies. Bioactive compounds may inhibit the growth of Plasmodium parasites. Traditionally used to manage fever associated with malaria.

2. Antipyretic (Fever-Reducing)

Leaves are commonly used in traditional medicine to reduce body temperature. Decoctions help in treating fever and infections.

3. Antimicrobial Activity

Exhibits activity against various bacteria and fungi. Useful in treating infections and promoting wound healing.

4. Antidiabetic Activity

May help in reducing blood glucose levels. Improves insulin sensitivity in some experimental studies.

LIFE CYCLE OF MALARIA ⁶

1. In the Mosquito (Sexual Phase)

- When a mosquito bites an infected person, it ingests gametocytes (male and female forms of the parasite).
- Inside the mosquito's gut:
 - Gametocytes fuse → form a zygote
 - Zygote develops into an ookinete
 - Ookinete becomes an oocyst on the gut wall
- The oocyst produces thousands of sporozoites

- Sporozoites migrate to the mosquito's salivary glands, ready to infect another human

2. In Humans (Asexual Phase)

(a) Liver Stage (Pre-erythrocytic stage)

- Infected mosquito bites a human and injects sporozoites
- Sporozoites travel to the liver and infect liver cells
- They multiply to form merozoites
- Liver cells rupture and release merozoites into the bloodstream

(b) Blood Stage (Erythrocytic stage)

- Merozoites infect red blood cells (RBCs)
- Inside RBCs:
 - Develop into trophozoites
 - Then into schizonts
- RBCs burst → release more merozoites
- This cycle causes fever, chills, and other malaria symptoms

(C) Gametocyte Formation

- Some merozoites develop into gametocytes
 - These remain in the blood and are taken up by another mosquito during a bite
- Cycle repeats

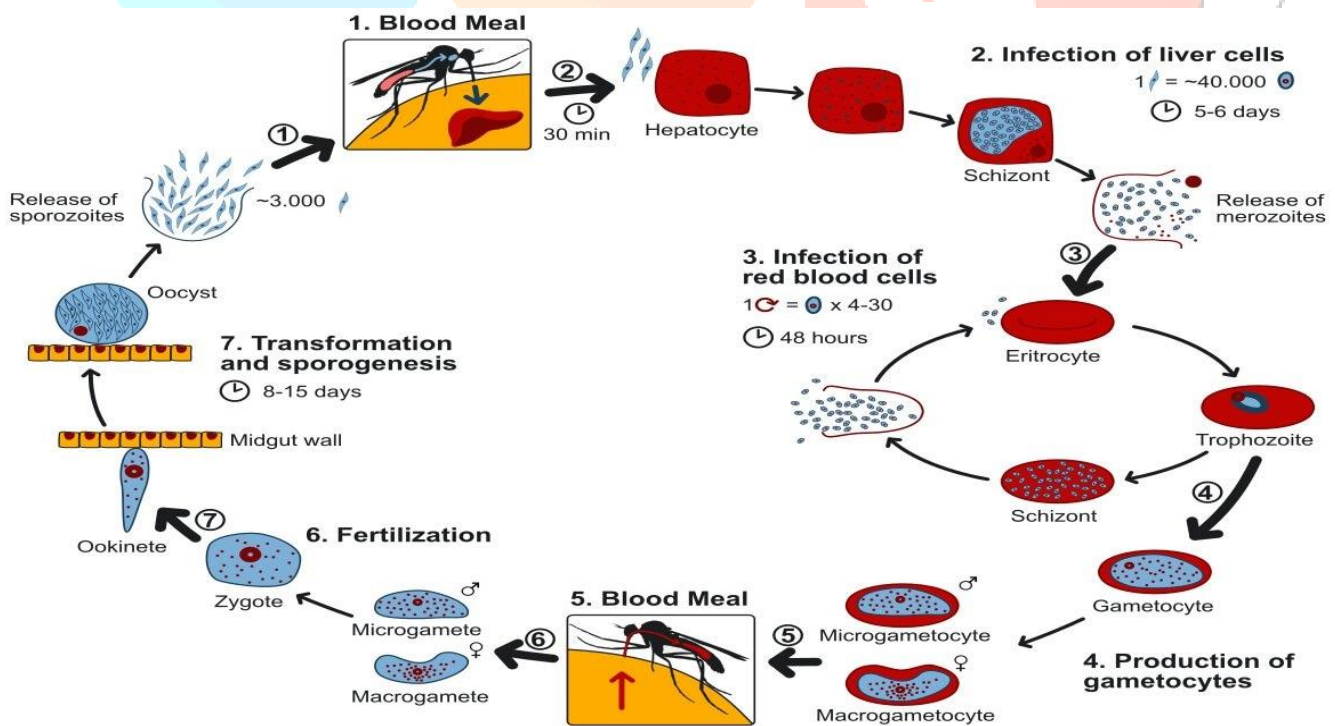


Fig 3:- Life cycle of malaria

MATERIALS AND METHOD

Table of Ingredients:

Table 1: Ingredients

| SR.NO | INGREDIENTS | ROLE |
|-------|----------------------------|-------------------|
| 1. | Tamarind leaves extract | Active Ingredient |
| 2. | Microcrystalline Cellulose | Diluent / Filler |
| 3. | Starch | Binder |
| 4. | Sodium Starch Glycolate | Superdisintegrant |
| 5. | Povidone (K-30) | Binder |
| 6. | Magnesium Stearate | Lubricant |
| 7. | Talc | Glidant |

FORMULATION TABLE:-

| SR.NO | INGREDIENTS | QUANTITY |
|-------|----------------------------|----------|
| 1. | Tamarind leaves extract | 5.0g |
| 2. | Microcrystalline cellulose | 2.0g |
| 3. | Lactose | 1.1g |
| 4. | Sodium starch Glycolate | 0.4g |
| 5. | Povidone (K-30) | 0.3g |
| 6. | Magnesium stearate | 0.1g |
| 7. | Talc | 0.1g |

PRE-FORMULATION PARAMETERS:-

1) Moisture Content :-

The moisture content of tamarind leaves powder was determined by hot air oven method. About 3 g of accurately weighed powder was placed in a moisture dish and dried at 105°C until a constant weight was obtained. The loss in weight was recorded as moisture content. The test was performed in triplicate and the average value was calculated.⁷

2) Angle of Repose :-

The angle of repose was determined using the fixed funnel method.

Formula:

$$\tan \theta = h/r$$

Where,

h = height of the powder heap

r = radius of the circular base

The experiment was carried out three times and the average value was taken.⁸

3) Bulk Density :-

Bulk density was determined by pouring 10 g (M) of tamarind leaves powder into a 50 mL measuring cylinder and noting the bulk volume (Vo).

Formula:

$$D_b = M/V_o$$

Where,

D_b = Bulk density

M = Mass of powder

V_o = Bulk volume

The readings were taken in triplicate and averaged.⁹

4) Tapped Density :-

Tapped density was determined by placing the sample in a measuring cylinder and subjecting it to 250 taps using a tapped density apparatus. The final volume (V_t) was recorded.

Formula:

$$D_t = M / V_t$$

Where,

D_t = Tapped density

M = Mass of powder

V_t = Tapped volume

Triplicate readings were taken and mean values reported.¹⁰

5) Relative Density and Porosity

Relative density and porosity were calculated using bulk and tapped density values.

Formula:

$$RD = TD_{250} /$$

$$\rho_s \epsilon = 1 - RD$$

Where,

RD = Relative density

ϵ = Porosity

ρ_s = particle density¹¹

6) Determination of Carr's Index

Carr's index CI, was calculated from the results obtained from bulk and tapped densities above

Using the relation;

Formula:

$$CI = (T_d - B_d) \times 100 / T_d$$

Where,

CI = Carr's Index¹²

7) Determination of Hausner's Ratio:-

Hausner's Ratio HR, was determined using the results Obtained from both bulk and tapped Densities. It Was calculated using the formula

Formula:

$$HR = Td / Bd$$

Where,

HR = Hausner's Ratio¹³

8) Ash Value:-

A 2 g sample of tamarind leaves powder was taken in a silica crucible and incinerated at 500–600°C until carbon-free ash was obtained. The residue was cooled and weighed.

Formula:

$$\% \text{ Ash value} = W_{ax} 100 / W_{sp}$$

Where,

W_a = Weight of ash

W_s = Weight of sample¹⁴

Characterization Result of Tamarind leaves Powder:(TAMARINDUS INDICA)

| Sr. no | Parameters | Tamarind leaves powder |
|--------|-----------------------|------------------------|
| 1. | Moisture content (%) | 5.2 ± 0.5 |
| 2. | Angle of repose (°) | 30.5 ± 1.3 |
| 3. | Bulk density (g/ml) | 0.48 ± 0.03 |
| 4. | Tapped density (g/ml) | 0.60 ± 0.04 |
| 5. | Carr's index (%) | 20.0 ± 1.1 |
| 6. | Hausner's ratio | 1.25 ± 0.05 |
| 7. | Ash value (%) | 9.5 ± 0.8 |
| 8. | Percentage yield (%) | 80.0 ± 2.5 |

METHODOLOGY:-

1. Preparation of Tamarind Leaves Powder:¹⁵

- **Harvesting:** Fresh leaves of Tamarindus indica are collected from healthy plants and cleaned thoroughly to remove dirt, dust, and foreign materials.
- **Drying:** The leaves are washed and shade-dried or dried in an oven (40–50°C) until complete removal of moisture to prevent degradation of active constituents.
- **Grinding:** The dried leaves are ground using a grinder or mortar and pestle to obtain a fine powder.
- **Sieving:** The powder is passed through a sieve (e.g., 50 µm) to obtain uniform particle size.

2. Mixing of the Ingredients:¹⁶

- **Binder Addition:** Add starch or suitable binder (e.g., PVP or starch solution) to improve cohesiveness of the powder.
- **Disintegrants:** Add sodium starch glycolate or starch to ensure proper disintegration.
- **Lubricants:** Add magnesium stearate to prevent sticking during processing.
- **Fillers:** Add lactose or microcrystalline cellulose to increase bulk and improve handling.

3. Granulation Process:¹⁷

- **Wet Granulation:**

- A small quantity of binder solution is added to the powder mixture to form a wet mass.
- The wet mass is passed through a sieve (e.g., sieve no. 16 or 22) to form granules.
- The granules are dried in an oven (60–65°C) or air-dried.
- The dried granules are sieved again to obtain uniform size.

4. Capsule Filling Process:¹⁸

- **Sizing of Granules:** The dried granules are passed through a sieve (e.g., sieve no. 20–40) for uniform size suitable for capsule filling.
- **Lubrication:** Add a small quantity of lubricant such as magnesium stearate (≈ 0.5 –1%) to improve flow properties.
- **Blending:** The granules are mixed uniformly to ensure even distribution.
- **Capsule Shell Selection:** Select appropriate hard gelatin capsules (e.g., size 0 or 00) based on required dose.
- **Filling Process:¹⁹**
 - Granules are filled into empty capsule shells manually or using a capsule filling machine.
 - Each capsule is filled with a uniform weight.
 - Capsules are properly locked after filling.



Fig:- capsule of tamarind Leave powder

Evaluation Parameter for Formulated capsule

1. Weight Variation Test²⁰

- 20 capsules are selected randomly and weighed individually.
- The average weight is calculated.
- Individual capsule weights are compared with the average weight.

Result: The weight variation of capsules was found within ± 5 –10%, which is within acceptable pharmacopeial limits.

2. Disintegration Test:²¹



Fig: Disintegration test

Six tablets were randomly selected and placed on their Handles in six channels on the shelf of the folding Machine. The metal is raised and lowered at a constant Rate in deionized water in a glass beaker suspended in A water bath whose temperature is maintained at 37 ± 1 °C. The time required for the final mass or part of it To pass through a 2 mm mesh in water (depleted water) Is recorded as the settling time.

Result: The capsules disintegrated within 20–30 minutes, which is within the normal acceptable range.

3. Dissolution Test:²²

Capsules were subjected to in vitro dissolution using USP dissolution apparatus in suitable medium at 37 ± 0.5 °C. Samples were withdrawn at specific time intervals and analyzed.



Fig:-Dissolution test

Result: More than 75% of drug release ($Q \geq 75\%$) was observed within the specified time, indicating good dissolution.

4. Moisture Content (Loss on Drying):

Capsules were weighed and dried in a hot air oven at 105°C until constant weight was obtained. The loss in weight was calculated as percentage moisture content.

Result: The moisture content was found to be $\leq 5\%$, indicating good stability and

suitability of the formulation.

RESULTS AND CONCLUSION:

The tamarind leaves capsules were successfully formulated using finely dried and sieved *Tamarindus indica* leaf powder. The pre-formulation studies showed that the powder blend had acceptable bulk density, tapped density, and angle of repose, indicating good flowability and suitability for capsule filling. Post-formulation evaluation revealed that the capsules complied with standard pharmacopoeial limits for weight variation, ensuring dose uniformity. The drug content uniformity test confirmed that the active constituents were evenly distributed throughout all capsules. The disintegration test demonstrated that the capsules broke down within the prescribed time, allowing proper release of the herbal material. In-vitro dissolution studies indicated a steady and sufficient release of bioactive compounds, suggesting good availability for absorption. Furthermore, phytochemical analysis confirmed the presence of flavonoids, tannins, alkaloids, saponins, and phenolic compounds, which are known for their antimalarial, antioxidant, and anti-inflammatory properties. These results collectively indicate that the formulated capsules possess desirable pharmaceutical qualities and potential therapeutic activity.

In conclusion, the study demonstrates that tamarind leaves can be effectively developed into a stable and efficient capsule dosage form with satisfactory pharmaceutical characteristics. The evaluation parameters confirmed that the formulation meets quality standards in terms of uniformity, disintegration, and drug release. The presence of various bioactive phytoconstituents supports the potential antimalarial activity of the formulation, making it a promising herbal alternative for malaria management. Additionally, the use of tamarind leaves offers advantages such as natural origin, affordability, and ease of formulation. However, despite these promising results, the study is limited to in-vitro evaluation, and further research is essential. Advanced studies including in-vivo testing, pharmacokinetic analysis, toxicity studies, and controlled clinical trials are necessary to validate its safety, efficacy, and therapeutic applicability in humans.

FEATURE SCOPE:-

The future scope of the formulation and evaluation of tamarind leaves capsule for the treatment of Malaria is very promising in the field of herbal medicine and pharmaceutical research. Tamarind leaves from *Tamarindus indica* contain various phytochemicals such as flavonoids, tannins, alkaloids, and phenolic compounds that may possess antimalarial activity. Future studies can focus on detailed pharmacological and toxicological investigations to confirm the safety and effectiveness of the formulation. Clinical trials on human subjects can also be conducted to establish proper dosage, therapeutic efficacy, and possible side effects. Advanced formulation techniques may be used to improve the stability, bioavailability, and patient compliance of the capsules. There is also scope for isolating and identifying the active constituents responsible for antimalarial action and developing more potent herbal formulations. In addition, tamarind leaves capsules may be explored for combination therapy with existing antimalarial drugs to reduce drug resistance and improve treatment outcomes. Large-scale manufacturing, standardization, and commercialization of the herbal capsule can further contribute to providing an affordable and natural treatment option for malaria, especially in rural and economically weaker regions.

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