Formulation and Evalution of Arthritis Nano-Emulsion by Using Karanja Oil

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***Abstract*—Arthritis is a chronic inflammatory condition that affects joints, causing pain, stiffness, and reduced mobility. It is commonly seen in older adults but can affect people of all ages. The most common types are osteoarthritis and rheumatoid arthritis, both of which involve inflammation and gradual damage to joint tissues.**

This study focuses on the development of a patient-friendly oral nano-emulsion using Karanja oil (Pongamia pinnata), known for its anti-inflammatory and analgesic properties. The formulation combines Karanja oil with natural ingredients like turmeric extract, aloe vera, sesame oil, and vitamin E, which work together to reduce joint pain, swelling, and oxidative stress. To improve taste and odor, sweeteners and flavoring agents were added, making the nano-emulsion more acceptable for long-term use.

The nano-emulsion was prepared using a controlled emulsification process to prevent phase separation and ensure stability. Its therapeutic activity is based on the inhibition of inflammatory mediators such as COX-2, TNF-α, and IL-6, along with antioxidant protection and immune modulation. This formulation offers a promising natural alternative for managing arthritis symptoms and improving patient compliance.

***Index Terms*—Nano-emulsion, Herbal Product, Arthritis, Anti-inflammatory, Anti-Arthritis**

I. INTRODUCTION

The word "arthritis" is derived from the Greek words arthro (joint) and itis (inflammation)

Arthritis is a condition that causes pain, swelling, and stiffness in the joints. It happens when the tissues in and around the joints become inflamed or damaged.

Arthritis is a broad term encompassing a group of more than 100 disorders that primarily affect the joints, causing pain, swelling, stiffness, and reduced mobility. It is characterized by inflammation of one or more joints, often accompanied by structural changes in cartilage, synovial membrane, and surrounding tissues.

Arthritis can affect people of all ages, but its prevalence increases with age. According to global health data, it is one of the leading causes of disability, especially among older adults. The condition not only impairs physical function but also impacts emotional well-being, social participation, and overall quality of life

Current treatment strategies include non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, disease-modifying antirheumatic drugs (DMARDs), and biologic agents targeting specific immune pathways. While these therapies can reduce symptoms and slow disease progression, they often come with side effects and long-term risks.

Given the limitations of conventional drugs, there is growing interest in natural and plant-based alternatives that offer anti-inflammatory and antioxidant benefits with improved safety profiles. Herbal compounds such as karanjin, pongamol, and curcumin have shown promise in modulating inflammatory pathways and protecting joint tissues.

Thus, arthritis remains a major public health concern requiring innovative, patient-friendly therapeutic approaches. The development of a sweetened oral nano-emulsion using Karanja oil and supportive herbal actives represents a novel strategy to enhance treatment efficacy, improve compliance, and reduce adverse effects.

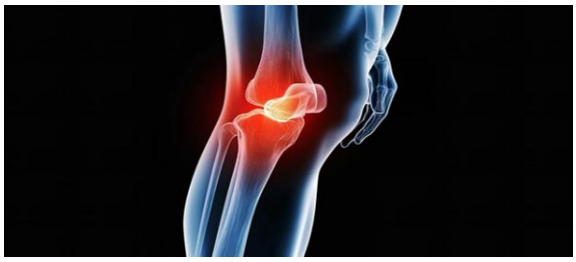


Fig.No.1

Types

I. Osteoarthritis
II. Rheumatoid Arthritis
III. Gouty Arthritis
IV. Psoriatic Arthritis
V. Ankylosing Spondylitis
VI. Juvenile Idiopathic Arthritis
VII. Infectious (Septic) Arthritis
VIII. Reactive Arthritis

a) Osteoarthritis:

This is the "wear and tear" type. It happens when the cushion between your bones (cartilage) wears down. Achy joints, especially after moving a lot. Common in knees, hips, and hands.

b) Rheumatoid Arthritis:

This is when your immune system attacks your joints by mistake. Swollen, stiff joints (especially in the morning), tiredness, and sometimes fever. It usually affects both sides of the body equally.

c) Gouty Arthritis:

Caused by too much uric acid in the body, which forms crystals in the joints. Feels like: Sudden, sharp pain—often in the big toe. The joint gets red, hot, and swollen.

d) Psoriatic Arthritis:

This happens in people who have psoriasis (a skin condition). Feels like: Joint pain and swelling, plus skin rashes and nail changes. Fingers and toes may look swollen like sausages.

e) Ankylosing Spondylitis:

A type of arthritis that mainly affects the spine. Feels like: Stiffness and pain in the lower back, especially in the morning. Over time, the spine may become less flexible.

f) Infectious (Septic) Arthritis:

Caused by an infection in the joint. Feels like: Sudden pain, swelling, and redness in one joint—often with fever. Needs quick medical treatment.

g) Reactive Arthritis:

Happens after an infection in another part of the body (like the stomach or bladder). Feels like: Joint pain, eye redness, and pain when peeing. Can also cause skin rashes.

Symptoms:

I. Joint Pain: Persistent or intermittent pain, often worsened by movement or pressure.
II. Joint Swelling: Inflammation leads to visible puffiness and tenderness around affected joints.
III. Stiffness: Especially noticeable in the morning or after periods of inactivity.
IV. Reduced Range of Motion: Difficulty in fully bending, extending, or rotating joints.
V. Warmth and Rednesse: inflamed joints may feel warm to the touch and appear reddish.
VI. Fatigue: Common in autoimmune types like rheumatoid arthritis due to systemic inflammation.
VII. Joint Deformity: In advanced cases, structural changes may cause visible joint misalignment.
VIII. Muscle Weakness: Surrounding muscles may weaken due to disuse or inflammation.

Causes

I. Wear and tear: Over time, joints naturally break down. This is the main cause of osteoarthritis.
II. Immune system problems: In rheumatoid arthritis, your body mistakenly attacks its own joints.
III. Genetics: If your parents or grandparents had arthritis, you might be more likely to get it too.
IV. Infections: Bacteria or viruses can enter a joint and cause infectious (septic) arthritis.
V. Injury: A past joint injury (like a fracture or sprain) can lead to arthritis later.
VI. Obesity: Extra weight puts more pressure on joints, especially knees and hips.
VII. Uric acid buildup: Too much uric acid in the blood can form crystals in joints, causing gout.
VIII. Skin conditions: People with psoriasis may develop psoriatic arthritis.
IX. Digestive or urinary infections: These can trigger reactive arthritis.
X. Age: The older you get, the higher your risk of developing arthritis.

Pathophysiology:

Rheumatoid Arthritis (RA):

1. The immune system, which normally protects the body, starts attacking the joints by mistake.

2. It targets the lining of the joints (called the synovium), causing swelling and pain.

3. Special immune cells release chemicals like TNF-α and IL-6 that increase inflammation.

4. The body also makes antibodies like rheumatoid factor (RF) that worsen the damage.

5. The inflamed lining grows into a thick layer called pannus, which damages cartilage and bone.

6. This leads to joint deformity, loss of movement, and long-term disability.

7. RA can also affect other parts of the body like the lungs, heart, and eye

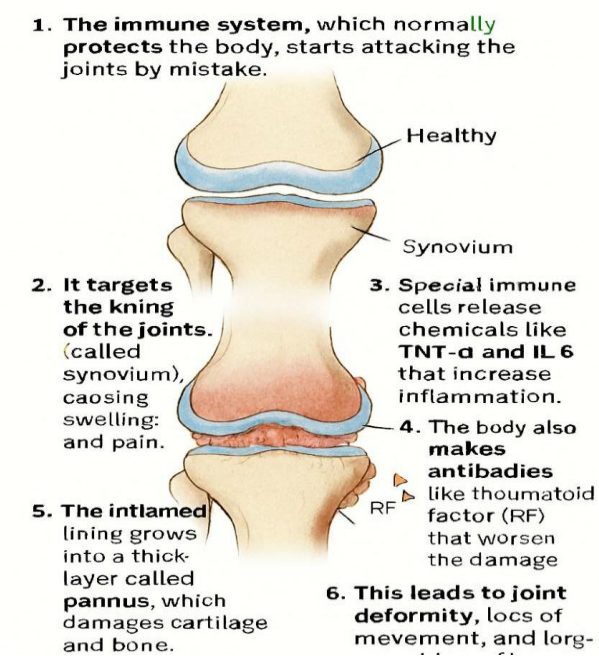


Fig.No.2

Osteoarthritis (OA):

1. The joints go through wear and tear over time due to aging, injury, or repeated use.

2. The smooth cartilage that covers the ends of bones starts to break down.

3. Without enough cartilage, bones rub against each other, causing pain and stiffness.

4. The body tries to repair the damage, but this leads to extra bone growth called bone spurs.

5. The space between the bones becomes narrow, and the joint loses flexibility

6. Mild inflammation may occur, adding to the discomfort.

7. Over time, the joint becomes stiff, painful, and harder to move.

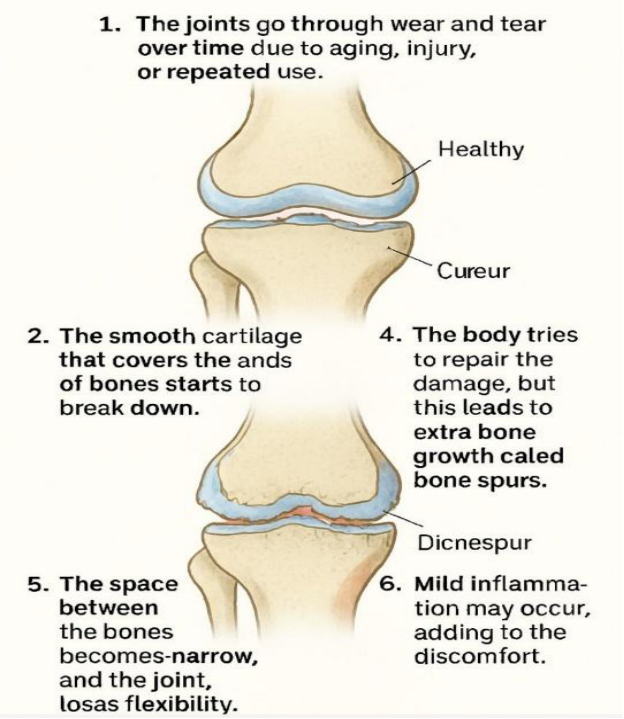


Fig.No.3

II. LITERATURE SURVEY

I. Textbook of Pharmacognosy – C.K. Kokate, A.P. Purohit, S.B. Gokhale – Nirali Prakashan, 2020 – Supports herbal drug source and Karanja oil selection

II. Essentials of Medical Pharmacology – K.D. Tripathi – Jaypee Brothers Medical Publishers, 2021 – Explains anti-inflammatory pharmacology relevant to arthritis

III. Textbook of Biopharmaceutics and Pharmacokinetics – Shobha Rani R. Hiremath – Prism Books Pvt. Ltd., 2019 – Guides absorption and bioavailability of oral nano-emulsion

IV. Textbook of Pharmaceutical Analysis – Ashok K. Kulkarni – Nirali Prakashan, 2020 – Supports evaluation and validation of nano-emulsion formulation

V. Pharmacognosy and Phytochemistry – Vinod D. Rangari – Career Publications, 2022 – Details phytochemical screening of Karanja oil

VI. Pharmaceutical Microbiology – N.K. Jain – Vallabh Prakashan, 2018 – Assists in microbial testing of herbal nano-emulsion

VII. Textbook of Industrial Pharmacy – P.G. Yeole, S.K. Jain, S.J. Wadher – Everest Publishing House, 2020 – Supports formulation scale-up and SUPAC compliance

VIII. Pharmaceutical Jurisprudence – Mithal B.M. – Vallabh Prakashan, 2019 – Covers regulatory guidelines for herbal products

IX. Handbook of Medicinal Plants – S.S. Handa, M.K. Kaul – CBS Publishers & Distributors, 2021 – Provides ethnobotanical data on Karanja and its therapeutic use

X. Herbal Drug Technology – A.K. Gupta, S.S. Tandon – CBS Publishers & Distributors, 2020 – Supports formulation techniques and standardization of herbal nano-emulsions

III. PLANOFWORK

1) Introduction
2) Literature review
3) Selection of standard plant
4) Selection of material
5) Phytochemical screening
6) Formulation process
7) Evaluation of herbal Nano-emulsion.
8) Result and discussion
9) Conclusion
10) Reference

IV. MATERIAL

Drug: Karanja Oil (Pongamia Pinnata)
Excipient: Karanja Oil, Olive Oil, Beeswax, Turmeric Extract, Aloe Vera Extract, Lecithin, Polysorbate 80, Vitamin E, Citric Acid, Rosemarry Extract, Glycerin, Sorbitol, Orange flavor, Distilled Water.
Equipment: Beaker, Funnel, Stirrer, Separating Funnel, Tripod Stand, Teat Tube.
Instrument: Weighing Balance, Mixture.

V. METHOD

Process of Extraction:
A) Turmeric extract:
1. Selection & Cleaning
Choose mature, dried turmeric rhizomes.
Wash thoroughly to remove dust and soil.
2. Drying & Powdering
Shade-dry the rhizomes until crisp.
Grind into fine powder using a grinder.
3. Weighing
Take 25–50 g of turmeric powder depending on batch size.
4. Mixing with Water
Add powder to 250–500 mL of distilled water in a beaker.
Stir well to form a uniform suspension.
5. Heating
Heat the mixture at 60–70°C for 1–2 hours using a water bath.
Stir occasionally to enhance extraction.
6. Cooling
Allow the mixture to cool to room temperature.
7. Filtration
Filter through muslin cloth or Whatman filter paper.
Collect the yellow aqueous extract.

B) Aloe Vera Extract:
1. Leaf Selection & Cleaning
Choose thick, mature Aloe vera leaves.
Wash thoroughly under running water.
2. Peeling
Cut off spiny edges.
Peel away the green outer layer to expose the clear gel.
3. Gel Collection
Scoop out the gel using a sterile spoon or knife.
4. Homogenization
Blend the gel to obtain a smooth, uniform consistency.
5. Filtration
Filter through muslin cloth to remove fibers and impurities.

VI. PLANT PROFILE

Karanja Oil (Pongamia Pinnata).
Drug Name: Pongamia Pinnata.

Biological Source: The drug consists of dried seeds and sometimes oil obtained from seeds of Pongamia pinnata.
Family: Fabaceae (Leguminosae).
Chemical Constituents:
Fixed oil (27–36%) → Karanja oil.
Furanoflavones (Karanjin, Pongamol).
Flavonoids (Kanugin, Glabrin, Pinnatin).
Tannins.
Minor constituents → sterols, fatty acids (oleic, linoleic, palmitic).
Morphological Characteristics:
Colour: Brown to dark brown.
Odour: Characteristic, slightly unpleasant (due to oil).
Taste: Bitter, acrid, and disagreeable.
Texture: Oily, smooth externally, hard seed coat, kernel oily.

Uses
Anti-inflammatory: Effective in treating joint pain and arthritis.
Antimicrobial: Active against skin and wound infections.
Antioxidant: Protects tissues from oxidative stress.
Emollient: Used in topical and oral formulations for soothing effects.
Traditional use: Ayurvedic applications for skin diseases, ulcers, and joint disorders.

VII. EXCIPIENTS

1.Olive Oil

Drug Name: Olive Oil

Biological Source: Olive oil is a fixed oil obtained from the ripe fruit of Olea europaea Linn. (family: Oleaceae).

Chemical Constituents:

- Oleic acid (55–85%)
- Palmitic acid (7–20%)
- Linoleic acid (3.5–20%)
- Stearic acid (0.5–5%)
- Sterols (β-sitosterol)
- Tocopherols (Vitamin E)
- Squalene
- Pigments (chlorophyll, carotenoids)

Morphological Characteristics (of Oil):

- Colour: Pale yellow to greenish-yellow liquid.
- Odor: Pleasant, faint characteristic odor.
- Taste: Bland, faintly sweet, oily taste.
- Consistency: Thick, oily liquid at room temperature.
- Solubility: Insoluble in water; soluble in organic solvents like ether, chloroform, petroleum ether.

Uses:

- Emollient, demulcent, mild laxative.
- Used in liniments and ointments as a base.
- Antioxidant and cardioprotective (rich in monounsaturated fatty acids).
- Anti-inflammatory (used in arthritis and joint pain). Mild cholagogue (stimulates bile flow).

2. Aloe Vera:

Drug Name: Aloe (Aloe vera gel / Aloe juice)

Biological Source: Obtained from the leaves of Aloe vera (syn. Aloe barbadensis Linn.,

Family: Liliaceae / Asphodelaceae).

- Chemical Constituents:
- Polysaccharides (acemannan, glucomannan)
- Glycoproteins
- Vitamins (A, C, E, B12, folic acid)
- Minerals (Ca, Mg, Zn, Se)

Morphological Characteristics:

- Colour: Colourless to pale yellow, transparent, mucilaginous mass.
- Odor: Faint, characteristic.
- Taste: Mucilaginous, slightly bitter.

Uses:

- Wound healing, burns
- Skin ulcers.
- Anti-inflammatory
- Moisturizing agent.
- Immunomodulatory
- Antioxidant.

3. Turmeric

Drug Name: Turmeric, Curcuma

Biological Source:Dried rhizomes of Curcuma longa Linn. (syn. Curcuma domestica Valeton), family Zingiberaceae.

Chemical Constituents:

- Curcumin (diferuloylmethane)
- Demethoxycurcumin
- Bis-demethoxycurcumin
- Volatile Oil (2–7%)
- α- and β-Turmerone
- Zingiberene
- Phellandrene
- Sabinene

Morphological Characteristics:

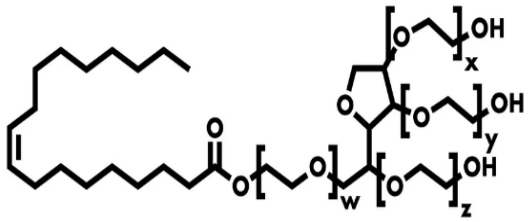
- Shape: Short, thick, ovate or cylindrical, branched (“finger rhizomes”).
- Colour: Yellowish to orange internally; brownish externally.
- Fracture: Hard, horny.
- Odor: Aromatic, characteristic.
- Taste: Bitter, slightly pungent.

Uses:

- Anti-inflammatory, antioxidant, antimicrobial.
- Used in arthritis, wound healing, digestive disorders.
- Hepatoprotective (supports liver).
- Potential anticancer activity.

3. Polysorbate 80

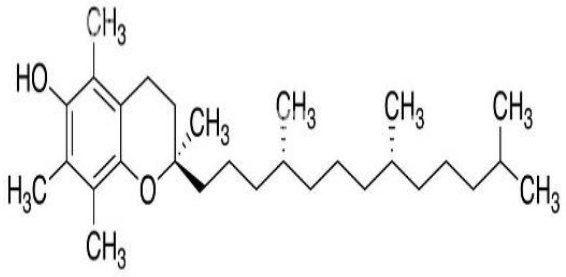
- Official Name: Polysorbate 80 (as per IP, USP, BP)
- Chemical Name: Polyoxyethylene (20) sorbitan monooleate
- Structure:



- Molecular Formula: $C_{64}H_{124}O_{26}$
- Molecular Weight: 1,310 g/mol
- Category: Non-ionic surfactant, emulsifying agent, solubilizer
- Description:
- Colour: Amber-yellow to orange oily liquid
- Viscosity: Viscous.
- Odour: Faint, characteristic
- Solubility: Freely soluble in water, ethanol, and methanol Miscible with oils, aromatic hydrocarbons, and chlorinated solvents

4.Vitamin E

- Official Name: Tocopherol or α-Tocopherol (most active form)
- Chemical Name: (2R)-2,5,7,8-tetramethyl-2-[(4R,8R)-4,8,12-trimethyltridecyl]-6-chromanol
- Structure:



- Molecular Formula: $C_{29}H_{50}O_2$
- Molecular Weight: 430.71 g/mol
- Category:
  - Fat-soluble vitamin
  - Antioxidant
  - Nutraceutical / dietary supplement
- Description:

A light yellow to amber, clear, viscous oil. It is sensitive to light and air, and gradually darkens upon exposure.

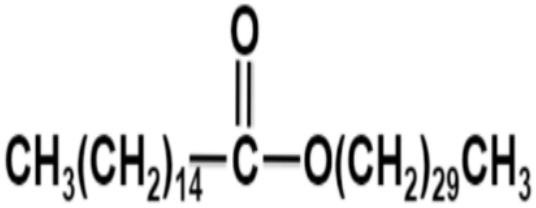
- Odour:

Practically odourless or very faint characteristic odour.

- Solubility:
  - Soluble in fats, oils, alcohol, ether, chloroform, acetone.
  - Practically insoluble in water.

5. Beeswax:

- Official Name: Beeswax (Yellow Beeswax / White Beeswax as per processing)
- Chemical Name: Esters of myricyl alcohol ($C_{30}H_{61}OH$) with palmitic acid ($C_{16}H_{32}O_2$), along with hydrocarbons and free fatty acids.
- Structure:



- Molecular Weight: Variable (depends on components), approx. ≈700–1200 g/mol for esters.
- Category:
  - Natural product
  - Pharmaceutical excipient (base for ointments, creams)
  - Cosmetic ingredient
  - Polishing / coating agent
- Description:

Yellow or whitish solid, tough but pliable, with a granular fracture. Softens when warmed, and melts at about 62–65 °C.

- Odour:

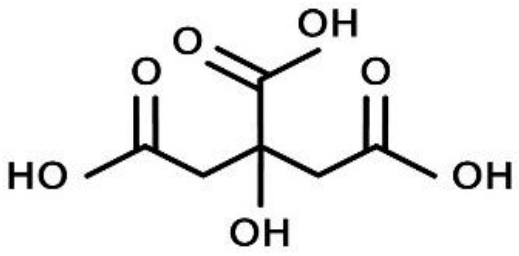
Characteristic honey-like odour.

- Solubility:
  - Practically insoluble in: water
  - Slightly soluble in: alcohol
  - Soluble in: chloroform, ether, fixed oils, volatile oils

6. Citric Acid

- Official Name: Citric Acid Monohydrate (most common official form) or Citric Acid Anhydrous
- Chemical Name: 2-hydroxy-1,2,3-propane-tricarboxylic acid

- Structure:



- Molecular Formula:
  - Anhydrous: $C_6H_8O_7$
  - Monohydrate: $C_6H_8O_7 \cdot H_2O$
- Molecular Weight:
  - Anhydrous: 192.12 g/mol
  - Monohydrate: 210.14 g/mol
- Category:
  - Acidulant
  - Antioxidant synergist
  - Buffering agent
  - Chelating agent
  - Pharmaceutical excipient / food additive (E330)
- Description:
  Colourless, odourless, crystalline solid or white, crystalline powder with a strong acidic taste.
- Odour: Odourless
- Solubility:
  - Freely soluble in: water, ethanol (95%)
  - Practically insoluble in: ether, chloroform

7.Methylparaben:

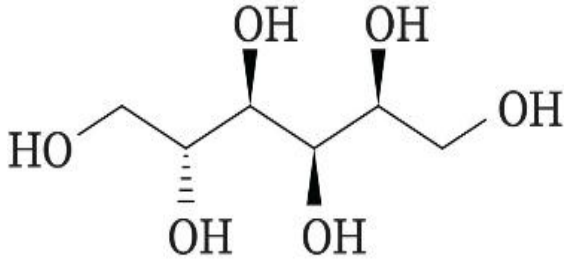
- Official Name: Methylparaben (also called Methyl 4-hydroxybenzoate)
- Chemical Name: Methyl 4-hydroxybenzoate
- Molecular Formula: $C_8H_8O_3$
  - Molecular Weight: 152.15 g/mol
- Category:
  - Antimicrobial preservative
  - Pharmaceutical excipient
  - Cosmetic preservative
  - Food preservative (E218)
- Description:
  White, crystalline powder or colourless crystals. Stable on storage and incompatible with strong oxidizing agents.
- Odour:

Practically odourless or faint characteristic odour.

- Solubility:
  - Soluble in: ethanol, ether, acetone, propylene glycol
  - Slightly soluble in: water (about 0.25% at room temperature)
  - Freely soluble in: alkaline solutions (due to salt formation)

8.Sorbitol

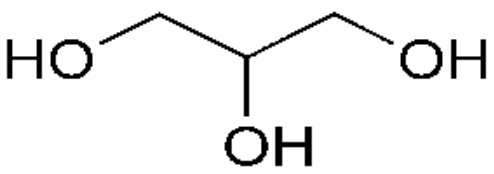
- Official Name: Sorbitol (Ph. Eur., USP, IP)
- Chemical Name: D-glucitol (a sugar alcohol derived from glucose)
- Molecular Formula: $C_6H_{14}O_6$.
- Structure



- Molecular Weight: 182.17 g/mol
- Category:
  - Humectant
  - Sweetening agent
  - Stabilizer
  - Pharmaceutical excipient / food additive (E420)
- Description: Colourless, odourless, sweet, viscous liquid (70% solution) or white crystalline solid.
- Odour: Odourless
- Solubility:
  - Freely soluble in water
  - Slightly soluble in ethanol
  - Practically insoluble in ether and chloroform
- Uses:
  - Sweetener in syrups, lozenges, toothpaste, chewing gum
  - Humectant in cosmetics & pharmaceuticals
  - Laxative (osmotic action)
  - Prevents crystallization in syrups

9.Glycerin

- Official Name: Glycerin (IP, USP) / Glycerol (Ph. Eur.)
- Chemical Name: Propane-1,2,3-triol
- Structure:



- Molecular Formula: $C_3H_8O_3$

- Molecular Weight: 92.09 g/mol
- Category
  - Humectant
  - Emollient
  - Sweetening agent
  - Pharmaceutical excipient
  - Cosmetic ingredient

- Description
  Clear, colourless, viscous liquid with a sweet taste. Hygroscopic in nature.
- Odour: Odourless
- Solubility:
  - Freely soluble in: water, alcohol
  - Miscible with: chloroform and propylene glycol
  - Practically insoluble in: oils and fats.
- Uses
  - Humectant in creams, lotions, and oral formulations
  - Sweetening agent in syrups
  - Solvent for drugs (especially tannins, phenols, boric acid)
  - Laxative (osmotic action in high doses)
  - Plasticizer in capsule shells
  - Emollient in dermatological preparations

VIII. FORMULATION TABLE

Sr NO.	Ingredient	Use	F1	F2	F3
1	Karanja Oil	Active Anti-inflammatory Agent	7.5ml	7.5ml	7.5ml
2	Olive Oil	Enhances Absorption	2.5ml	2.5ml	2.5ml
3	Aloe vera	Smoothing, Supports tissue repair	2.5ml	2.5ml	2.5ml
4	Turmeric Extract	Anti-inflammatory	1ml	1ml	1ml
5	Polysorbate 80	Solubilizer & Stabilizes Emulsion	0.5gm	0.5gm	0.5gm
6	Vitamin E	Prevents Oxidation	0.25ml	0.25ml	0.25ml
7	Beeswax	Emulsifier & Stabilizer	2.5gm	2.5gm	2.5gm
8	Citric Acid	PH Adjuster	0.1gm	0.1gm	0.1gm
9	Methylparaben	Preservative	0.3ml	0.3ml	0.3ml
10	Sorbitol	Sweetening Agent	3gm	3gm	3gm
11	Glycerin	Sweetener & Humectant	5ml	4ml	3ml
12	Orange Flavour	Flavouring Agent	2.4ml	2.4ml	2.4ml
13	Distilled Water	Vehicle	22.4ml	23.4ml	24.ml

IX. EVALUTION PARAMETER

1.Physical Properties

This test evaluates the nano-emulsion's appearance, colour, odour, and consistency. A stable nano-emulsion should exhibit uniform colour, pleasant odour (especially if flavoured), and smooth texture without signs of phase separation or creaming. These properties reflect the product's aesthetic appeal and initial stability.

2.Solubility

Solubility testing determines how well the nano-emulsion disperses in water. A small quantity of nano-emulsion is mixed with distilled water and observed for miscibility. Complete dispersion without oil droplets confirms an oil-in-water system and ensures ease of administration and absorption.

3.Homogeneity

Homogeneity ensures that all ingredients are uniformly distributed throughout the nano-emulsion. It is assessed visually or microscopically. A homogeneous nano-emulsion lacks lumps, aggregates, or layering, which is critical for consistent dosing and therapeutic effect.

4.Stability Study

Stability testing evaluates the nano-emulsion's resistance to physical and chemical changes over time, Centrifugation test to detect phase separation, Stable nano-emulsions show no separation, discoloration, or odour change, confirming shelf-life and robustness.

5.Measurement of pH

The pH of the nano-emulsion is measured using a digital pH meter. For oral formulations, a pH range of 5.5–7.0 is ideal to ensure mucosal compatibility and minimize irritation. pH also influences drug stability and taste.

6.Zeta Potential (Optional)

Indicates electrostatic stability of nano-emulsion droplets.

Higher absolute values suggest better repulsion and stability.

7.Drug Content Uniformity

MeasuredZ using UV spectrophotometry or HPLC.

Ensures accurate dosing and therapeutic consistency.

X. CHEMICAL TEST

1.Alkaloids (Mayer's and Wagner's Test)

Procedure: Mix 1 ml of Karanja oil extract with dilute HCl, Add a few drops of Mayer's reagent (potassium mercuric iodide) or Wagner's reagent (iodine in potassium iodide).

Observation: Formation of cream-colored (Mayer's) or reddish-brown (Wagner's) precipitate indicates presence of alkaloids.

2.Flavonoids:

Procedure: Add magnesium turnings and a few drops of concentrated HCl to 1 mL of extract.

Observation: Appearance of pink or red coloration confirms flavonoids.

3.Saponins (Foam Test)

Procedure: Shake 1 mL of extract with 10 mL distilled water in a test tube, let it stand for 15 minutes.

Observation: foam formation indicates saponins.

4. Test for Tannins (Ferric Chloride Test)

Procedure: Add a few drops of 5% ferric chloride solution to 1 mL of extract.

Observation: Formation of blue-black or greenish-black colour confirms tannins.

5. Test for Glycosides (Keller-Killiani Test)

Procedure: Mix 2 mL of extract with glacial acetic acid, one drop of ferric chloride, and concentrated sulfuric acid.

Observation: Formation of brown ring at the interface indicates presence of cardiac glycosides.

Phytochemical Screening:

Sr No.	Phytochemical	Method Use	Observation
1	Alkaloids	Mayer's, Wagner's, Dragendorff's	Creamy white, reddish-brown, or orange precipitate
2	Flavonoids	Alkaline Reagent, Shinoda's	Yellow coloration (alkaline), pink/red (Shinoda's)
3	Saponins	Foam Test	Persistent froth after shaking
4	Tannins	Ferric Chloride Test	Blue-black or greenish-black coloration
5	Glycosides	Keller-Killiani Test	Reddish-brown ring and bluish-green layer

XI. CONCLUSION

Karanja oil-based nano-emulsion presents a highly promising and innovative herbal approach for the effective management of arthritis. Due to its enhanced penetration capability, improved solubility, superior stability, and minimal side effects, this nano-emulsion formulation offers significant therapeutic advantages over conventional dosage forms. The incorporation of Karanja oil into a nano-emulsion system provides excellent anti-inflammatory and analgesic properties, which are essential for reducing pain, swelling, and joint stiffness associated with arthritis. Thus, a safe, effective, and patient-friendly nano-emulsion formulation can be successfully developed to improve treatment outcomes and enhance patient compliance. In conclusion, Karanja oil-based nano-emulsion stands as a highly beneficial advancement in herbal nanotechnology, offering a modern, natural, and scientifically supported solution for arthritis treatment and holding great potential for future therapeutic use.

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