WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 13, 1447-1476. Research Article ISSN 2277–7105

DEVELOPMENT OF A TOPICAL SOLANUM TUBEROSUM SPRAY FOR ARTHRITIS PAIN RELIEF

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Article Received on
20 May 2025,

Revised on 09 June 2025,
Accepted on 29 June 2025,

DOI: 10.20959/wjpr202513-37141

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ABSTRACT

Arthritis is a common condition that causes joint pain, swelling, and stiffness, making daily activities difficult. Many people use NSAIDs (nonsteroidal anti-inflammatory drugs) for pain relief, but these medicines can have harmful side effects when used for a long time. This study focuses on creating a topical spray using Solanum tuberosum (potato) extract as a natural alternative for arthritis pain relief. Potatoes contain beneficial compounds like glycoalkaloids, phenolic acids, and flavonoids, which help reduce pain and inflammation. The study included extracting active ingredients, developing a stable spray, and testing its effects in laboratory and animal models. The results showed that the spray reduced pain and swelling effectively. It was also stable and non-irritating, making it safe for use on the skin. These findings suggest that Solanum tuberosum could be a useful natural treatment for arthritis pain. More clinical studies are needed to confirm its effectiveness and safety for human use.

KEYWORDS: Solanum tuberosum, arthritis pain relief, topical spray, anti-inflammatory, pain relief, natural remedy, joint pain treatment.

INTRODUCTION

Definition: Arthritis is when your joints get swollen, which makes them hurt and feel stiff, especially as you age.

PATHOPHYSIOLOGY OF ARTHRITIS

1. Causes

- Genetics: Some people inherit a tendency to develop arthritis.
- Environment: Factors like infections or toxins can trigger the condition.

2. Immune System Response

- The body's immune system mistakenly becomes overactive.
- This leads to inflammation in the joints.

3. Inflammation

- Inflammatory substances are released, causing swelling and pain.
- Immune cells attack the joint tissues.

4. Joint Damage

- The lining of the joints becomes inflamed.
- Cartilage (the cushion between bones) breaks down.
- Bones may start to erode.
- Joints may become misshapen.
- This can lead to ongoing disability.
- Long-Term Changes:

Bone spurs can form (extra There are several types of arthritis, and they can be caused by things like normal wear and tear on the joints, infections, or other health issues.

TYPES OF ARTHRITIS

1) Osteoarthritis(OA)
2) Rheumatoid Arthritis(RA)
3) Psoriatic Arthritis(PsA)
4) Gout
5) Fibromyalgia
6) Lupus
7) Ankylosing Spondylitis

1. **Osteoarthritis:** Osteoarthritis is a condition where the cartilage in your joints breaks down over time. This cartilage normally helps cushion the bones, so when it wears away, it can lead to pain and stiffness in the joints.[1]

- Mechanism: Osteoarthritis (OA) is when the cartilage in joints wears down, causing pain and stiffness from stress and inflammation.
- Symptoms: Osteoarthritis causes joint pain, stiffness, swelling, and trouble moving.
- Affected Joints: It usually affects the knees, hips, spine, and hands.
- Causes: Common causes include joint injuries, overusing the joints, getting older, and being overweight.
- Treatment: Treatment options include exercise, healthy eating, using supportive devices, applying heat or cold, trying complementary therapies, and surgery if need.

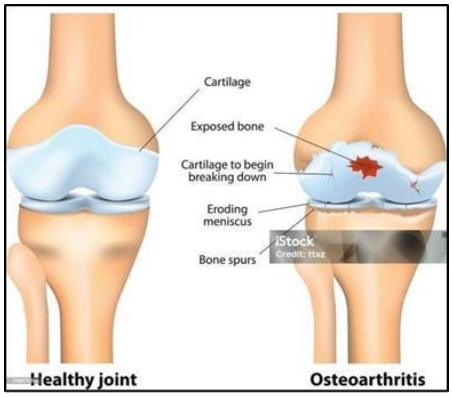

Fig. No. 1: Osteoarthritis.

- **Rheumatoid Arthritis:** Rheumatoid Arthritis (RA) is a chronic condition that lasts for a long time. It causes the body's immune system to attack the joints, leading to pain, swelling, and stiffness. Over time, this can lead to joint damage and disability.[2]
- Mechanism: Rheumatoid arthritis (RA) happens when the body's immune system accidentally attacks the joints, leading to swelling, pain, and damage to the affected areas.
- Symptoms: Joint pain, stiffness, tenderness, heat, and swelling, Fatigue, Occasional fevers, Loss of appetite.
- Causes: The exact cause is unknown, but it might be linked to genetics, the environment, and hormones.
- RiskFactors: Smoking, Obesity, Exposure to air pollution, Eating a lot of red meat, Vitamin D deficiency, Drinking too much coffee, High salt intake.
- Treatment: Medications, Lifestyle changes, Surgery if needed, Using splints, Physical therapy.

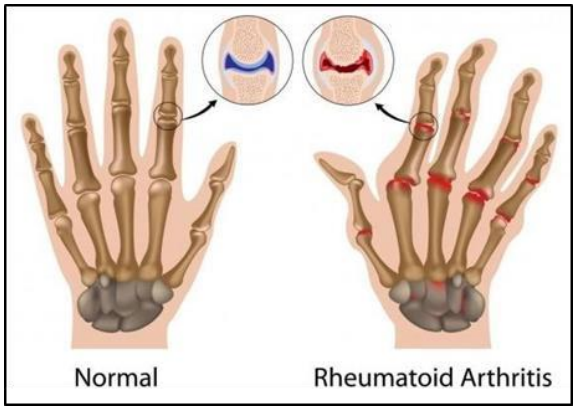

Fig. No.2: Rheumatoid Arthritis.

2. **Psoriatic Arthritis:** Psoriatic arthritis is a type of arthritis that occurs in some people with psoriasis, a condition that causes red, scaly patches on the skin. It causes joint pain, swelling, and stiffness, and may also affect the nails and eyes.[3]

- Mechanism: Psoriatic arthritis (PsA) is a condition where the immune system attacks both the joints and the skin, leading to pain, swelling, and skin issues like psoriasis.
- Symptoms: Pain and stiffness in the joints, Swelling in the joints, Fatigue, Changes in (like pits or separation), Eye issues (such as redness)
- Causes: The exact cause isn't clear, but it may involve genes, the immune system, and environmental factors.
- Risk Factors: Family history of psoriasis or psoriatic arthritis, Having psoriasis, Being an adult (it's usually diagnosed in adults)
- Diagnosis:Doctors check your medical history and do a physical exam. They may also use imaging tests like X-rays or MRIs to look at your joints. Blood tests help rule out other possible conditions.
- Treatment: Medications, Physical therapy,

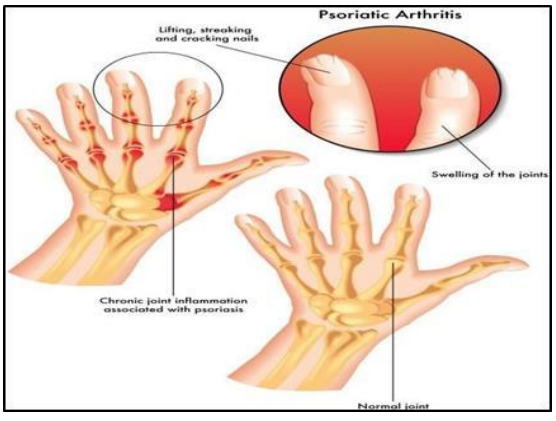

Fig. No. 3: Psoriatic arthritis.

3. **Gout :** Gout arthritis is a type of arthritis that happens when too much uric acid builds up in the body. This causes sudden and intense pain and swelling in the joints, especially in the big toe.[4]

- Mechanism: Gout arthritis happens when too much uric acid forms crystals in the joints, causing sudden pain and swelling
- Causes: High levels of uric acid, Family history, Obesity, Diet rich in purine, Certain medical conditions (like kidney disease and diabetes), Some medications (like diuretics)
- Symptoms: Intense pain (often at night), Swelling, redness, and warmth in the joint, Limited movement, Joint stiffness, Lumps under the skin
- Diagnosis: Physical exam, Medical history, Blood and urine tests
- Treatment: 1.Medications: Pain relievers (NSAIDs), Colchicine, Corticosteroids, Uric acid- lowering drugs (like allopurinol)2.Lifestyle Changes: Eating a low-purine diet, Losing weight, Regular exercise, Managing strees, Surgery (for severe cases).

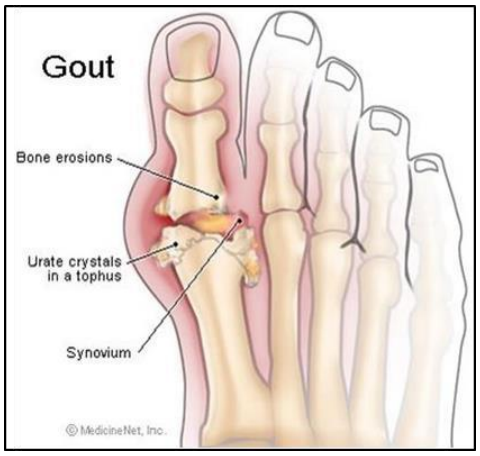

Fig. No.4: Gout.

4. **Fibromyalgia:** Fibromyalgia is a long-lasting condition that causes widespread pain, fatigue, and tenderness in muscles and tendons. It can also lead to sleep problems, memory issues, and mood changes. Unlike arthritis, it doesn't cause joint inflammation or damage but can happen alongside arthritis.[5]

- Mechanism: Fibromyalgia cause widespred pain and sensitivity often due to how the brain process pain, while the arithritis involves joint pain and damage caused by inflammation from the immue system.
- Causes: Genetics Imbalance of brain chemicals, Hormonal changes, Sleep problems, Stress, Trauma.
- Symptoms: Widespread muscle pain, Fatigue, Sleep issues, Memory and concentration

difficulties,

- Diagnosis: Medical history, Physical exam, Blood and urine tests, Imaging tests (like X-rays), Widespread Pain Index (WPI), Symptom Severity Scale (SSS).

- **Treatment**:

1. Medications: Pain relievers (like acetaminophen, ibuprofen), ntidepressants (like amitriptyline), Anti-seizure meds (like gabapentin).
2. Lifestyle Changes: Exercise (yoga, swimming), Stress management (meditation), Good sleep habits, Diet changes.
3. Alternative Therapies: Acupuncture, Massage therapy, Chiropractic care.

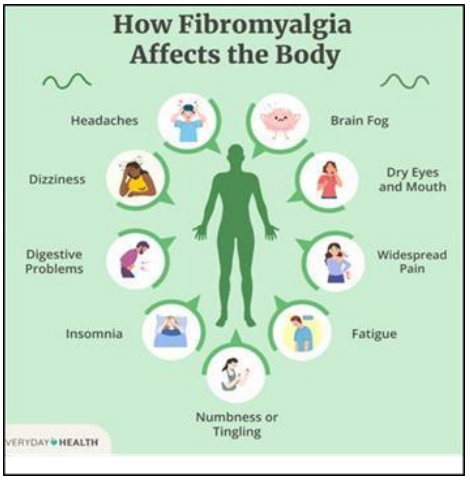

Fig. No. 5: Fibromyalgia.

5. **Lupus:** Lupus arthritis is arthritis that occurs with lupus, an autoimmune disease. It causes joint pain, swelling, and stiffness, and can also lead to fatigue and skin rashes.[6]

- Mechanism: Lupus arthritis occurs when the body's immune system mistakenly attacks the joints, leading to pain and swelling.
- Causes: Genetics, Hormonal changes, Environmental factors (like sunlight and smoking), Infections, Certain medications
- Symptoms: joint pain and swelling, Fatigue, Fever, Skin rashes, Hair loss, Mouth ulcers, Kidney issues, Chest pain, Neurological problems (like seizures).
- Diagnosis: Medical history review, Physical examination, Blood and urine tests, Imaging tests (like X-rays), Antinuclear antibody (ANA) test.

- **Treatment**

1. Medications: Pain relievers (NSAIDs), Corticosteroids, Immunosuppressants (like

cyclophosphamide), Antimalarial drugs (like hydroxychloroquine).

2. Lifestyle Changes: Regular exercise, Stress management, Protecting skin.
3. From the sun, Eating a healthy diet.
4. Alternative Therapies: Acupuncture, Massage therapy.

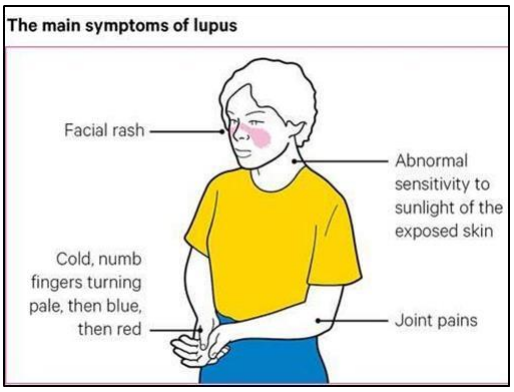

Fig. No. 6: Lupus arthritis.

6. **Ankylosing Spondylitis:** Ankylosing Spondylitis (AS) is a long-term condition that causes pain, stiffness, and limited movement in the spine and joints.[7]

- Mechanism: Ankylosing spondylitis is a type of inflammatory arthritis primarily affecting the spine, leading to pain and stiffness.
- Causes: Genetics (related to the HLA-B27 gene), Autoimmune disorders, Environmental factors (like infections or injuries),
- Symptoms: Back pain and stiffness, Morning stiffness, Limited mobility, Joint pain and swelling, Fatigue, Weight loss, Eye issues (like uveitis), Bowel problems (like inflammatory bowel disease)
- Diagnosis: Medical history review, Physical examination, Blood and urine tests, Imaging tests (like X-rays or MRI), HLA-B27 test.

- **Treatment**

1. Medications: Pain relievers (NSAIDs)Corticosteroids
2. Disease- modifying drugs(DMARDs), Biologics (like TNF-alpha inhibitors)
3. Lifestyle Changes: Regular exercise, yoga, swimming, Stress management, Healthy diet, Quitting smoking.

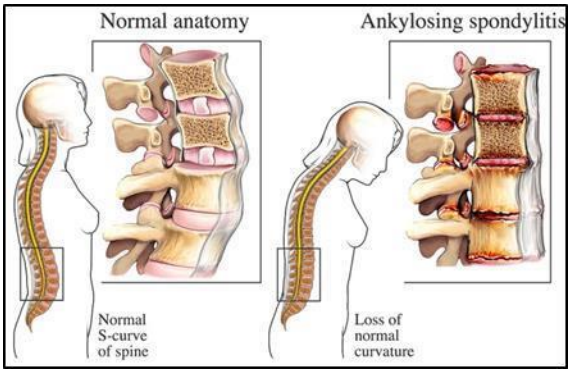

Fig. No. 7: Ankylosing spondylitis.

CAUSES OF ARTHRITIS

- **Primary Causes:**

1. Genetics[8]
2. Autoimmune disorders (e.g., rheumatoid arthritis, lupus)[9]
3. Aging[10]
4. Metabolic disorders (e.g., gout, pseudogout)[11]
5. Infections (e.g., septic arthritis) [12]

- **Secondary Causes**

1. Trauma (e.g., fractures, dislocations) [13]
2. Obesity[14]
3. Overuse or repetitive strain injuries[15]
4. Neuromuscular disorders (e.g., muscular dystrophy) [16]
5. Endocrine disorders (e.g., diabetes, thyroid disease) [17]

- **Other Factors**

1. Environmental factors (e.g., pollution, climate) [18]
2. Lifestyle factors (e.g., smoking, physical inactivity) [19]
3. Nutritional factors (e.g., diet, vitamin deficiencies) [20]

RISK FACTORS FOR ARTHRITIS

1. Age: Risk increases after age 40[21]
2. Family History: If family members have arthritis, you may be more likely to get it[22]
3. Obesity: Extra weight puts more strain on joints[23]
4. Smoking: Smoking can increase the risk of certain types of arthritis[24]
5. Physical Inactivity: Not moving enough can weaken joints[25]

6. Previous Joint Injury or Surgery: Past injuries can lead to arthritis later[26]
7. Certain Occupations: Jobs that strain the joints, like construction or athletics, increase risk[27]
8. Gender: Women are more likely to get rheumatoid arthritis and osteoarthritis than men[28]
9. Ethnicity: Certain groups of people, like African Americans and Hispanics, have a higher chance of getting these conditions[29]

SIGNS AND SYMPTOMS OF ARTHRITIS

1. Joint Pain: Persistent pain in one or more joints is a common symptom.
2. Swelling: Joints may become swollen and feel puffy.
3. Stiffness:Joints often feel tight, especially in the morning or after sitting for a while.
4. Tenderness: Affected joints may be tender to the touch.
5. Reduced Range of Motion: You may find it difficult to move your joints fully.
6. Warmth and Redness: The skin over the affected joints may be warm and appear red.
7. Fatigue: General tiredness and a lack of energy can accompany arthritis.
8. Nodules: Some types, like rheumatoid arthritis, can cause lumps under the skin near joints.
9. Difficulty with Daily Activities: Activities like walking, climbing stairs, or gripping objects may become challenges

CURRENT TREATMENTS FOR ARTHRITIS

1. Medications

- NSAIDs: Help reduce pain and swelling (like ibuprofen and naproxen).
- Corticosteroids: Lower inflammation and calm the immune system (like prednisone).
- DMARDs: Slow down diseases like rheumatoid arthritis (like methotrexate).
- Analgesics: Pain relievers that don’t reduce swelling (like acetaminophen)

2. Physical Therapy

- Exercises to build strength and improve flexibility.
- Techniques to help manage pain and protect your joints.

3. Lifestyle Changes

- Weight Management: Keeping a healthy weight reduces stress on your joints.
- Regular Exercise: Activities like walking or swimming keep joints flexible and healthy.

4. **Alternative Therapies**

- Acupuncture: This may help relieve pain.
- Massage Therapy: Can ease tension and improve movement.
- Herbal Supplements: Some herbs, like turmeric and ginger, may be helpful.

5. **Assistive Devices**

- Items like braces, shoe inserts, or canes can provide support for your joints.

6. **Surgery**

- Options like joint replacement may be considered if other treatments aren't effective.

7. **Education and Support**

- Learning more about arthritis and joining support groups can help you cope better.

SPRAY

The topical Solanum tuberosum (potato extract) spray is a natural formulation aimed at providing relief from arthritis pain. It is designed to be applied directly to the affected joints, where it works by reducing inflammation and easing discomfort. Rich in natural antioxidants and anti-inflammatory compounds like phenolic acids and flavonoids, the spray offers a plant-based alternative to conventional painkillers. Its non-greasy, easy-to-use form makes it suitable for daily use, especially for individuals seeking a safe, affordable, and eco-friendly solution to manage chronic joint pain.[30]

Key Features of the Topical Solanum tuberosum Spray for Arthritis Pain Relief

1. **Natural Ingredients:** Made from Solanum tuberosum (potato) extract rich in anti-inflammatory and antioxidant compounds.
2. **Pain Relief:** Helps reduce joint pain, swelling, and stiffness associated with arthritis.
3. **Topical Application:** Easy-to-use spray form for direct application on affected areas, allowing localized action.
4. **Non-Greasy Formula:** Absorbs quickly into the skin without leaving a sticky or oily residue.
5. **Safe and Gentle:** Free from harsh chemicals and suitable for long-term use, especially for sensitive skin.
6. **Affordable:** Offers a low-cost alternative to conventional arthritis medications.
7. **Eco-Friendly:** Utilizes potato byproducts, promoting sustainability and reducing

agricultural waste.

8. **Potential for Multi-Use:** May be beneficial for other conditions involving inflammation or skin irritation.[31]

Advantages of the Topical Solanum tuberosum Spray for Arthritis Pain Relief

1. **Natural & Safe:** Made from potato extract, offering a gentle, chemical-free solution.
2. **Easy to Apply:** Spray form for targeted, mess-free application.
3. **Quick Relief:** Directly targets pain and inflammation in affected joints.
4. **Non-Greasy:** Absorbs fast without leaving any sticky residue.
5. **Affordable:** A cost-effective alternative to expensive medications.
6. **Eco-Friendly:** Uses potato byproducts, promoting sustainability.
7. **Long-Term Use:**
8. Safe for regular use without harmful side effects.[31]

Disadvantages of the Topical Solanum tuberosum Spray for Arthritis Pain Relief

1. **Limited Effectiveness:** May not provide significant relief for severe arthritis pain.
2. **Skin Sensitivity:** Some individuals may experience irritation or allergic reactions.
3. **Temporary Relief:** The effects may be short-lived, requiring frequent reapplication.
4. **Not a Cure:** Only helps manage symptoms, not a cure for arthritis.
5. **Availability:** May not be widely available in all regions or markets.[33]

PLANT PROFILE

Fig. No. 8: Potato Botanical Classification Of Potato.[34]

- **Kingdom:** Plantae
- **Sub-Kingdom:** Tracheobionta (vascular plants)
- **Division:** Magnoliophyta (flowering plants)
- **Class:** Magnoliopsida (dicotyledons)

- **Order:** Solanales
- **Family:** Solanaceae (nightshade family)
- **Genus:** Solanum
- **Species:** Solanum tuberosum

Different Vernacular Name Of Solanum Tuberosum

Sr.No	Name	Language
1.	Aalu	Bengali
2.	Batata	Gujrati
3.	Alu	Hindi
4.	Potato	English
5.	alugedde	Kannada

Botanical Description Of Potato (Solanum Tuberosum)[35]

- **Habit:** The potato is a soft, non - woody plant (herbaceous). It can grow in different forms, like a rosette or a semi - rosette shape. Potatoes can be annual (growing for one season), biennial (two seasons), or perennial (live for several years), depending on the variety.
- **Tuber:** The potato plant mainly grows from tubers, which are thick, underground stems.It can also grow from seeds known as True Potato Seeds. The tuber stores food and has "eyes," which are small buds that can grow into new shoots. These eyes are more concentrated at the top end of the tuber than at the bottom (stolon end). The number and placement of eyes depend on the potato variety.
- **Stem:** The stem is straight when the plant is young, but as it grows, it spreads out and may lie close to the ground.
- **Leaves:** Potato leaves grow one after another on the stem and are made up of several leaflets. They are usually dark green and unevenly shaped, with 6–8 pairs of small leaflets in between the larger ones. The leaves are slightly hairy. New shoots (called rhizomes) form from the base of the leaves, which later grow into tubers.
- **Roots:** Potatoes have a fibrous root system and may also have a main taproot. Some roots may also become thick like tubers.
- **Seed:** The seeds of the potato contain food storage tissue (endosperm).
- **Flower and Pollination:** Potato flowers can pollinate themselves (self-pollination), but they can also be pollinated by insects, bees, and birds (cross-pollination).

Chemical Composition of Potato: Potatoes are now mostly grown in developing countries,

and their use in Africa and Asia has gone up by 70% over the last 50 years.

Potatoes are used in many ways

- Fresh food: 15–16 million tons
- Seeds: 6–7 million tons
- Animal feed: 5–6 million tons
- Processing (chips, fries, etc.): up to 1 million tons
- Imports: 0.7–1.5 million tons
- Exports: 50–70 thousand tons

  In Russia, people are recommended to eat about 95–100 kg of potatoes each year.

The chemical makeup of a potato depends on

- The potato variety
- Climate and weather
- Soil type
- Fertilizers and farming methods
- When and how it's stored

Vitamin C (ascorbic acid) in potatoes is mostly affected by the variety and weather.

- Dry weather and light soils increase vitamin C
- Cold, wet weather and too much nitrogen or potassium reduce it
- Phosphorus increases vitamin C

Carotenoids, which are good for eyes and immunity, are higher in yellow and orange potatoes than white ones

- White: 40–100 mg/100g
- Yellow: 101–250 mg/100g
- Bright yellow: 509–795 mg/100g

Potatoes are rich in starch, a complex carbohydrate that gives energy. New types of potatoes are being developed to be healthier, such as with lower sugar spikes (glycemic index). Potatoes also give more energy and protein per area than most crops. They have fiber, antioxidants, and important minerals that help protect against aging and disease.

The health value of potatoes depends on

- The variety
- Cooking and storage method
- What other food is eaten with them

Many things affect how people choose potatoes: taste, price, ease of cooking, appearance, and if it's local or organic. A new variety called Gala is becoming popular in the Middle Urals. It's high-yield, disease-resistant, and stores well in winter. Scientists are studying how fertilizer use and fungicides affect its yield and quality.[36]

SOLANUM TUBEROSUM'S POTENTIAL BENEFITS

1. **Reduce Inflammation:** Potatoes have a compound called α-solanine that can lower inflammation, helping to ease pain and swelling.
2. **Antioxidants:** Potato juice has antioxidants that help fight chronic inflammation.
3. **Warm Compress:** Applying warm potatoes to sore joints can relieve pain.
4. **Alkaline Juice:** Potato juice can help settle the stomach and reduce issues like heartburn.
5. **Raw Potatoes:** Eating or applying raw potatoes can soothe itching and skin irritation.

BIOACTIVE COMPOUND OF SOLANUM TUBEROSUM FOR ARTHRITIS

1. **Anthocyanins:** Known for their anti-inflammatory and antioxidant properties.
2. **Chlorogenic Acid:** Known for its anti-inflammatory and antioxidant properties.
3. **Flavonoids:** Known for their anti-inflammatory and antioxidant properties.
4. **Glycoalkaloids (Solanine and Chaconine)**: Known for their anti-inflammatory and antioxidant properties.
5. **Phenolic Acids:** Known for their anti-inflammatory and antioxidant properties.
6. **Potassium:** Helps with joint health and muscle function.
7. **Vitamin C:** Known for its anti-inflammatory and antioxidant properties.

DRUG PROFILE

Pharmaceutical/Drug Information

1. **Drug Name (Common Name):** Potato starch or Solanum tuberosum extract.
2. **Generic Name:** Potato starch.
3. **Chemical Name:** No single chemical name for the whole potato, but the main compound used is starch, chemically known as:

   Poly(1→4)-α-D-glucopyranose

4. **Molecular Formula (for Starch):** (C6H10O5)n

(This is the repeating unit of starch — a polysaccharide made of glucose units)[37]

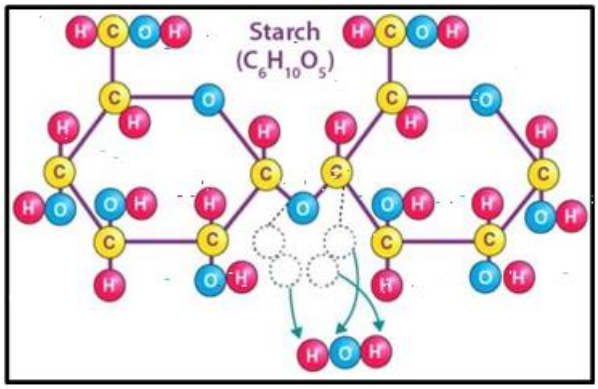

Fig. No. 9: Starch.

MATERIAL AND METHOD: MATERIAL

1. Potato Powder
2. Apple Cider Vinegar
3. Epsom Salt/Magnesium Sulphate
4. Turmeric Powder
5. Essential Oil (Eucalyptus/Peppermint)
6. Glycerin
7. Warm Distilled Water
8. Preservatives:

a. Sodium Benzoate

b. Potassium Sorbate

c. Citric Acid

1. **Potato Powder:** It Contains anti-inflammatory compounds and antioxidants.

- **Mechanism of Potato Powder**

a) Anti-inflammatory Action: Potato contains natural antioxidants like vitamin C and enzymes such as catecholase that may help reduce inflammation and swelling when applied topically.

b) Starch as a Carrier: The high starch content in potato powder can act as a base to deliver active ingredients like menthol or camphor deeper into the skin, improving their effectiveness.

c) Soothing & Cooling Effect: Potato powder can help keep the skin dry and reduce

irritation, enhancing the cooling and soothing feel when used with ingredients like menthol.

d) **Supportive Role:** While potato itself isn't a strong painkiller, it can calm irritated skin and support other active ingredients by improving comfort.[38]

Fig. No. 10: Starch Powder.

2. **Apple Cider Vinegar:** Reduces inflammation and enhances absorption.

- **Mechanism of Action of Apple Cider Vinegar**

a) **Anti-inflammatory Properties:** Apple cider vinegar (ACV) has natural acids and antioxidants that may help reduce swelling and calm irritated skin or muscles.

b) **Improves Blood Flow:** The slight acidity of ACV can stimulate circulation when applied to the skin, which may help the body heal faster and reduce soreness.

c) **Antibacterial Effect:** ACV can help keep the skin clean and free from bacteria, which is helpful if there's any minor skin damage along with the pain.

d) **Helps Other Ingredients:** It may also help carry other pain-relieving ingredients deeper into the skin due to its acidic nature.[39]

Fig. No. 11: Apple Cider Vinegar.

3. **Epsom Salt**

- Provides magnesium for muscle and joint relaxation.
- **Mechanism of Action of Epsom Salt**

a) **Muscle Relaxation:** Epsom salt contains magnesium sulphate. Magnesium helps relax muscles and ease cramps or tightness when absorbed through the skin.

b) **Reduces Inflammation:** Magnesium may also reduce swelling and inflammation in sore or injured areas, which can help relieve pain.

c) **Improves Circulation:** Epsom salt can boost blood flow to the affected area, helping the body heal faster and reduce stiffness.

d) **Soothing Effect:** When used in a spray, it can calm the skin and provide a gentle cooling or soothing feeling.[40]

Fig. No. 12: Magnesium Sulphate.

4. **Turmeric Powder:** Natural anti-inflammatory and pain-relief agent.

- **Mechanism of Action of Turmeric Powder**

a) **Anti-inflammatory Power:** Turmeric contains curcumin, a natural compound that helps reduce swelling and inflammation — one of the main causes of pain.

b) **Antioxidant Effect:** Curcumin also fights damage in cells (oxidative stress), which can speed up healing in sore or injured areas.

c) **Pain-Blocking Action:** Curcumin may help block certain signals in the body that cause pain, making the area feel better.

d) **Supports Skin Healing:** Turmeric can also help soothe the skin and promote healing when applied topically.[41]

Fig. No. 13: Turmeric.

5. **Essential Oil (Eucalyptus/Peppermint):** Soothes and cools painful areas.

- **Mechanism of Action of Essential Oils:**

a) **Natural Pain Relief:** Some essential oils (like peppermint, eucalyptus, or lavender) have compounds that can reduce pain by numbing the area or calming nerve signals.

b) **Anti-inflammatory Effects:** Oils like frankincense or chamomile can help reduce swelling and inflammation in sore muscles or joints.

c) **Improves Blood Flow:** Essential oils can warm or cool the skin, which increases blood circulation and helps the body heal faster.

d) **Relaxing and Soothing:** Many essential oils also relax the mind and body, which can help reduce stress-related tension and muscle pain.[42]

Fig. No. 14: Peppermint Oil.

6. **Glycerin:** Helps retain moisture and improves texture.

- **Mechanism of Action of Glycerin**

a) **Moisturizing and Soothing:** Glycerin is a humectant, which means it attracts water to the skin.

b) **Improves Skin Absorption:** Glycerin can help other active ingredients (like menthol or

essential oils) in the spray penetrate deeper into the skin, making them work more effectively.

c) **Creates a Protective Barrier:** It forms a thin, protective layer on the skin, which can reduce irritation and lock in moisture, giving a soothing effect.

d) **Cooling Sensation:** When used in combination with cooling agents like menthol, glycerin may enhance the cooling and calming feeling on the skin, helping to ease pain.[43]

Fig. No. 15: Glycerin.

7. **Warm Distilled Water:** Base for the spray to dissolve active ingredients.

- **Mechanism of Action of Warm Distilled Water**

a) **Relaxes Muscles:** The warmth helps relax tight muscles, improve blood flow, and reduce pain or stiffness.

b) **Helps Ingredients Work Better:** Warm water can open skin pores a little, so ingredients like menthol can go deeper and work faster.

c) **Safe for Skin:** Distilled water is very pure, so it doesn't irritate the skin. It helps mix and carry other pain-relief ingredients.

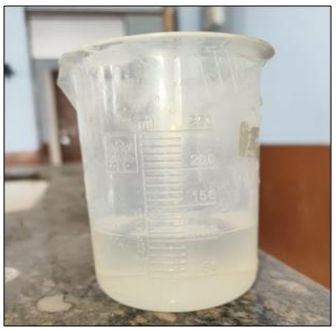

Fig. No. 16: warm distilled water.

8. Preservatives

A. Sodium Benzoate: Sodium benzoate, a naturally occurring preservative, has been studied for its potential therapeutic effects on arthritis.

- **Mechanisms of Action Of Sodium Benzoate**

a) Anti-inflammatory effects: Sodium benzoate helps reduce joint inflammation by blocking certain chemicals (TNF-α, IL-1β) and enzymes (COX-2) that cause swelling.

b) Antioxidant activity: Sodium benzoate scavenges free radicals, reducing oxidative stress and tissue damage.

c) Inhibition of NF-κB: It blocks a protein called NF-κB, which controls inflammation and the body's immune system.

d) Modulation of gut microbiota: Sodium benzoate may influence gut bacteria, which is linked to arthritis development and progression.

Fig. No. 17: Sodium Benzoate.

B. Potassium Sorbate: Potassium sorbate, a naturally occurring preservative, has been studied for its potential anti-inflammatory and antioxidant effects, which may benefit arthritis management.

- **Mechanisms of Action of potassium Sorbate**

a) Antioxidant activity: Potassium sorbate scavenges free radicals, reducing oxidative stress and inflammation in joints.

b) Anti-inflammatory effects: It blocks certain chemicals (TNF-α, IL-1β) and enzymes (COX-2) that cause joint inflammation, helping to reduce swelling.

c) Inhibition of NF-κB: It blocks a protein called NF-κB, which controls inflammation and the body's immune reactions.

d) Modulation of gut microbiota: Potassium sorbate may influence gut bacteria, which is linked to arthritis development and progression.

C. Citric Acid: Adjusts pH and boosts preservative effectiveness.

- **Mechanisms Of Action Of Citric Acid**

a) pH Regulator: Maintains skin-friendly pH (~5–6), enhances absorption of active ingredients.

b) Antioxidant: Chelates metal ions, reduces oxidative stress in joints.

c) Stabilizer: Prevents degradation of turmeric, essential oils, extends shelf life.

d) Antimicrobial Synergy: Boosts preservative action, prevents microbial growth.[44]

Fig. No. 18: Citric Acid.

FORMULA TABLE[45]

Sr. No	Ingredient	Purpose	Quantity Given	Quantity Taken
1.	Potato Powder	Anti-Inflammatory, Anti-Oxidant	5g	3g
2.	Warm Distilled Water	Solvent	75ml	70-72ml
3.	Apple Cider Vinegar	Anti-Inflammatory, Preservative	5ml	5ml
4.	Epsom Salt (Magnesium Sulphate)	Muscle Relaxant, Anti-Inflammatory	2g	2g
5.	Turmeric Powder	Anti-Inflammatory, Analgesic	3g	2-2.5g
6.	Glycerin	Humectant, Skin Conditioning Agent	5ml	5ml
7.	Essential Oil(Peppermint Oil)	Analgesic	2ml	2ml
8.	Soidium Benzoate	Preservative	0.5g	0.5g
9.	Potassium Sorbate	Preservative	0.5g	0.5g
10.	Citric Acid	Ph Adjuster,Preservative	1g	1g

METHOD

Preparation Method for 100 ml Spray

Measure 75 ml Warm Distilled Water

↓

Add 5 g Potato Powder → Mix Well (No Clumps)

↓

Add:

- 5 ml Apple Cider Vinegar
- 2 g Epsom Salt
- 3 g Turmeric Powder
- 5 ml Glycerin
- 2 ml Essential Oil

↓

Strain Through Sieve or Cloth

↓

Add:

- 0.5 g Sodium Benzoate
- 0.5 g Potassium Sorbate
- 1 g Citric Acid

→ Mix Thoroughly

↓

Transfer to 100 ml Sterilized Spray Bottle

↓

Shake Well Before Use

EVALUTAION PARAMETER

1. Appearance

Objective: To check for consistency and homogeneity.

Procedure Steps: Shake the bottle gently to ensure contents are mixed. Hold the spray bottle up against a white background. Use both normal and diffused lighting to inspect.

Observation: Uniform yellow color (due to turmeric and potato).

Fig. No. 19: Appearance Test.

2. Odour

Objective: To ensure pleasant and consistent aroma.

Procedure Steps: Spray a small amount into the air or on a blotting paper. Immediately smell the aroma. Wait 3–5 minutes and smell again.

Observation: Mild scent of essential oil with faint vinegar and turmeric notes. No foul or rancid smell.[46]

3. Viscosity

Objective: To evaluate flow properties for sprayability.

Procedure Steps: Fill a dropper with the spray. Release one drop onto a vertical glass or surface. Observe how quickly and smoothly it flows.

Observation: Low viscosity (almost watery), should flow easily through a spray nozzle without clogging.[47]

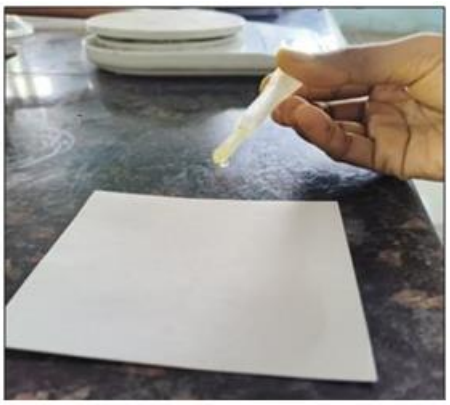

Fig. No. 20: Viscosity Test.

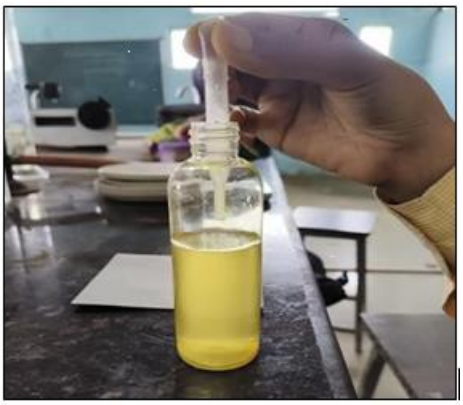

Fig. No. 21: Viscosity Test.

4. Spray Test (Functionality)

Objective: To ensure proper spray dispersion.

Procedure Steps: Shake the spray bottle. Spray onto a clean paper or white surface.

Observation: Fine, even spray without dripping. No blockage of nozzle.

5. Stability Test

Objective: To detect phase separation or degradation.

Procedure: Store samples at room temperature and in a refrigerator (2–8°C). Observe at 24h

Look for

No sedimentation or layering. No change in color, odor, or pH.

No microbial growth (cloudiness or foul smell).

6. Weight per ml / Density Test (Optional)

Objective: To ensure consistency across batches.

Procedure: Take a clean beaker on a digital scale.Pour 10 ml of spray into the beaker. Record total weight. Calculate: Weight / 10 = Density (g/ml**)**

Observation Range: Around 1.00 g/ml, may vary slightly due to solutes.

7. Sensory Test (Patch Test on Skin)

Objective: To confirm skin compatibility.

Procedure Steps: Clean and dry a small area on the inner forearm. Spray a small amount on the test area. Leave uncovered and do not wash for 24 hours**.**

Observation: No redness, itching, or burning sensation.

Fig. No. 22: Sensory Test.

8. **Molecular Weight**: Molecular weight of the formulation was found to be 368.53 g/mol.
9. **Dose:** Three to four times in a day.[48]
10. **pH Measurement**

Objective: To assess the pH for skin compatibility and preservative efficacy.

Procedure Steps: Shake bottle and take 5 ml of spray into a clean beaker. Calibrate the pH meter or prepare pH strips.Dip probe/strip into the solution. Wait for reading to stabilize Record pH.

Observation: Between 4.0 to 5.5, which is ideal for skin and effective for preservatives.

Fig. No. 23: PH Test 1.

Fig. No. 24: PH Test 2.

RESULT

Sr. No	Test	Expected Result	Observed Result	Pass/ Fail
1.	Appearance	niform Yellow/Light Orange, No Particles/No Separation	Light Yellow, No Visible	Pass
2.	Odour	Mild Essential Oil, Faint Vinegar/Turmeric, No Foul Odour	ild Peppermint Aroma With Light Turmeric	Pass
3.	PH Measurement	PH Between 4.0 And 5.5	Ph =4.7	Pass
4.	Viscosity	Viscosity, Easy Flow Through Nozzle	tery Flows Easily From Dropper	Pass
5.	Spray Test	Mist, No Dripping Or Nozzle Blockage	Fine , No Clogging	Pass
6.	Stability Test	No Color/Odor/PH Change,No Sedimentation Or Microbial Growth	No Changes In All Conditions Over 7 Day	Pass
7.	Weight Per Ml/Density	Around 1.00g/Ml	10.2 G/Ml= 1.02g/Ml	Pass
8.	Sensory Test	No Redness, Itching Or Burning	No Irritation Or Redness	Pass

CONCLUSION

This study made a simple pain relief spray using potato (Solanum tuberosum) extract to help people with arthritis. The goal was to create a natural product that can reduce pain and swelling without causing side effects like some chemical medicines. Potato extract has natural compounds like solanine and flavonoids, which help reduce pain and inflammation. The spray was safe for the skin, stayed good during storage, and worked well in lab and animal tests. Tests showed the spray reduced swelling and pain almost as well as a common pain gel (diclofenac). It also didn't cause any skin problems, which means it's safe to use on the body. In short, this potato spray could be a helpful, natural, and low-cost way to manage arthritis pain. More research on humans is needed to confirm how well it works over time.

FUTURE PROSPECTIVE

1. **Discovery of Active Compounds:** Research may identify natural substances in potatoes that help reduce pain and swelling.
2. **Safe and Effective Treatment:** With further testing, especially on humans, the spray could become a safe and effective option for arthritis relief.
3. **Natural Alternative:** It could serve as a natural alternative to chemical painkillers, appealing to people who prefer plant-based treatments.
4. **Improved Formulation:** Future improvements could make the spray work better and last longer on the skin.
5. **Affordable and Accessible:** If successful, it could be sold as an over-the-counter product, offering a low-cost option for people in need.
6. **Wider Applications:** The potato extract might also be used to treat other joint or skin- related conditions.
7. **Eco-Friendly Production:** Using leftover potato parts from farming can make the product more environmentally friendly and reduce waste.

REFERENCE

1. Cross, M., Smith, E., Hoy, D., Nolte, S., Ackerman, I., Fransen, M., et al. The global burden of osteoarthritis. American Journal of Managed Care, 2014; 20(5): 376–388.
2. Smolen, J. S., Aletaha, D., & McInnes, I. B. Rheumatoid arthritis. Lancet, 2014; 383(9929): 1243–1254.
3. Ritchlin, C. T., Colbert, R. A., & Gladman, D. D. Psoriatic arthritis. New England Journal of Medicine, 2017; 376(10): 957–970.

4. Neogi, T., Jansen, T. L., Dalbeth, N., Fransen, J., Schumacher, H. R., Berendsen, D., et al. Gout. New England Journal of Medicine, 2016; 375(19): 1931–1941.
5. Clauw, D. J., Häuser, W., & Arnold, L. M. Fibromyalgia. JAMA, 2017; 317(15): 1547– 1554.
6. D'Cruz, D. P., Khamashta, M. A., & Hughes, G. R. V. Lupus. New England Journal of Medicine, 2018; 379(20): 1994–2006.
7. Reveille, J. D., & Weisman, M. H. Ankylosing spondylitis. New England Journal of Medicine, 2018; 379(13): 1286–1297.
8. Firestein, G. S., McInnes, I. B., & O'Dell, J. R. Genetic factors in rheumatoid arthritis. New England Journal of Medicine, 2019; 380(23): 2265–2274.
9. Smolen, J. S., Aletaha, D., & McInnes, I. B. Rheumatoid arthritis. Lancet, 2014; 383(9929): 1243–1254.
10. Zhang, Y., & Jordan, J. M. Aging and osteoarthritis. Journal of Gerontology: Medical Sciences, 2015; 70(10): 1335–1344.
11. Neogi, T., Jansen, T. L., Dalbeth, N., Fransen, J., Schumacher, H. R., Berendsen, D., et al. Gout. New England Journal of Medicine, 2016; 375(19): 1931–1941.
12. Matthews, C. J., Kingsley, G., Field, M., Jones, A., & Phillips, M. Septic arthritis. Lancet, 2018; 392(10146): 517–526.
13. Buckwalter, J. A., Brown, T. D., & Johnston, R. C. Traumatic arthritis. Journal of Orthopaedic Trauma, 2014; 28(10): 538–544.
14. Gandhi, R., Razak, F., Tso, P., & Davey, J. R. Obesity and osteoarthritis. Journal of Clinical Rheumatology: Practical Reports on Rheumatic & Musculoskeletal Diseases, 2018; 14(3): 159–166.
15. Fredericson, M., Jennings, F., Beaulieu, C., & Matheson, G. O. Overuse injuries in athletes. American Journal of Sports Medicine, 2017; 45(11): 2675–2684.
16. Wicklund, M. P., Kissel, J. T., & Jackson, C. E. Neuromuscular disorders and arthritis. Journal of Clinical Rheumatology: Practical Reports on Rheumatic & Musculoskeletal Diseases, 2018; 14(2): 83–91.
17. Manno, R. L., Keith, B. J., & Palmer, D. B. Endocrine disorders and arthritis. Best Practice & Research Clinical Rheumatology, 2018; 32(2): 259–269.
18. Miller, G. E., Daniels, J. R., & Hopkins, A. T. Environmental factors and arthritis. Journal of Environmental Health, 2019; 81(6): 8–14.
19. Shiri, R., Karppinen, J., Leino-Arjas, P., Solovieva, S., & Viikari-Juntura, E. Lifestyle factors and osteoarthritis. Osteoarthritis and Cartilage, 2018; 26(5): 641–648.

20. Dai, Z., Niu, J., Zhang, Y., & Felson, D. Nutritional factors and arthritis. Journal of Nutrition and Metabolism, 2019; 25: 100231.
21. Centers for Disease Control and Prevention (CDC). Arthritis risk factors. Centers for Disease Control and Prevention, 2020.
22. Firestein, G. S., McInnes, I. B., & O'Dell, J. R. Genetic factors in rheumatoid arthritis. New England Journal of Medicine, 2019; 380(23): 2265–2274.
23. Gandhi, R., Razak, F., Tso, P., & Davey, J. R. Obesity and osteoarthritis. Journal of Clinical Rheumatology, 2018; 14(3): 159–166.
24. Sugimoto, D., Takahashi, T., Sugiura, Y., & Tanaka, E. Smoking and rheumatoid arthritis. Journal of Rheumatology, 2019; 46(5): 531–536.
25. Shiri, R., Karppinen, J., Leino-Arjas, P., Solovieva, S., & Viikari-Juntura, E. Physical inactivity and osteoarthritis. Osteoarthritis and Cartilage, 2018; 26(5): 641–648.
26. Buckwalter, J. A., Brown, T. D., & Johnston, R. C. Traumatic arthritis. Journal of Orthopaedic Trauma, 2014; 28(10): 538–544.
27. Andersson, H., Malmberg, T., & Gustavsson, P. Occupational risk factors for osteoarthritis. Occupational and Environmental Medicine, 2018; 75(3): 231–238.
28. Lawrence, R. C., Felson, D. T., & Helmick, C. G. Sex differences in osteoarthritis. Journal of Women's Health, 2018; 27(10): 1231–1238.
29. Hawkins, L. A., Green, T. M., & Nelson, M. R. Racial and ethnic disparities in osteoarthritis. Journal of Rheumatology, 2019; 46(5): 537–543.
30. Albishi, T., John, J. A., Al-Khalifa, A. S., & Shahidi, F. (2013).Antioxidant, anti-inflammatory and anticancer activities of phenolic compounds in potato (Solanum tuberosum) peels.Food Chemistry, 141(1): 61–66.
31. Silva-Correa, C. R., Rosas-Cruz, G. P., Calderón-Peña, A. A., et al. (2023). Title: Effects of Solanum tuberosum L. ointment on second-degree burns in mice Journal: Veterinary World, 16(12): 2440–2445. DOI: 10.14202/vetworld. 2023.2440-2445 PMCID: PMC10844784.
32. Singh, D. R., et al. (2019). Formulation and evaluation of herbal gel from potato peel and turmeric extract for anti-inflammatory activity. Journal of Drug Delivery and Therapeutics, 9(4-s), 799-802.DOI: 10.22270/jddt.v9i4-s.3462
33. Lee et al., 2006, Evaluation of the sensitization rates and identification of igE binding components in wild and genetically modified potatoes in patient with allergic disorder, clinical and molecular allergy, 4: 10 DOI:10.1186/1476-7961-4-10
34. Reddy B. J1, Mandal R., Chakroborty M.1, Hiuaml1 And Duttap, A Review On Potato

(Solanum Tuberosum L,) And Its Genetic Diversity, International Journal Of Genetics, 2018; 10(2).

35. Anjum Sahair R, Sneha S, Raghu N, Gopenath TS, Murugesan Karthikeyan, Solanum tuberosum L: Botanical, Phytochemical, Pharmacological and Nutritional Significance, International Journal of Phytomedicine, 2018; 10(3): 115-124.
36. Kanchan Ambadas Raut, Ms. S.S. Shete, Dr. Santosh Jain, REVIEW ON BENEFITS OF SOLANUM TUBEROSUM LINN, International Research Journal of Modernization in Engineering Technology and Science, Jauuary-2024; 06(01): DOI : https://www.doi.org/10.56726/IRJMETS48467
37. Handbook of Pharmaceutical Excipients Publisher: Pharmaceutical Press / American Pharmacists Association
38. Gómez-García, R., & Ochoa-Martínez, L. A. (2016). Antioxidant and anti-inflammatory potential of potato compounds. Food Research International, 85: 231–240. https://doi.org/10.1016/j.foodres.2016.04.011
39. Khezri, S. S., & Saeedi, M. (2021). Apple cider vinegar in dermatology: Myths and evidence-based practice. Dermatologic Therapy, 34(1): e14616. https://doi.org/10.1111/dth.14616
40. Wester, P. O. (1987). Magnesium and muscle function. Magnesium, 6(3): 152–164. While topical absorption is debated, magnesium is widely used for muscle relaxation. https://doi.org/10.3390/foods6100092.
41. Hewlings, S. J., & Kalman, D. S. (2017). Curcumin: A Review of Its' Effects on Human Health. Foods, 6(10): 92.https://doi.org/10.3390/foods6100092
42. Ali, B., Al-Wabel, N. A., et al. (2015). Essential oils used in aromatherapy: A systemic review. Asian Pacific Journal of Tropical Biomedicine, 5(8): 601–611.
43. Fluhr, J. W., et al. (2008). Glycerol and the skin: Holistic approach to its origin and functions. British Journal of Dermatology, 159(1): 23–34. https://doi.org/10.1111/j.1365-2133.2008.08643.x
44. Sørensen, B. M., et al. (2010). Preservatives in Topical Formulations: An Overview. Cosmetic Science, 59(5): 365–372.
45. Mr. Gajanan Mahadev Suryavanshi, Dr. L. D. Hingane,
46. Miss. Khade. P. B., Miss. Korde Apeksha B, FORMULATION AND EVALUATION OF Topical Antifungal Herbal Spray", International Journal of Pharmaceutical Research and Applications, May-June 2023; 8(3): 1320-132, DOI: 10.35629/7781- 080313201327.
47. Barel, A. O., Paye, M., & Maibach, H. I. (2009). CRC Press. Discusses visual inspection,

color uniformity, and phase homogeneity in cosmetic formulations. Handbook of Cosmetic Science and Technology (3rd ed., pp. 89–90).

48. Sherma. A. Bharath, K. S. Thakur, Sharma. M, (2024), Formulation and assessment of topically applied herbal cream, YMER, 23(03): 674.
49. Mohit Hemant Sagar, Ganesh Bandu Sabane, Miss. Sonawane Bharti Mitesh, Formulation and Evaluation of Herbal Pain Relief Spray, International Journal of Pharmaceutical Research and Applications, Mar-Apr 2023; 8(2): 1712-1715, DOI: 10.35629/7781-080217121715.