Formulation and Evaluation of Herbal Liniment for treatment of Arthritis

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Abstract: This study uses giloy (Tinospora cordifolia), a potent medicinal plant that is commonly used in Ayurveda, to prepare and assess a herbal liniment. Giloy is well-known for its pain-relieving, anti-inflammatory, immune-stimulating, and antipyretic qualities. In order to facilitatee the components' rapid skin absorption, the liniment was created with Giloy extract, eucalyptus oil, camphor, and menthol combined with an isopropyl alcohol base. The liniment is designed for external application to reduce stiffness, edema, joint discomfort, and muscular soreness. It was made by soaking Giloy stems in alcohol to extract the active ingredients, a process known as maceration. The finished product's color, texture, pH, odor, and stability over time were all evaluated.

The findings demonstrated that the Giloy liniment was non-greasy, had a pleasant scent, and produced a cooling effect when applied. It did not split or change hue; it stayed steady. A natural and safe substitute for medications that use chemicals to treat pain could be this herbal liniment. especially for individuals who choose plant-based or Ayurvedic therapies.

Keywords: Arthritis, Herbal liniment, Pain relief, Anti- inflammatory, Sprains, Joint Pain, Topical drug delivery.

INTRODUCTION

Many people suffer from joint pain, which can be caused by arthritis, aging, or even normal wear and tear. Even if there are a lot of medications and lotions available, not everyone wants to depend on chemicals to feel better. Herbal liniment can help with it. It is a natural treatment derived from medicinal plants such as menthol, camphor, and eucalyptus.It provides a warming or cooling sensation when applied to the skin, which relieves stiffness and aching joints. Herbal liniments are a gentle, efficient method to feel better without using harsh substances, and they have been used for generations.

Osteoarthritis (OA), rheumatoid arthritis (RA), post-traumatic arthritis, and avascular necrosis are the most common causes of joint discomfort. Deformities or direct injuries to the joint can also result in joint discomfort. Sometimes people avoid utilizing a painful joint, which weakens the muscles and makes the joint increasingly harder to move. This exacerbates joint discomfort. Numerous therapeutic approaches, including conservative and surgical ones, are being used to address these issues. Conservatively, some of the most straightforward external application techniques for pain relief are analgesics, muscle relaxant gel, and pain relief liniments. One of the most commonly prescribed types of drugs are the non-steroidal anti-inflammatory agents or NSAIDs, which has to be taken for long-term to reduce both the pain and swelling caused by arthritis. Although NSAIDs are among the most commonly prescribed pharmaceuticals, indigestion, burning, bleeding, and gastrointestinal (GI) ulcers are common side effects (Wallace and Vong, 2008). The therapy of OA may benefit greatly from the use of COX-2 inhibitors, a relatively new family of anti-inflammatory medications. Although COX-2 inhibitors were said to have no ulcer-promoting effects, this promise has not been kept, and there are questions regarding their cardiovascular safety (Wallace and Vong, 2008; Vardeny and Solomon, 2008).The therapy of OA may benefit greatly from the use of COX-2 inhibitors, a relatively new family of anti-inflammatory medications. Although COX-2 inhibitors were said to have no ulcer-causing effects, this promise has not been kept, and there are questions regarding their cardiovascular safety (Wallace and Vong, 2008; Vardeny and Solomon, 2008). Serious gastrointestinal issues, such bleeding, can occasionally happen suddenly. Aspirin allergies should not be treated with NSAIDs or COX-2 inhibitors (Bavbek et al., 2007; Palmer, 2005). Corticosteroids are another class of drugs used to treat extreme pain and edema. Injections of corticosteroids provide rapid and efficient pain relief.They damage bone and cartilage, thus they can only be used a few times a year (Silbermann et al., 1981a; Silbermann et al., 1981b; Silbermann et al., 1979; Silbermann as al., 1977). Additionally, a doctor must supervise the use of corticosteroids due

to the possibility of other potentially dangerous side effects (Benyamin et al., 2008; Kubota et al., 2008).

JOINT PAIN AND ARTHRITIS

The Greek word for arthritis means "disease of the joints." Acute or chronic joint inflammation that frequently coexists with pain and structural damage is its definition. Arthralgia, which is defined as pain that is localized to a joint, independent of its cause (which may or may not be attributable to joint inflammation), is not the same as arthritis. There are various forms of arthritis, and each one requires a distinct approach to treatment. While further laboratory and imaging tests may occasionally be required to confirm the diagnosis, a history and physical examination are essential in identifying the kind of arthritis. The assessment and management of arthritis are described in this activity, along with the function of the interprofessional team in the care of patients with this illness.

Osteoarthritis: The progressive loss of articular cartilage is a hallmark of osteoarthritis, a chronic degenerative disease with an unclear etiology. With a global spread, it is the most common disease in contemporary culture. In the western world, it ranks eighth for men and fourth for women in terms of health impact.

Signs and symptoms: Minimal Swelling , Joint pain, Toughness
Arthritis Rheumatoid: Usually manifesting between the ages of 30 and 50, rheumatoid arthritis is a chronic, systemic, inflammatory autoimmune disease that causes symmetrical polyarthritis of both large and small joints. An estimated 25 men and 54 women per 100,000 people suffer from the most prevalent inflammatory arthritis, which causes 250,000 hospitalizations and 9 million doctor visits annually in the United Arab Emirates.

Signs and symptoms: Joint Lining Is Affected by Pain
Gout: One medical ailment that is frequently mistaken for inflammatory arthritis is gout. Gout is not a degenerative condition like arthritis is. Frequent episodes of edema, redness, and a sensitive, warm, and swollen appearance of bone joint locations are its typical characteristics.

Signs and symptoms: stiffness, redness, and edema in the joints.
Materials and Methods:

1.*Tinospora Cordifolia*
Synonyms: *Tinospora Cordifolia,* Gulvel, Giloy, Guduchi, Amrita, Gurcha, Gulo, Gulancha.

Taxonamical Classification:

Kingdom	Plantae
Division	Mangnoliophyta
Class	Mangnoliophyta
Order	Ranunculales
Family	Menispermaceae
Genus	Tinospora
Species	T Cordifolia

Table No.1 : Taxonamical Classification of *Tinospora Cordifolia*

Botanical Description: There are over 450 species and 70 genera in the plant family Menispermeaceae, which are found in tropical lowland areas. The deciduous perennial twiner Tinospora cordifolia has a succulent stem. The bark has large, rosette-like lenticels and is papery, creamy white to gray in hue. Simple, exchange, or lobed leaves are entire, cordate, and have seven to nine nerves; tiny, cymose growth appears yellow or greenish in shade. Plants that are male or female develop on distinct branches. While female plants are often single, male plants are typically grouped together. The fruits are vivid, draping, pink, pea-shaped, and completely mature.

Chemical Constituents:
1.Alkaloids: Tinosporine, Berberine, Palmatine
2. Diterpenoid Lactones: Tinosporide, Tinosporon
3. Glycosides: Cordifolioside A
4. Steroids: Beta-sitosterol
5. Flavonoids & Phenolics: Quercetin, Apigenin
6. Essential Oils & Volatiles (when extracted or mixed with other oils)

Morphology:

Fig No.1.Tinospora Cordifolia Plant

Fig No.2.Stem of Tinospora Cordifolia

Fig No.3:Leaves of *Tinospora Cordifolia*

Fig No.4: Roots of Tinospora Cordifolia

Fig No.5:Fruits of *Tinospora Cordifolia*

Traditional Uses:

Giloy (Tinospora cordifolia), also known as Guduchi, is a widely used herb in traditional Ayurvedic medicine. It is renowned for its rejuvenating and immunity-boosting properties. Traditionally, giloy has been used to treat chronic fevers, especially those caused by infections like malaria, dengue, and typhoid, due to its antipyretic nature. It is also valued for its detoxifying properties, helping to cleanse the liver, purify the blood, and promote healthy skin. Giloy is commonly used to improve digestion, relieve constipation, and treat acidity. In Ayurveda, it is often prescribed for managing diabetes, as it is believed to help regulate blood sugar levels. Its anti-inflammatory properties make it useful in treating arthritis, gout, and other joint disorders. Additionally, giloy supports respiratory health and is used in the treatment of asthma, coughs, and bronchitis. It is also considered an adaptogen, helping the body cope with stress and enhancing mental clarity. These traditional uses make giloy a versatile and highly valued herb in Ayurvedic healing.

2.Eucalyptus Oil: The leaves of the eucalyptus tree, especially Eucalyptus globulus, are the source of eucalyptus oil, a potent essential oil. It is well-known for both its many medicinal benefits and its unique, reviving scent. Rich in a substance known as eucalyptol (1,8-cineole), eucalyptus oil is frequently used to treat respiratory conditions like bronchitis, sinus congestion, coughs, and colds. It functions as a natural expectorant and decongestant and is frequently applied to chest rubs or inhaled through steam. When diluted appropriately, eucalyptus oil can be used to treat small wounds, muscle soreness, and skin infections in addition to respiratory health because of its potent antibacterial and anti-inflammatory properties.

Fig No.6.Eucalyptus oil

3.Mustard Oil: Castor oil is often used in liniments due to its anti-inflammatory and pain-relieving effects. It functions as a base oil in liniment compositions, aiding in the deep penetration of active substances into the skin and underlying tissues. Castor oil effectively relieves stiffness, joint pain, and muscular aches due to its calming properties from ricinoleic acid. Additionally, it functions as a carrier oil, combining well with herbal extracts and essential oils that are frequently used in liniments. In places that are sore or irritated, its inherent warming impact helps improve circulation and encourage healing.

Fig No.7: Castor Oil

4.Castor Oil: Because of its warming and stimulating qualities, mustard oil is frequently used in liniments; when applied topically, it helps to increase blood circulation, which relieves muscle aches, joint pain, and stiffness; its strong, pungent aroma and heat can help soothe sore muscles, reduce inflammation, and promote the healing of bruises or strains; it is frequently combined with other essential oils or herbs in liniment formulations to enhance its therapeutic effects, making it an effective natural remedy for conditions like arthritis or general muscle discomfort; and its antimicrobial qualities make it helpful in preventing infections in minor cuts or injuries.

Fig No.8: Mustard Oil

5. Peppermint Oil: Because peppermint oil has inherent analgesic and anti-inflammatory qualities, it is frequently used in liniments. Peppermint oil offers a cooling effect in topical treatments, like liniments, which helps reduce inflammation, joint discomfort, and aching muscles. The chilling impact produced by the key ingredient, menthol, stimulating the skin's cold receptors might momentarily ease pain and discomfort. All things considered, peppermint oil improves the therapeutic impact of liniments by providing the skin with a calming effect and minor pain alleviation.

Fig No.9: Peppermint Oil

6.Curcuma Oil :The rhizomes of the ginger-family plant Curcuma longa are used to extract curcuma oil, sometimes referred to as turmeric essential oil. Bioactive substances, including turmerone and curcumin, which have strong anti-inflammatory, antioxidant, and antibacterial qualities, are abundant in this golden-yellow oil. Curcuma oil has long been utilized in Ayurvedic and traditional Chinese medicine because of its beneficial effects on skin healing, immunity, and joint health. It is frequently used in skincare products, aromatherapy, and natural treatments for ailments such skin irritations, arthritis, and muscle soreness. It is also a well-liked option for relaxation and emotional grounding due to its earthy, comforting scent.

Fig No.10: Curcuma Oil

7.Camphor :

A white, crystalline material, camphor has a powerful, piercing scent. The wood of the camphor tree (Cinnamomum camphora), which is indigenous to Asia, especially China, Japan, and Taiwan, is the source of this naturally occurring substance. Turpentine oil can also be used to create synthetic camphor. Because of its calming and cooling properties, it has been used for generations in religious ceremonies, traditional medicine, and as a component of balms and ointments. Nowadays, camphor is frequently used in goods like insect repellents, pain relievers, and vapor rubs. It is a chemical that can be used in both therapeutic and aromatic applications because of its antibacterial, antifungal, anti-inflammatory, and analgesic qualities.

Fig No.11: Camphor

Method Of Preparation :

Step 1 : Extraction of Giloy Oil

1.Preparation of Plant Material:

Fresh leaves of Tinospora cordifolia were collected and thoroughly washed with distilled water to remove surface impurities. The leaves were then air-dried at room temperature (in the shade) for 2–3 days to reduce moisture content without degrading bioactive compounds. Partially dried leaves were then cut into small pieces and lightly macerated or crushed to facilitate solvent penetration.

2. Soxhlet Extraction Procedure:

About 50 g of the semi-dried, crushed leaves were placed in a cellulose thimble and loaded into the Soxhlet extractor.

Approximately 250 mL of 95% ethanol was added to the round-bottom flask.

The extraction was carried out continuously for 6–8 hours until the siphon tube showed a colorless solvent, indicating exhaustive extraction.

3. Concentration of Extract:

The ethanol extract was concentrated using a rotary evaporator at 40–45°C under reduced pressure to remove the ethanol, yielding a semi-solid oily extract rich in phytoconstituents.

4. Storage:

The Giloy extract was weighed and stored in amber-colored glass bottles at 4°C for future formulation and analysis.

Step 2 : Preparation the base:

In a clean beaker, mix castor oil and mustard oil thoroughly.

Slightly warm the mixture using a water bath (do not overheat), just enough to aid mixing.

Step 3: Add active ingredients:

Add Giloy oil, eucalyptus oil, turmeric oil, and peppermint oil to the base mix while stirring continuously.

Step 4: Final blending:

Stir the entire mixture thoroughly to ensure uniform blending of all oils.

Srep 5: Cooling and storage:

Let the mixture cool to room temperature. Transfer into an amber-colored glass bottle to protect from light.

Formulation Table :

Sr. No.	Ingredient	F1	F2	F3
1	Giloy Oil	20 ml	20ml	20 ml
2	Eucalyptus Oil	10 ml	12ml	15ml
3	Castor Oil	10 ml	15ml	20 ml
4	Mustard Oil	10 ml	10ml	15ml
5	Turmeric Oil	5 ml	5ml	5 ml
6	Peppermint Oil	2 ml	5ml	5 ml
7	Camphor (powdered)	4 g	6g	5 g

Table No.2: Formulation Table

How Herbal Liniment works :

1. Anti-inflammatory Action:

Aids in lowering inflammation of the muscles or joints, as well as redness and swelling. beneficial for musculoskeletal discomfort, gout, and arthritis. Giloy liniment aids in the reduction of muscle or joint irritation, redness, and swelling. It works very well for reducing the symptoms of inflammatory diseases like gout, arthritis, and musculoskeletal discomfort. It not only reduces discomfort but also encourages better joint function and mobility by addressing the underlying inflammation. Frequent use can improve general physical well-being and quality of life by causing a discernible decrease in stiffness and discomfort.

2. Pain Relief: As a natural analgesic, giloy liniment effectively relieves sprains, minor injuries, and joint and muscular discomfort. Alkaloids and glycosides, two of Giloy's active phytoconstituents, help block enzymes that cause pain and lessen the sensitivity of pain receptors in the afflicted area. When applied topically, the liniment deeply penetrates the skin and deeper tissues, relieving discomfort by calming inflamed nerves and reducing inflammation. Its warming properties might improve local circulation even more, hastening the healing process and easing tense muscles. Because of this, Giloy liniment is especially helpful for people who are coping with ordinary pains and strains, chronic pain issues, or discomfort after exercising. Frequent use can

provide a safer, herbal alternative for long-term relief while also reducing reliance on synthetic medications and managing acute pain attacks.

3. Improves Joint Mobility:
It can improve afflicted joints' mobility and flexibility by lowering stiffness and inflammation. Through the reduction of stiffness, inflammation, and discomfort, this medication can greatly improve general flexibility and joint mobility. People with arthritis, joint injuries, or age-related joint degeneration may find that regular use helps them move more easily and lead active lives. Better posture and a lower chance of developing more joint-related problems can both be supported by this improvement in joint function.

4.Antioxidant Protection:
Promotes healing and repair by shielding tissues and skin from oxidative stress. This formulation's abundance of antioxidants helps shield the skin and underlying tissues from the harm that free radical-induced oxidative stress can do. It maintains cellular health, slows down aging symptoms, and encourages the body's natural healing processes by neutralizing these damaging chemicals. In addition to keeping skin looking young, this protection increases the skin's resistance to environmental aggressors.

5. Skin-Soothing Properties
Because of its calming and antibacterial properties, it can be used to treat minor skin inflammation, rashes, and itching. This lotion calms irritated, sensitive, or inflamed skin because it is made with relaxing components. It leaves the skin feeling nourished, pleasant, and soft after relieving issues including eczema, dryness, redness, or minor rashes. It supports a smooth, healthy complexion and helps preserve the skin's natural moisture barrier, making it perfect for daily usage.

6. Supports Detoxification: Giloy has a reputation for eliminating toxins, and when used topically, it may aid with ailments where the skin or joints are impacted by toxin accumulation. In traditional medicine, giloy is well known for its strong cleansing qualities. It promotes internal cleaning and general wellness by aiding in the body's removal of toxic substances. When administered topically, Giloy may aid in the elimination of pollutants that build up in the skin or joints as a result of exposure to the environment, unhealthy lifestyle choices, or underlying medical issues. Clearer skin, less inflammation, and alleviation in areas where toxins have accumulated can result from this detoxifying effect. By reducing the toxic burden on essential organs, regular use may also boost immunological response and metabolic performance.

Evaluation of herbal Liniment:
Organoleptic evaluation

Parameter	Observation
Appearance	Clear to slightly turbid liquid; no visible suspended particles.
Color	yellowish-brown,
Odor	Characteristic herbal odor;
Consistency	Uniform and free-flowing; no phase separation observed.
Clarity	Clear to slightly turbid when viewed against white and black backgrounds.
Feel on Skin	Smooth, non-sticky; imparts mild cooling followed by warmth on application.
Homogeneity	Homogeneous with no visible lumps or separation of phases.
Spreadability	Spreads easily over the skin surface with minimal effort.
Volatility	Evaporates gradually without leaving residue, aiding rapid absorption.
Stability (Prelim.)	Stable under ambient conditions over a short observation period.

Table No.3: Organoleptic Evaluation

Physicochemical Evaluation :
1) pH measurement
Procedure :–
Using pH paper

1. Dip a strip of pH paper into the solution or place a drop of solution on the paper.
2. Observe the colour change.
3. Compare the colour to the provided chart to determine the pH value.
4. Final reading – Upto 5 (indicates the suitability for skin application).

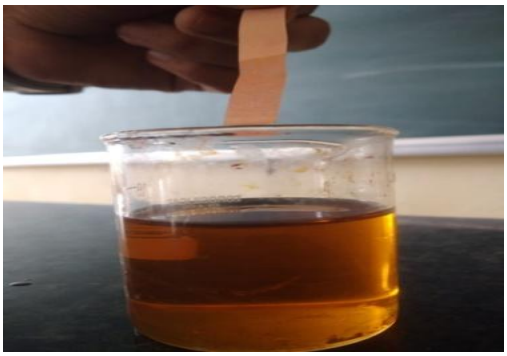

Fig No.12: pH measurement

2. Skin Irritation or Sensitization Test

Purpose: To ensure the spray does not cause irritation, redness, itching, or allergic reactions.

Method: Apply the liniment to a small area on the animal or human volunteer (with ethical approval). Observe for signs of erythema, edema, or rashes over 24-72 hours.

Fig No13.: Skin Irritation Test

3. Stability Study:

The procedure involves storing the prepared herbal liniment in a closed container at 40°C for 24 hours. Obseration shows no significant change in colour, odor, phase separation or consistency indicating good physical stability.

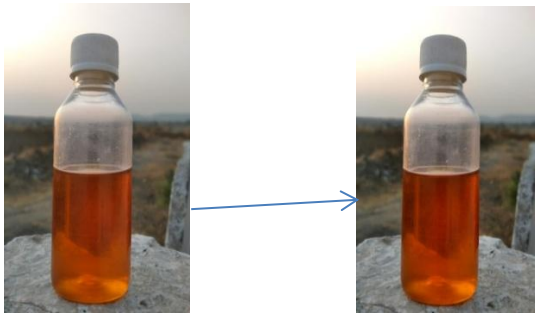

Fig No.14: Stability Testing

4.Viscosity :

Viscosity was determined using a Ostwald viscometer at room temperature. The viscosity was found to be 210cps, ensuring the liniment has appropriate flow properties for easy application.

Fig No.15: Viscosity Measurement

5.Specific Gravity :

Specific gravity was measured using a specific gravity bottle. The value obtained was 0.95, indicating the less density of the formulation in comparison to water.

Fig No.16: Measurement of specific gravity

6.Solubility Test:

Take two beakers, in one beaker take 5ml water and another beaker take 5ml ethanol.

Add 1ml liniment in both beakers and check the solubility.

The liniment is miscible with alcohol and immiscible with water.

Fig No.17: Solubility in ethanol

Fig No.18: Solubility in water

Parameter	Result
pH	Upto 5 (4.9)
Viscosity	210 cps
Specific Gravity	0.95
Solubility	Miscible with alcohol; immiscible with water
Stability (Accelerated)	No phase separation or color change observed over 24 hour at 40°C

Table No.4: Physicochemical Evaluation

Future Scope: The future scope of Giloy (Tinospora cordifolia) herbal liniment is promising due to its potential in natural pain and inflammation management. Continued research, including clinical trials and mechanistic studies, can help validate its efficacy and safety. Innovations in formulation, such as enhanced transdermal delivery and combination therapies, could improve therapeutic outcomes. As consumer interest in herbal products grows, standardized and regulatory-compliant Giloy liniments could find wider use in integrative medicine, physiotherapy, and wellness industries, offering a valuable alternative to synthetic topical agents.

RESULT

Using Tinospora cordifolia extract, camphor, eucalyptus oil, and a suitable carrier such as castor oil and mustard oil, the herbal liniment was effectively formulated. The formulation was characterized by a pleasing odor, homogeneity, and clarity. It was very readily disseminated and rapidly absorbed into the skin. screening of phytochemicals Preliminary phytochemical analysis of the extract showed the presence of alkaloids, flavonoids, saponins, terpenoids, and glycosides, which are known to have anti-inflammatory and analgesic properties. No signs of erythema or edema were observed on human volunteers indicating the liniment is safe for topical application.

1.pH measurement of Formulation:
pH of skin is 4.7 - 5.7
In first batch of formulation obtain pH is 4.5 which does not suitable for skin, In second batch of formulation ph is 4.7 which is causing mild irritations to the skin. In third batch pH obtain is 4.9 which is skin friendly.

Parameter	F1	F2	F3
pH measurement	4.5	4.7	4.9

Table No.5: pH measurement of Formulation

2.Skin Irritation or Sensitization: The formulation does not cause irritation, redness, itching, or allergic reactions.

Parameter	F1	F2	F3
Skin Irritation or Sensitization	Mild irritation, Mild Itching	Mild Itching	No Irritation or other allergic reactions.

Table No.6: Skin Irritation or Sensitization of Formulation

3.Stability Study: Instability of formulation shows significant change in colour, odor,phase separation or consistency indicating bad physical stability.
The final formulation shows the no phase separation and colour change shows the good physical stability of formulation.

Parameter	F1	F2	F3
Stability Study	Phase separation, slightly color change	Slightly color change	No phase separation or colour change

Table No.7: Stability Study of Formulation

4.Viscosity Measurement:Viscosity was determined using a Ostwald viscometer at room temperature.final viscosity is found to be 210cps.

Parameter	F1	F2	F3
Viscosity	180cps	200cps	210cps

Table No.8: Viscosity Measurement of Formulation

5.Specific Gravity: Specific gravity was measured using a specific gravity bottle.

Parameter	F1	F2	F3
Specific Gravity	0.99	0.97	0.95

Table No.9: Specific Gravity of Formulation

6.Solubility Test:
Because of low density the liniment is Immiscible with water and shows phase separation. The liniment is miscible with alcohol and immiscible with water.

Parameter	F1	F2	F3

Solubility Test	Imiscible with water,Miscible with ethanol	Imiscible with water,Miscible with ethanol	Imiscible with water,Miscible with ethanol

Table No10.10: Solubility Test of Formulation

CONCLUSION

Tinospora cordifolia (Giloy) was used in this study to successfully formulate and assess a herbal liniment for the treatment of arthritis. The liniment's traditional usage in treating joint pain and stiffness is supported by its potential anti-inflammatory and analgesic qualities. The presence of bioactive components such as alkaloids, glycosides, and flavonoids all of which are known to support its therapeutic effects was verified by phytochemical analysis. The formulation showed high stability, acceptable physicochemical qualities, and was well-tolerated during preliminary skin irritation experiments. Overall, the findings point to a natural and efficient substitute for giloy-based liniment in the treatment of arthritis symptoms.

REFERENCE

[1] P. Sharma, B.P. Dwivedee, D. Bisht, A.K. Dash and D. Kumar. "The chemical constituents and diverse pharmacological importance of Tinospora cordifolia," Helion, PMC - PubMed, 2019.Kumar A. "Cultivation and Medicinal Properties of Giloy [Tinospora cordifolia (Thunb.) Miers] Development of Agro-technology of aromatic plants View project," 2019.

[2] Tiwari P, Nayak P, Prusty SK, Sahu PK. Phytochemistry and pharmacology of Tinospora

[3] cordifolia: A review. Sys Rev Pharm, 2018.

[4] Sharma U, Bala M, Kumar N, Singh B, Munshi RK, Bhalerao S. Immunomodulatory active compounds from Tinospora cordifolia. J Ethnopharmacol, 2012.

[5] S. Saha and S. Ghosh. "Tinospora cordifolia: One plant, many roles," Anc sci life, 2012.

[6] V. Aher and A.K.Wahi, "Biotechnical approach to evaluate immunomodulatory activity of ethanolic extract of Tinospora cordifolia stem (mango plant climber)," Iran J Pharm Resm, 2011-12.

[7] P. More and K. Pai, "In vitro NADH-oxidase, NADPH-oxidase and myeloperoxidase activity of macrophages after Tinospora cordifolia (guduchi) treatment," Immunopharmacol Immunotoxicol,2012.

[8] K. Singletary, Turmeric: an overview of potential health benefits, Nutr. Today 45 (2010)

[9] M.Q.I. Khuda, A. Khaleque, N. Ray, Tinospora cordifolia constituents of plants fresh from the field, Sci. Res. 1 (1964)

[10] J.B. Hanuman, R.K. Bhatt, B.K. Sabata, A diterpenoid furanolactone from Tinospora cordifolia, Phytochemistry 25 (1986).

[11] R.K. Bhatt, J.B. Hanuman, B.K. Sabata, A new clerodane derivative from Tinospora cordifolia, Phytochemistry 27 (1988)

[12] J.B. Hanuman, R.K. Bhatt, B. Sabata, A clerodane furano-diterpene from Tinospora cordifolia, J. Nat. Prod. 51 (1988).

[13] R.K. Bhatt, B.K. Sabata, A furanoid diterpene glucoside from Tinospora cordifolia, Phytochemistry 28 (1989)

[14] M.A. Khan, I.A. Gray, P.G. Waterman, Tinosporaside an 18-norclerodane glucoside from Tinospora cordifolia, Phytochemistry 28 (1989).

[15] V.D. Gangan, P.P. Arjun, T. Sipahimalani, A. Banerji, A. Cardifolisides, C. B, Norditerpene furon glucoside from Tinospora cordifolia, Phytochemistry 37 (1994)

[16] R. Maurya, S.S. Handa, Tinocordifolin, a sesquiterpene from Tinospora cordifolia, Phytochemistry 44 (1998).

[17] Devprakash et al "Tinospora Cordifolia: A Review On Its Ethnobotany, Phytochemical & Pharmacological Profile" Asian Journal of Biochemical and Pharmaceutical Research, 2011

[18] Girendra Kumar Gautam et al "Uses of Some Traditional Medicinal Indian Plants" International Journal of Chemistry and Pharmaceutical sciences, 2014

[19] Singh SS, Pandey SC, Srivastava S, Gupta VS, Patro B, Ghosh AC. "Chemistry and medicinal properties of Tinospora cordifolia (Guduchi)" Indian Journal of Pharmacology, 2003

[20] Nagaraja puranik et al "Anti-diabetic activity of Tinospora cordifolia (Willd.) in streptozotocin diabetic rats; does it act like sulfonylureas?" Turk J Med Sci., 2010

[21] V Sivakumar et al "preliminary phytochemical screening and evaluation of Tinospora cordifolia" IJPPS.