



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Review Article

Development and Assessment of Novel Therapeutic Formulation for the Lipoma Treatment

Nikhat Maindargi*, Urvi Dalvi, Pratiksha Ghadge, Raj Jadhav, Onkar Kedar

Vijayrao Naik college of pharmacy, Shirval, Kankavli - 416602, Maharashtra, India

ARTICLE INFO

Published: 02 May 2026

Keywords:

Quercetin, Boswellia serrata, hydrogel beads, ionic gelation, green tea extract, controlled drug delivery, herbal formulation, IR spectroscopy, Lipoma.

DOI:

10.5281/zenodo.19975470

ABSTRACT

Lipomas are benign fatty tumors that are soft, moveable, and usually don't require much treatment or surgery to remove. Using a mix of natural bioactive compounds, such as quercetin, Boswellia serrata, and green tea extract, the current study investigates a unique treatment method for lipoma management. These substances are good candidates for targeted therapy because they have strong anti-inflammatory, antioxidant, and lipid-lowering qualities. Hydrogel beads are created by the formulation using the ionic gelation process, in which polymers react with multivalent ions to create stable, biocompatible carriers. This technique is intended to guarantee localized delivery of active ingredients, promote regulated medication release, and improve stability. By reducing systemic exposure and increasing therapeutic effectiveness, this strategy is very helpful in treating localized lipomas. Important topics like lipoma genesis, pathology, diagnostics, and current treatment approaches are also covered in the study. It also describes evaluation characteristics such as melting point, solubility, infrared (IR) spectroscopy, organoleptic qualities, and calibration curves. Further experimental validation is necessary to confirm the study's efficacy and practical application because it is mostly dependent on theoretical and literature data.

INTRODUCTION

Lipomas are slow-growing, mostly usually benign fatty tumors. The subcutaneous tissues are where they are most commonly found. Most lipomas are clinically identifiable, asymptomatic, and incurable. These tumors may also be found in deeper tissues such as the thorax, the internal auditory canal, the oral cavity, the abdominal

organs, the intermuscular septa, and the cerebellopontine angle. While 2-4 lipomas can occur in people of any age, they usually initially appear in those between the ages of 40 and 60. Congenital lipomas have been described in children. Some lipomas are believed to have developed as a result of severe trauma. Women are more likely to have a single lipoma, while men are

***Corresponding Author:** Nikhat Maindargi

Address: *Vijayrao Naik college of pharmacy, Shirval, Kankavli - 416602, Maharashtra, India*

Email ✉: maindargi.nikhatvncop@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



more likely to have many tumors, or lipomatosis. Multiple lipomatosis with autosomal dominance Gardner's syndrome, an autosomal dominant illness characterized by intestinal polyposis, cysts, and osteomas, may also be associated with lipomatosis. This disorder is characterized by widespread symmetric lipomas that usually appear over the trunk and limbs and are most common in men. Benign symmetric lipomatosis, also known as Madelung's disease, is the term used to describe lipomatosis of the head, neck, shoulders, and proximal upper extremities. The characteristic "horse collar" cervix can be seen in people with

Madelung's illness, who are usually men who drink. Lipomas usually appear as round, moveable masses with a characteristic soft, doughy texture that are painless. The skin on top appears to be normal. On the basis of their clinical appearance alone, lipomas are usually appropriately diagnosed. Under a microscope, lipomas are composed of mature adipocytes arranged in lobules, many of which are covered in a fibrous capsule. When a nonencapsulated lipoma occasionally penetrates muscle, it is referred to as an infiltrating lipoma.^[1]



Fig no. 01

A biopsy specimen may reveal four additional lipoma kinds.

- 1. Angiolipoma:** Include several small blood arteries as well as mature fat cells. often more excruciating than typical lipomas.
- 2. Lipoma spindle cell:** Include spindle-shaped cells and mature fat. usually observed on the back, neck, or shoulders of older men.
- 3. Lipoma Myxoid:** Has a gelatinous, myxoid stroma around its fat cells. Under a microscope, it appears more mucous and softer.
- 4. Lipoma pleomorphic:** involves unusual, multinucleated enormous cells in addition to fat and spindle cells. mostly affects the neck and back.^[2]

Lipomas can occasionally, albeit infrequently, be associated with illnesses such as multiple hereditary lipomatosis, Gardner syndrome, adiposis dolorosa, and Madelung disease. ^{[3][4]} Angiolipoma, chondroid lipoma, lipoblastoma, myolipoma, pleomorphic lipoma/spindle cell lipoma, intramuscular and intermuscular lipoma, nerve lipomatosis, tendon sheath and joint lipoma, lipoma arborescens, multiple symmetric lipomatosis, diffuse lipomatosis, adiposis dolorosa, and hibernoma are some of the uncommon types of lipomas.

1.1 Lipoma can also be:

Deep-seated, happening within muscles or organs such as the liver and kidney. Multiple, particularly in heritable disorders such as familial multiple lipomatosis. Although encapsulated, it can

occasionally infiltrate adjacent tissues, complicating removal.

1.1.1 Mechanism of action of lipoma

A lipoma forms when adipocytes, or fat cells, in a specific area of the body begin to proliferate and grow at an abnormally high rate. This produces a non-cancerous soft lump beneath the skin. Although the actual cause is not always evident, the following important elements may contribute to this:

Genetic Alterations: Mutations in the HMGA2 gene, for example, can cause excessive fat cell development.

Stem Cell Imbalance: Mesenchymal stem cells, the body's repair cells, can mistakenly differentiate into fat cells and create a mass.

Trauma or Minor Injury: In some situations, trauma can cause fat tissue to expand in an abnormal manner. **Family History:** A predisposition to develop numerous lipomas is inherited by some individuals. [5]

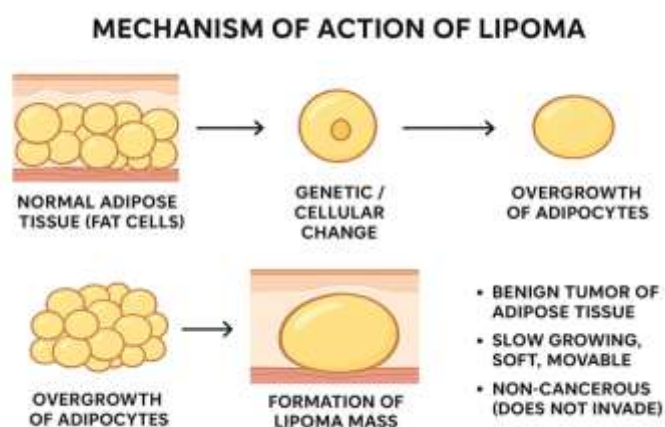


Fig no.02

1.2 Causes of Lipoma

1. Genetic factors

- most common cause, especially in case of multiple lipomas.
- Condition like familial multiple lipomas are inherited.
- Gene mutation.

2. Metabolic Disorders:

Certain metabolic conditions may increase the risk:

- Madelung's disease (multiple symmetrical lipomatosis)
- Diabetes

- Dyslipidemia (abnormal fat levels in blood)

3. Age:

- Lipomas are most common in people aged 40 to 60
- Rare in children and young adults

4. Family History

- A strong genetic predisposition exists in many cases.
- People with a family history of lipoma are more likely to develop them.

1.3 Common early warning signs can include:



Soft, painless lump: A soft, rubbery lump beneath the skin is usually the first noticeable symptom.

Slow growth: The lump typically increases slowly over a few weeks or months. The bulge is often moveable with light pressure beneath the skin.

Size: Usually little (less than 5 cm), but occasionally bigger.

No skin changes: In general, the skin around the mass is not red, heated, or infected.

Usually painless: Lipomas are typically asymptomatic, but if they press against muscles or nerves, they may occasionally cause pain.^[6]

Anatomical Pathology

Mesenchymal tumors, usually located subcutaneously, are referred to as lipomas.^[7] They can also be found on internal organs including the colon and stomach; however this is less common. Usually, these masses are not connected to the muscular tissue beneath them. Lobulated, mature, slow-growing adipose tissue with little connective tissue stroma makes up lipomas. Usually, a thin, fibrous capsule encloses them.

Variants of lipoma defined by location include:

- Intermuscular lipoma
- Intramuscular lipoma
- Parosteal/ periosteal lipoma
- Lipoma arborescens (synovial lipomatosis)
- Intracranial lipoma

CLINICAL PATHOLOGY

Patients frequently report feeling a mobile, squishy mass of tissue beneath their skin. Unless they invade blood vessels, joints, or nerves, these are usually harmless. These are frequently observed by patients in the upper body. These lipomas might infrequently develop in organs or muscles. Most lipomas are benign, and they are only removed or treated if their position causes pain or if they interfere with an organ's ability to function. However, because these tumors are often visible through the skin due to their subcutaneous location, some patients decide to have them removed for aesthetic purposes. Small incisions can be used to remove lipomas smaller than 4 cm, and scarring is typically not a major concern. According to research, open surgery is still a better option than suction-assisted lipectomy through small incisions for the removal of giant lipomas (greater than 10 cm) because it allows for better judgment, prevents recurrences, and avoids damage to the surrounding tissues.^[8]

Treatment and Management

Unless they create discomfort, cosmetic issues, or functional issues, most lipomas don't need to be treated.

❖ Surgical Excision

The most popular course of treatment is surgical removal. To stop recurrence, the tumor and its capsule are removed.

❖ Liposuction

In some cases, liposuction may be used to remove fatty tissue through a small incision.^[9]

❖ Steroid Injections

Lipomas may not be totally eradicated by steroid injections, but they can be made smaller.



❖ Emerging Treatments:

Researchers are exploring non-surgical treatments including:

Injectable fat-dissolving agents

Targeted drug delivery systems

Hydrogel-based localized therapy

These approaches aim to reduce tumor size with minimal invasive procedures.^[10]

Clinical Significance

While lipomas can appear at any age, they usually do so in people between the ages of 40 and 60, and there is no evidence of gender bias. Other age groups are more likely to experience certain forms of lipomas. For instance, lipoblastomas and diffuse lipomatosis are frequently observed in children beyond the age of three, while hibernomas typically manifest clinically at the age of thirty. Five percent of patients have more than one lipoma.

According to reports, 1% of people have lipomas, and their incidence—which may be underreported—is 2.1 per 1000 people year.

A positive diagnosis of a lipoma typically involves the following:

- Physical exam performed by a medical doctor
- An ultrasound of the mass should reveal that the lipoma or adipose mass is deeper than the surrounding fatty tissue and that it has different characteristics from the adipose tissue that is healthy or normal.
- A biopsy (and subsequent examination of a tissue sample) is not performed routinely in standard practice because the diagnosis is

typically made clinically, and it may be difficult to identify lipomas from healthy adipose tissue histologically.

Surveillance

If lipomas are not painful and harmless, there is no need for removal.

Treatment

These methods include liposuction of the tumor, surgical excision, intralesional steroids mixed with isoproterenol (a beta-2 adrenergic agonist), and intralesional transcutaneous sodium deoxycholate (related or not to phosphatidylcholine) injections. The latter is probably the best way to stop them from happening again, but for the best course of action and to lower the chance of recurrence, the encapsulation must also be removed.^[11] In order to minimize the possibility of lipomas encroaching on joints, nerves, and blood arteries, which would make the excision more challenging and invasive, it is best to remove lipomas when they are still small rather than after they have grown larger.

Prognosis

Benign lipomas have an excellent prognosis. There is no chance that these benign entities may develop into malignant ones.^[12] These tumors frequently do not recur after being removed, mostly for cosmetic purposes. To avoid this, however, the fibrous capsule encircling the lipoma must be completely removed.

Classification

World Health Organization (WHO) classification system classified lipomatous tumors into the following sub types^[13]

- Lipoma



- Lipomatosis
- Lipomatosis of nerve
- Lipoblastoma/ lipoblastomatosis
- Angiolipoma
- Myolipoma of soft tissue
- Chondroid lipoma
- Spindle-cell lipoma/pleomorphic lipoma
- Hibernoma.

Table no 1.1: Marketed products used to treat lipoma

Brand Name	Ingredients	Image
Bakson's Lipoma Aid Drops	Calcarea Fluorica, Baryta Carbonica, Thuja occidentalis	
Kybella	Deoxycholic acid (ATX-101)	
Ayurvedic Lipoma Capsules	Triphala, Guggul, Turmeric, Haritaki, Bibhitaki	
Trilone Injection	Triamcinolone acetonide	

Mechanism of Action of Active Ingredients

Green tea:

Biologically active polyphenols called catechins, especially Epigallocatechin gallate, are found in green tea extract and are crucial for lipid metabolism. Green tea catechins increase lipolysis in the context of catecholamine stimulation by norepinephrine, according to in vitro research utilizing differentiated adipocyte cell lines such 3T3-L1. Treatment with catechin causes adipocytes to produce more glycerol and free fatty acids, which suggests that stored triglycerides are

being broken down more effectively. Important lipolytic enzymes including hormone-sensitive lipase are activated and phosphorylated during this process. Furthermore, the first phase of triglyceride hydrolysis is catalyzed by Adipose Triglyceride Lipase, whose mRNA and protein expression levels are increased by catechins. Additionally, green tea catechins block Catechol-O-methyltransferase, which prolongs norepinephrine's effect and increases lipolysis. Green tea extract stimulates overall fat metabolism, enhances fatty acid mobilization, and encourages triglyceride breakdown through several processes. ^[14]



Quercetin:

Quercetin has a number of biological effects that could help treat lipomas. By suppressing adipogenic transcription factors including PPAR- γ and C/EBP α , which are necessary for the transformation of pre-adipocytes into mature adipocytes, it prevents adipogenesis. Quercetin inhibits the production of new fat cells in lipomatous tissue by blocking several processes. Furthermore, quercetin increases the breakdown of stored triglycerides into free fatty acids and glycerol via activating AMP-activated protein kinase (AMPK). Its potent antioxidant properties aid in reducing oxidative stress and neutralizing reactive oxygen species, both of which may be factors in aberrant adipose tissue growth. Additionally, by blocking inflammatory mediators including TNF- α and NF- κ B signaling pathways in adipose tissue, quercetin demonstrates strong anti-inflammatory effects. Additionally, it alters the enzymes involved in lipid metabolism, enhancing the metabolic equilibrium of fat cells. When taken as a whole, these strategies may limit the growth of lipomas, lessen the accumulation of lipids, and eventually diminish the size of lipomas while lowering the risk of recurrence. ⁽¹⁵⁾

Boswellia serrata:

Boswellic acids, particularly AKBA (Acetyl-11-keto- β -boswellic acid), are active chemicals found in *Boswellia serrata* resin that have therapeutic and anti-inflammatory actions via a variety of metabolic routes.

1. Inhibition of 5-Lipoxygenase (5-LOX)

- The enzyme 5-lipoxygenase is specifically inhibited by boswellic acids.
- 5-LOX transforms arachidonic acid into leukotrienes (LTB₄, LTC₄, and LTD₄).

- Leukotrienes are potent mediators of edema, bronchoconstriction, and inflammation.
- Boswellia inhibits this enzyme, which lowers leukotriene production and thus inflammation in illnesses such as arthritis, asthma, and inflammatory bowel disease.

2. Reduction of Leukocyte Elastase

- Boswellic acids inhibit human leukocyte elastase (HLE).
- HLE damages connective tissue during chronic inflammation.
- Inhibition prevents tissue destruction and cartilage degradation, which is beneficial in osteoarthritis and rheumatoid arthritis.

3. Inhibition of Pro-Inflammatory Cytokines

Boswellia suppresses the release of inflammatory mediators such as:

- TNF- α (Tumor Necrosis Factor-alpha)
- IL-1 β
- IL-6

This occurs by blocking activation of the transcription factor NF- κ B, which regulates many inflammatory genes.

4. Inhibition of Matrix Metalloproteinases (MMPs)

- Boswellic acids inhibit MMP-3 and MMP-9, enzymes responsible for cartilage breakdown.
- This contributes to chondroprotective activity in joint diseases

5. Inhibition of Complement System

- Boswellia suppresses activation of the classical complement pathway, reducing immune-mediated inflammation.

6. Antioxidant Activity



- Boswellia compounds scavenge reactive oxygen species (ROS) and reduce oxidative stress at inflamed sites.

7. Anti-Proliferative and Anti-Tumor Effects

AKBA:

- Induces apoptosis in cancer cells
- Inhibits topoisomerase I and II
- Blocks angiogenesis (VEGF signaling)

This contributes to its studied role in cancers and brain tumors.

8. Effects on Immune Modulation

- Modulates T-cell and B-cell activity
- Reduces excessive immune response while maintaining normal immunity.^[16]

List of materials

Table no.1.2: List of materials

Sr. No	Material	Role
1	Green Tea	Lipolytic Agent
2	Boswellia serrata	Anti-inflammatory
3	Quercetin	Antioxidant
4	Sodium alginate	Polymer
5	Calcium chloride	Cross linking agent
6	Glycerol	Plasticizer
7	Cyclo dextrin	Solubalizer
8	Soya lecithin	Sustain release
9	Poloxamer	Surfactant
10	Sorbitol	Stabilizer
11	Chitosan	Targeting agent
12	Pectin	Gelling agent

List of Equipment, Instrument, Glassware

Table no.1.3: List of Equipment, Instrument, Glassware

1	Magnetic stirrer
2	Hot plate
3	Beaker (250ml)
4	Conical flask
5	Measuring Cylinder

6	Optical microscope or Stereomicroscope
7	Analytical balance
8	pH meter
9	Filtration setup (Buchner Funnel Setup)
10	Drying equipment 1) Hot air oven 2) Freeze dryer

PLANT PROFILE

GREEN TEA:

Table No. 1.4 Profile of Green Tea

Synonym	Camellia sinesis
Appearance	Green or Yellowish
Chemical formula	C ₂₂ H ₁₈ O ₁₁
Molar mass	458.37g/mol
Brewing Temperature	60-85°C
Solubility	Soluble in water and alcohol Insoluble in oil

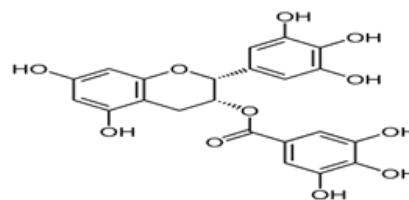


Fig no. 03 : structure of Green tea



Fig no.04 : Green tea

Lipolytic Agent

Catechins and caffeine, two of green tea's active ingredients, work together to encourage the breakdown and use of stored fat.

The primary catechin in green tea, epigallocatechin gallate (EGCG), has the ability to block the enzyme catechol-O-methyltransferase (COMT).

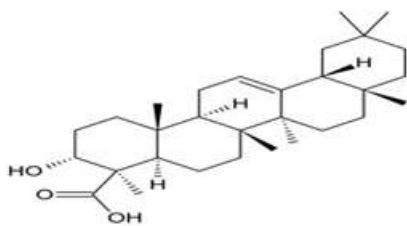
Norepinephrine, a hormone that burns fat, is broken down by this enzyme. EGCG stimulates and prolongs the function of norepinephrine, which tells fat cells to break down stored fat, via blocking COMT.

Increases norepinephrine: The enzyme that breaks down the hormone norepinephrine can be inhibited by green tea catechins, particularly EGCG. Norepinephrine levels rise as a result, which encourages lipolysis.

BOWELLIA SERRATA:

Table No. 1.5 Profile of Boswellia Serrata

Synonym	Indian frankincense
Appearance	light brown to yellowish powder
Chemical formula	C ₃₂ H ₄₈ O ₅
Molar Mass	456.7g/mol
Melting Point	266-228°C
Solubility	Poor in Water Soluble in Ethanol & DMSO



Figno.05 Structure of Boswellia Serrata



Fig no.06 Boswellia Serrata

Anti-inflammatory properties

Inhibits pro-inflammatory enzymes: Boswellia serrata's boswellic acids, especially 3-O-acetyl-11-keto β boswellic acid (AKBBA), are strong inhibitors of 5-lipoxygenase (5-LOX).

Lowers inflammatory mediators: Boswellia serrata lowers the synthesis of leukotriene and other pro-inflammatory molecules that cause inflammation by blocking 5-LOX.

Suppresses inflammatory mediators: It can lower the expression of adhesion molecules and suppress other inflammatory markers and enzymes, including cyclooxygenases (COX) and nitric oxide (NO).

QUERCETIN:

Table no.1.6: Profile of quercetin

Synonym	Quercetol
IUPAC name	2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-4H-1-benzopyran-4-one
Chemical formula	C ₁₅ H ₁₀ O ₇
Molar mass	302.236g/mol
Appearance	Yellow crystalline powder
Density	1.799g/cm ³
Melting point	316°C
Solubility	Ethanol

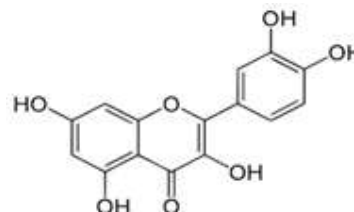


Fig no.7.1.5: Structure of Quercetin



Fig no.7.1.6: Quercetin

Antioxidant capacity:

Free radical scavenging: By donating electrons to neutralize free radicals, quercetin's five hydroxyl groups—especially those in the B and C rings—help avoid cellular damage.

Taking direct action against ROS, RNS, and RCS
Reactive oxygen species (ROS), reactive nitrogen species (RNS), and reactive chlorine species (RCS) can all be directly captured by it.

Chelation of metal ions: By chelating transition-metal ions, quercetin can function as a reducing agent by preventing them from starting chain reactions mediated by free radicals.

Modulation of cellular pathways: It can control the expression of genes linked to oxidative stress and have an impact on cellular signaling pathways.

Increasing endogenous antioxidants: Quercetin can raise glutathione (GSH) levels, an antioxidant that is essential for the body's defense systems against oxidative damage.

METHODOLOGY IDENTIFIED:

Pre formulation parameter

Organoleptic characteristic:

The herbal medication's color, taste, odor, and appearance will be determined

Solubility:

A variety of solvents, including water, methanol, and ethanol, are used to evaluate the solubility of herbal extract.

Melting point:

Determining the herbal extract's melting point is crucial for indicating the safe storage limit. The melting point of herbal extract is ascertained using the capillary method, which involves gathering and storing capillaries in a capillary device. It is observed that the product dissolves gradually, and occasionally the melting point shuts after the product has fully melted.

Spectroscopy in the infrared (IR):

The potassium bromide particle method was employed to record the infrared spectra of herbal extracts in the 400–4000 cm⁻¹ range. A Shimadzu FT will be used to compare the interaction of the FT-IR methods with the now-IR spectrophotometer, model IR affinity 1CE8,9.

Herbal extract calibration curve:

Herbal extracts will be used to create a calibration curve. The dissolving medium will be phosphate buffered at pH 6.8. Ten milligrams of extract should be weighed out and diluted in one hundred milliliters of phosphate buffer. The solutions will be separated into the following categories: 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 ug/ml. Plot the absorbance against the concentration after measuring the difference's absorbance using ultraviolet (UV) spectroscopy.

Post Formulation Studies:

Particle Size:

Using an optical microscope equipped with a calibrated ocular micrometer, measure the diameter of randomly chosen beads and note the average size.

Particle Size:

Using an optical microscope equipped with a calibrated ocular micrometer, measure the diameter of randomly chosen beads and note the average size.

Swelling Time:

Put dry beads in buffer and note how long it takes for the bead weight to stay constant, a sign of equilibrium swelling.

Consistency:



For the duration of the study, keep the beads at 4°C and frequently check for changes in size, color, shape, or structural integrity.

Shape:

Examine beads using a stereomicroscope to record any anomalies and assess sphericity and uniformity.

METHOD:

Procedure:

Weigh APIs (Green tea, Boswellia serrata, Quercetin)
↓
Dissolve APIs in distilled water
↓
Add sorbitol (stabilizer) and poloxamer (surfactant)
↓

Add sodium alginate and pectin → Stir to form uniform polymeric solution
↓
Prepare chitosan solution separately in mild acid
↓
Add chitosan solution to drug–polymer mixture
↓
Load final mixture into syringe
↓
Extrude dropwise into CaCl₂ solution (cross-linking bath)
↓
Formation of hydrogel beads by ionic gelation
↓
Allow curing for required time
↓
Collect beads and wash with distilled water
↓
Dry beads at controlled temperature until constant weight

Formulation table:

Table no.1.7 :Formulation table

Ingredient	F1	F2	F3	F4	F5	Role
Green Tea	1%	1%	1%	1%	1%	Lipolytic agent
Boswellia Serrata	18%	18%	18%	18%	18%	Anti-inflammatory agent
Quercetin	5%	5%	5%	5%	5%	Antioxidant agent
Sodium Alginate	2%	3%	1%	4%	1%	Polymer
Calcium chloride	0.5%	1%	0.3%	1%	0.4%	Cross linking agent
Glycerol	5%	6%	8%	7%	10%	Plasticizer
Cyclodextrin	2%	1%	3%	5%	4%	Solubilizer
Soya Lecitin	0.5%	1%	2%	5%	3%	Sustain release
Poloxamer	0.1%	1%	1.5%	1.8%	2%	Surfactant
Sorbitol	6%	7%	5%	9%	8%	Stabilizer
Chitosan	0.3%	0.5%	0.8%	0.9%	1%	Targeting agent
Pectin	1%	3%	2%	4%	2%	Gelling agent

EXPECTED RESULTS

RESULT

This outcome is predicated on theoretical concepts, and it may alter following actual execution. Colour , taste , and odor of the physical

composition. Boiling point, IR spectroscopy, and UV spectroscopy are pre-formulation characteristics; pH range, stability test, sedimentation volume ratio, particle size distribution, and viscosity are post-formulation parameters.



Physical parameters of formulation:

Evaluation parameters	Specification	Expected result
Color	White to off white	White to off white
Odor	Odorless	Odorless
Taste	Slightly mucilaginous	Slightly mucilaginous

Post formulation parameters:

Evaluation parameters	Specification	Expected result
Particle size	0.2–2 mm	0.7mm
Swelling ability	0.5-5gm	0.5gm
Swelling time	15 – 30 min	20 min
Stability	4 °C	4 °C
Shape	Spherical	Spherical

FUTURE PROSPECTS**1. Advanced Drug Delivery Systems:**

Hydrogel beads can be further developed as an effective carrier for targeted and sustained delivery of drugs to lipoma tissue.

2. Improved Biocompatibility:

Research can focus on using natural or biodegradable polymers to enhance the safety and compatibility of hydrogel formulations.

3. Controlled and Sustained Release:

Modification of cross-linking density and polymer composition can allow precise control over the drug release rate from the hydrogel beads.

4. Incorporation of Novel Therapeutic Agents:

Future studies may explore loading hydrogel beads with anti-lipogenic drugs, enzymes, or herbal extracts for improved lipoma reduction.

5. Development of Injectable Hydrogels:

Formulating injectable hydrogels that can solidify at the lipoma site could provide a small invasive alternative to surgery.

6. In-Vivo and Clinical Studies:

Further animal and human studies are needed to evaluate the therapeutic effectiveness, safety, and pharmacokinetic profile of hydrogel beads.

7. Commercial and Industrial Scale-Up:

Optimization of production processes can enable large-scale manufacturing and commercialization of hydrogel-based formulations.

8. Potential Application beyond Lipoma:

The developed hydrogel technology could also be applied to treat other localized fatty or benign growths and in controlled drug delivery for other diseases.

CONCLUSION

This report provides an in-depth theoretical understanding of lipoma and explores the potential use of *Boswellia serrata*, quercetin, and green tea extract as a combined therapeutic approach. The anti-inflammatory action of *Boswellia serrata*, the strong antioxidant capacity of quercetin, and the lipid-lowering effects of green tea polyphenols collectively present a promising strategy for targeting the underlying factors associated with lipoma formation. These natural agents may work synergistically to reduce inflammation, oxidative stress, and abnormal fat accumulation, which are commonly linked to lipoma growth.

However, the conclusions drawn in this study are based primarily on literature evidence rather than experimental validation. The actual clinical or experimental response to this combination may vary depending on dosage, formulation and



research conditions. While the theoretical framework highlights strong potential benefits, comprehensive practical studies, including in-vitro, in-vivo, and clinical investigations, are necessary to confirm the safety, efficacy, and mechanisms of action of this multi-component approach.

Overall, this report establishes a solid theoretical basis for further exploration into herbal-based lipoma treatments and encourages future research to translate these concepts into reliable therapeutic outcomes.

REFERENCES

1. Tong KN, Seltzer S, Castle JT. Lipoma of the parotid gland. *Head and Neck Pathology*. 2020 Mar;14(1):220-3.
2. Demicco EG. Molecular updates in adipocytic neoplasms. *Seminars in Diagnostic Pathology* 2019 Mar 1 (Vol. 36, No. 2, pp. 85-94). WB Saunders.
3. Creytens D. A contemporary review of myxoid adipocytic tumors. *Seminars in Diagnostic Pathology* 2019 Mar 1 (Vol. 36, No. 2, pp. 129-141). WB Saunders.
4. Burt AM, Huang BK. Imaging review of lipomatous musculoskeletal lesions. *Sicot-j*. 2017 May 5;3:34, pp. 2-17.
5. Putra J, Al-Ibraheemi A. Adipocytic tumors in children: a contemporary review. *Seminars in Diagnostic Pathology* 2019 Mar 1 (Vol. 36, No. 2, pp. 95-104). WB Saunders.
6. Amir R, Sheikh S. Adenolipoma of the skin: a report of 11 cases. *Case Reports in Dermatology*. 2018 Jun 18;10(1):76-81.
7. Fukushima M, Schaefer IM, Fletcher CD. Myolipoma of soft tissue: clinicopathologic analysis of 34 cases. *The American Journal of Surgical Pathology*. 2017 Feb 1;41(2):153-60.
8. Chen S, Osaki N, Shimotoyodome A. Green tea catechins enhance norepinephrine-induced lipolysis via a protein kinase A-dependent pathway in adipocytes. *Biochemical and biophysical research communications*. 2015 May 22;461(1):1-7.
9. Rosenberg AE. Pseudosarcomas of soft tissue. *Archives of pathology & laboratory medicine*. 2008 Apr 1;132(4):579-86.
10. Yavari M, Afshar A, Shahraki SS, Tabrizi A, Doorandish N. Management of symptomatic lipoma of the hand: a case series and review of literature. *Archives of Bone and Joint Surgery*. 2022 Jun;10(6):530-535
11. Shu S, Wang J, Zheng C. From pathogenesis to treatment, a systemic review of cardiac lipoma. *Journal of cardiothoracic surgery*. 2021 Jan 6;16(1):1,1-7
12. Köckerling F, Schug-Pass C. Spermatic cord lipoma—a review of the literature. *Frontiers in Surgery*. 2020 Jul 23;7:39,1-9
13. Derin AT, Yaprak N. Lipomas: Review and evaluation of the literature. *Clinics in Surgery* 2017; 2. 2017;1615.
14. Kurt AA, Aslan İ. A Novel Liposomal In-Situ Hydrogel Formulation of Hypericum perforatum L.: In Vitro Characterization and In Vivo Wound Healing Studies. *Gels*. 2025 Feb 26;11(3):165.
15. Seo DB, Jeong HW, Kim YJ, Kim S, Kim J, Lee JH, Joo K, Choi JK, Shin SS, Lee SJ. Fermented green tea extract exhibits hypolipidaemic effects through the inhibition of pancreatic lipase and promotion of energy expenditure. *British Journal of Nutrition*. 2017 Jan;117(2):177-86.
16. Ismail SM, Rao KR, Bhaskar M. Evaluation of anti-inflammatory activity of *Boswellia serrata* on carrageenan induced paw edema in albino Wistar rats. *Int. J. Res. Med. Sci*. 2016 Jul;4(7):2980-6.
17. Dong YS, Wang JL, Feng DY, Qin HZ, Wen H, Yin ZM, Gao GD, Li C. Protective effect of quercetin against oxidative stress and brain



- edema in an experimental rat model of subarachnoid hemorrhage. *International journal of medical sciences*. 2014 Jan 28;11(3):282.
18. Cadena PG, Pereira MA, Cordeiro RB, Cavalcanti IM, Neto BB, Pimentel MD, Lima Filho JL, Silva VL, Santos-Magalhães NS. Nanoencapsulation of quercetin and resveratrol into elastic liposomes. *Biochimica et Biophysica Acta (BBA)-Biomembranes*. 2013 Feb 1;1828(2):309-16.
 19. Islam MS, Quispe C, Hossain R, Islam MT, Al-Harrasi A, Al-Rawahi A, Martorell M, Mamurova A, Seilkhan A, Altybaeva N, Abdullayeva B. Neuropharmacological effects of quercetin: a literature-based review. *Frontiers in pharmacology*. 2021 Jun 17;12:665031.
 20. Singh S, Semwal BC, Sharma H, Sharma D. Impact of phytomolecules with nanotechnology on the treatment of inflammation. *Current Bioactive Compounds*. 2023 Dec 1;19(10):122-48.
 21. Islam MS, Quispe C, Hossain R, Islam MT, Al-Harrasi A, Al-Rawahi A, Martorell M, Mamurova A, Seilkhan A, Altybaeva N, Abdullayeva B. Neuropharmacological effects of quercetin: a literature-based review. *Frontiers in pharmacology*. 2021 Jun 17;12:665031..
 22. Raymond C.; Rowe, Paul J.; Sheskey, Sian C.; Owen. "A handbook of pharmaceutical 5th Edition 2006."
 23. Goh CH, Heng PW, Chan LW. Alginates as a useful natural polymer for microencapsulation and therapeutic applications. *Carbohydrate polymers*. 2012 Mar 17;88(1):1-2.
 24. Chan ES. Preparation of Ca-alginate beads containing high oil content: Influence of process variables on encapsulation efficiency and bead properties. *Carbohydrate polymers*. 2011 April 2;84(4):1267-75.

HOW TO CITE: Nikhat Maindargi, Urvi Dalvi, Pratiksha Ghadge, Raj Jadhav, Onkar Kedar, Development and Assessment of Novel Therapeutic Formulation for the Lipoma Treatment, *Int. J. of Pharm. Sci.*, 2026, Vol 4, Issue 5, 101-114. <https://doi.org/10.5281/zenodo.19975470>