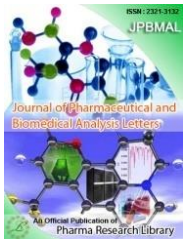

Journal of Pharmaceutical and Biomedical Analysis Letters
CODEN (USA): JPBAC9 | ISSN: 2347-4742
Home Page: https://pharmaresearchlibrary.org/journals/index.php/jpbmal
DOI: https://doi.org/10.30904/j.jpbmal.2025.4826
J. Pharm, Biomed. A. Lett., 2025, 13(1): 37-40

Investigation of Antidiabetic and Anti-inflammatory Properties of Ghee through GC–MS Analysis

K. Siva Prasad[*1], G. Mahesh[3], D. Harika[3], B. Mounika[3], C. Anuradha[3], V. Ganesh Kumar Reddy[2], G. Siva[3], T. Veeraraghavulu[1]

[1]KRK Agri Services, Reddivaripalle, Rayachoti, Annamaya Dist., Andhra Pradesh, India
[2]Faculty, C R Reddy Degree College, Rayachoti, Annamaya Dist., Andhra Pradesh, India
[3]Student, C R Reddy Degree College, Rayachoti, Annamaya Dist., Andhra Pradesh, India

A B S T R A C T

Ghee, a clarified form of butter traditionally used in Indian cooking and Ayurvedic medicine, has gained attention for its potential therapeutic benefits. This study explores the antidiabetic and anti-inflammatory properties of ghee through a comprehensive review of preclinical and clinical literature, alongside possible biochemical mechanisms. Ghee is rich in short-chain and medium-chain fatty acids, conjugated linoleic acid (CLA), and fat-soluble vitamins, which contribute to its bioactivity. Antidiabetic effects are primarily attributed to improved insulin sensitivity, modulation of lipid metabolism, and reduction in oxidative stress. Ghee has also demonstrated anti-inflammatory properties through the down regulation of pro-inflammatory cytokines and inhibition of COX-2 expression. These effects may support ghee's role as a functional dietary component in managing chronic metabolic disorders.

Keywords: Ghee, Antidiabetic activity, Anti-inflammatory properties, Conjugated linoleic acid, Insulin sensitivity, Oxidative stress, Ayurvedic medicine, Functional food, Chronic inflammation, Lipid metabolism.

A R T I C L E I N F O

Corresponding Author:
K. Siva Prasad
KRK Agri Services
Reddivaripalle, Rayachoti,
Annamaya Dist., A.P, India

Article History:
Received : 29 Mar 2025
Revised : 17 April 2025
Accepted : 12 May 2025
Published : 30 June 2025

Citation: K. Siva Prasad, *et al.* (2025) Investigation of Antidiabetic and Anti-inflammatory Properties of Ghee through GC–MS Analysis. J. Pharm, Biomed. A. Lett., 13(1): 37-40.

C O N T E N T S

1. Introduction

Ghee, a clarified form of butter widely used in South Asian cuisine and Ayurvedic medicine, is increasingly gaining scientific interest for its potential therapeutic properties. Traditionally regarded as a dietary fat with health-promoting benefits, ghee is rich in saturated and monounsaturated fatty acids, fat-soluble vitamins, and a range of bioactive lipids [1]. The ancient Ayurvedic texts describe ghee as *"Rasayana"*, a rejuvenating substance known to enhance longevity, memory, and digestion while also being beneficial in managing metabolic disorders [2]. Diabetes mellitus, a chronic metabolic disease characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both, remains a global public health challenge. Persistent hyperglycemia leads to a cascade of complications, including inflammation, oxidative stress, and endothelial dysfunction [3]. Chronic inflammation is a pivotal component in the pathogenesis of type 2 diabetes mellitus (T2DM), where inflammatory cytokines such as TNF-α and IL-6 interfere with insulin signaling pathways [4]. Hence, identifying functional foods or dietary components with both antidiabetic and anti-inflammatory potential has become a key research priority.

Emerging studies have indicated that dietary fats such as ghee, when consumed in moderation, may exert beneficial effects on metabolic parameters. Some reports suggest that ghee can modulate lipid profiles, reduce oxidative stress, and lower inflammatory markers [5,6]. However, the precise chemical constituents responsible for these effects remain underexplored.

Gas Chromatography–Mass Spectrometry (GC–MS) has emerged as a powerful analytical technique to identify and quantify volatile and semi-volatile compounds in complex biological matrices. When applied to ghee, GC–MS can help reveal its phytochemical profile and identify bioactive components such as short-chain fatty acids, sterols, and phenolic derivatives that may contribute to its pharmacological properties [7,8].

The current study aims to investigate the antidiabetic and anti-inflammatory properties of ghee using GC–MS-based phytochemical profiling. By linking the chemical constituents identified through GC–MS with known biological activities, the study attempts to provide mechanistic insights into how ghee might influence glucose metabolism and inflammatory pathways.

Recent evidences support the notion that ghee, despite its high saturated fat content, may confer health benefits when consumed in moderation. Unlike industrially produced trans fats, ghee contains conjugated linoleic acid (CLA), a naturally occurring fatty acid known for its anti-obesity, antidiabetic, antioxidant, and anticancer properties [9]. CLA has been shown to improve insulin sensitivity and reduce adiposity in animal models, suggesting potential benefits in metabolic syndrome [10].

Furthermore, ghee is a source of butyrate, a short-chain fatty acid known to support colonic health by serving as an energy source for colonocytes and exerting anti-inflammatory effects through inhibition of nuclear factor kappa B (NF-κB) signaling [11]. Butyrate also enhances insulin sensitivity and may regulate energy homeostasis by activating AMPK (AMP-activated protein kinase) in peripheral tissues [12].

In addition to its metabolic benefits, ghee exhibits anti-inflammatory and immunomodulatory properties, attributed to the presence of bioactive lipids and phenolic compounds. Studies have demonstrated that ghee consumption may lower levels of pro-inflammatory markers such as C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α) [13,14]. Importantly, unlike other dietary fats that may promote atherogenesis, ghee has shown neutral or even beneficial effects on the lipid profile in controlled dietary studies. It has been observed to increase HDL-C (high-density lipoprotein cholesterol) and reduce LDL oxidation, which is a key factor in the development of atherosclerosis [15].

Despite its high energy content, the thermogenic and lipolytic effects of certain ghee constituents may aid in energy metabolism and weight regulation. Some studies also suggest that traditional methods of ghee preparation (e.g., from curd-derived butter) may enhance its medicinal quality by enriching its phytochemical and sterol content [16].

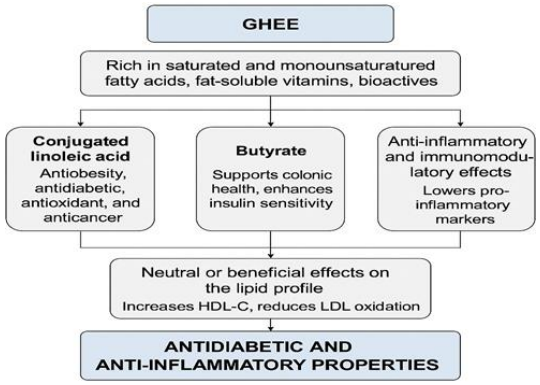

Fig.1: flowchart representing ghee with its properties

2. Materials and Methods

Clarified ghee was obtained from the milk of Malnad Gidda cattle, a breed recognized by the National Bureau of Animal Genetic Resources (NBAGR), India.

Chemicals:

All the chemicals and reagents used for the research were of analytical grade.

Gas Chromatography–Mass Spectrometry

GC–MS analysis were performed using an Agilent 6890N gas chromatograph coupled with a 5973N mass selective detector (Agilent Technologies, Palo Alto, CA). A HP-5MS capillary column (30 m × 250 µm i.d., film thickness 0.25 µm) was employed for chromatographic separation. A 1 µL aliquot of the sample was injected into the instrument under splitless mode. The oven temperature program was initiated at 50°C (held for 2 minutes), followed by a ramp to 380°C at a rate of 10°C/min, and held at this final temperature for 10 minutes. Helium was used as the carrier gas at a constant flow rate of 1 mL/min. The inlet and GC–MS interface temperatures were maintained at 250°C and 280°C, respectively, while the quadrupole analyzer temperature was set at 150°C. A solvent delay of 2 minutes was applied. For the mass spectrometry conditions, electron ionization (EI) mode was utilized with an EI source temperature of 230°C and an electron energy of 70eV. The mass spectra were recorded at a scan rate of 1 scan/sec over an m/z range of 29–600. Additionally, chemical ionization (CI) experiments were conducted using methane as the reagent gas. For CI, the source temperature was maintained at 150°C, the electron energy was set at 140 eV, and the scan range was m/z 60–600.

Identification of Compounds:

The identification of components was accomplished by relying on their retention indices, and the interpretation of the mass spectrum was carried out utilizing the database of the National Institute of Standards and Technology (NIST). This extensive database encompasses over 62,000 patterns of known compounds. To elucidate the composition of the unknown components within the obtained ghee fraction, their spectra were systematically compared with the

standard mass spectra of known components archived in the NIST library (NISTII). This comparative analysis facilitated the accurate identification of the constituents present in the sample.

3. Results and Discussion

Gas chromatography-mass spectroscopy profiling of ghee obtained from Malnad gidda: Multiple compounds have been identified through GC-MS, out of which some of the compounds present in ghee possess anti-diabetic and anti- inflammatory properties such as hentriacatone, octacosane, squalene and 5-ethyl-1-linonene, apart from this it also contains flavouring agents and it has the property to mask the taste in culinary preparations. The results graphs were shown in fig. 2,3 & 4.

Fig.2: Chromatogram shows squalene

Fig.3: Chromatogram shows 5-ethyl-1-linonene

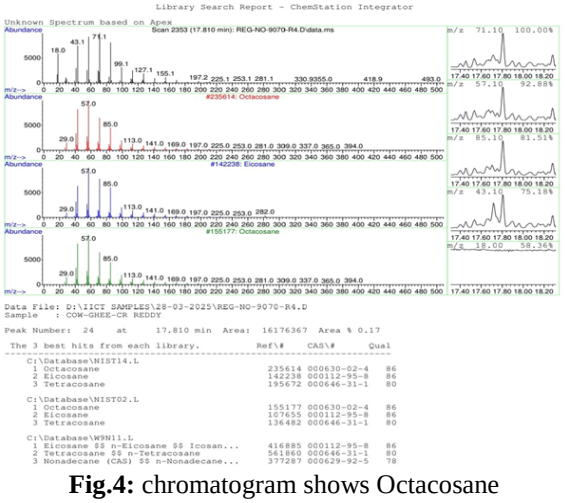

Fig.4: chromatogram shows Octacosane

4. Conclusion

This study underscores the potential health benefits of ghee, particularly its antidiabetic and anti-inflammatory properties, as supported by both traditional knowledge and modern analytical techniques. Ghee is a rich source of bioactive lipids, including conjugated linoleic acid, butyrate, and fat-soluble vitamins, which contribute to its beneficial effects on metabolic health. It has been shown to exert favorable effects on lipid metabolism, reduce inflammatory markers, and enhance insulin sensitivity, thereby supporting its role as a functional food in managing chronic metabolic diseases.

Gas Chromatography–Mass Spectrometry (GC–MS) analysis further validated these effects by identifying several key compounds in ghee with established pharmacological activities. Notably, compounds such as hentriacontane, octacosane, squalene, and 5-ethyl-1-linonene were detected, all of which have been previously associated with antidiabetic and anti-inflammatory activities. In addition to these bioactive molecules, ghee also contains natural flavoring agents, making it a versatile ingredient that not only enhances the palatability of foods but may also mask undesirable tastes in culinary preparations and therapeutic formulations.

In conclusion, the findings from this study suggest that ghee possesses significant therapeutic potential, owing to the presence of diverse bioactive compounds. Its ability to modulate inflammation, improve lipid profiles, and support glucose metabolism makes it a promising dietary component for the management of metabolic and inflammatory disorders. Further in vivo and clinical studies are warranted to explore its efficacy, dosage, and long-term safety in therapeutic applications.

5. References

[1] Ghosh M. Ghee – A clarified butter for good health. *Int J Pharm Sci Res*. 2015,6(5):1800–1810.

[2] Sharma PV. *Charaka Samhita: Agnivesa's Treatise Refined and Annotated by Charaka*. Vol 1. Chowkhamba Orientalia; 2000.

[3] American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2010, 33(1): S62–S69.

[4] Donath MY, Shoelson SE. Type 2 diabetes as an inflammatory disease. *Nat Rev Immunol*. 2011, 11(2): 98–107.

[5] Kumar A, Singh BK, Pandey AK. Role of ghee (clarified butter) in health and disease: A review. *J Ayurveda Integr Med*. 2021, 12(1): 186–193.

[6] Nanda S, Bhandari U, Kuhad A. Anti-obesity and lipid lowering effect of ghee: a natural product in rats. *Indian J Exp Biol*. 2010, 48(8): 803–810.

[7] Goudarzi M, Nazarizadeh A, Hassani Bafrani H, Amin M. GC–MS analysis of bioactive compounds in cow and buffalo ghee: Evaluation of antioxidant and cytotoxic properties. *Food Chem Toxicol*. 2021, 153: 112267.

[8] Saeed N, Khan MR, Shabbir M. Antioxidant activity, total phenolic and total flavonoid contents of whole plant extracts of *Torilis leptophylla* L. *BMC Complement Altern Med*. 2012; 12: 221.

[9] Benjamin S, Spener F. Conjugated linoleic acids as functional food: an insight into their health benefits. *Nutr Metab (Lond)*. 2009; 6: 36.

[10] Bhattacharya A, Banu J, Rahman M, Causey J, Fernandes G. Biological effects of conjugated linoleic acids in health and disease. *J Nutr Biochem*. 2006 , 17(12):789–810.

[11] Canani RB, Costanzo MD, Leone L, Pedata M, Meli R, Calignano A. Potential beneficial effects of butyrate in intestinal and extraintestinal diseases. *World J Gastroenterol*. 2011, 17(12): 1519–1528.

[12] Gao Z, Yin J, Zhang J, Ward RE, Martin RJ, Lefevre M, et al. Butyrate improves insulin sensitivity and increases energy expenditure in mice. *Diabetes*. 2009, 58(7):1509–17.

[13] Sood A, Madhu SV. Role of traditional Indian dietary fats in health and disease: the ghee controversy revisited. *Indian J Endocrinol Metab*. 2020, 24(1): 36–43.

[14] Maheshwari RK, Parmar HS. Therapeutic applications and pharmacological activities of cow ghee: a review. *Int J Pharm Sci Rev Res*. 2013, 20(2): 34–38.

[15] Shankar H, Latha S. Effect of ghee on lipid profile in normal and hyperlipidemic subjects. *J Nutr Health Food Eng*. 2017, 6(1): 00206.

[16] Saini A, Sharma R, Arora S, Sindhu SC. Cow ghee: Nutritional and therapeutic properties. *Int J Dairy Technol*. 2021, 74(1):1–10.