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A Comprehensive Review of Phytochemical Investigation and Therapeutic Approaches to Flaxseed Oils with Support from Traditional Medicine

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Abstract:

This paper presents a comprehensive exploration of the phytochemical composition of flaxseed oil, highlighting its abundance in bioactive compounds such as lignans, antioxidants, and omega-3 fatty acids. These constituents contribute to the oil's notable anti-inflammatory, antioxidant, and cardiovascular benefits. The review endeavors to narrow the divide between traditional medicine and contemporary scientific understanding by investigating the therapeutic potential of flaxseed oil. Through an examination of historical uses and traditional knowledge, the study seeks to establish a connection between ancient wisdom and current research. The paper evaluates the existing scientific evidence supporting the role of flaxseed oil in the treatment and prevention of various diseases. By delving into ongoing clinical trials and emerging research trends, the study offers insights into the evolving landscape of therapeutic applications for flaxseed oil. The synthesis of traditional medicinal practices with modern scientific findings underscores the versatility of flaxseed oil in promoting preventative and therapeutic healthcare strategies. This review aims to contribute to the growing body of knowledge surrounding flaxseed oil, advocating for its integration into mainstream healthcare practices based on its holistic potential.

Keywords: Flaxseed oils, Phytochemicals, Traditional Medicine, Bioactive compounds, Therapeutic Approaches.

Introduction:

Flaxseed, also known as linseed, is a plant in the Linaceae family and has been used for centuries for various purposes, including drying oil in painting and treating respiratory disorders [1]. It typically yields 35-45% oil, with 9-10% saturated fatty acids, 20% monounsaturated fatty acids and over 70% α-linoleic acid. Linseed oil is high in -linolenic acid (ALA), making it a good source of ALA in the human diet[2]. Linseed seed contains 33-47% oil, 5.5% Linolenic acid, 20.3% protein, 38% fat, 29% carbohydrate, 4.8% fibre, and

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2.4% ash in various kinds. Linseed is also a strong supplier of calcium and phosphate.. Flaxseed oil is rich in polyunsaturated omega-3 fatty acids, particularly linoleic and α-linolenic fatty acids [3]. These fatty acids are metabolized upon ingestion, leading to the production of arachidonic acid and eicosapentaenoic acid (EPA). EPA inhibits arachidonic acid metabolism and can also inhibit 5-lipoxygenase, resulting in mild inflammatory activity. α-linolenic acid is used as an anti-inflammatory agent, reducing the production of inflammatory cytokines, lipids, and lipoprotein [4]. Flaxseed oil also has antioxidant activity, including tocopherols, betacarotene, phytosterols, polyphenols, and flavonoids. The synergistic effect between tocopherols and omega fatty acids in flaxseed oil regarding antioxidant action remains to be determined [5]. Flaxseed oil, produced from Linum usitatissimum seeds, is both a matter of traditional devotion and scientific investigation due to its rich phytochemical profile [4].This comprehensive examination looks into its phytochemical investigation and therapeutic approaches in modern healthcare, using ideas from traditional medicine [3]. The oil's ligans, antioxidants, and omega-3 fatty acids are responsible for its medicinal potential. In order to close the gap between antiquated customs and contemporary scientific methods, the review also recognises the relationship between conventional medicine and the medicinal uses of flaxseed oil [6]. The study argues for the integration of ongoing clinical trials and existing scientific findings into standard healthcare practices by critically evaluating them [2].

Flaxseed oil extraction methods discovered just three forms of tocopherol isomers,,, and. Tocopherol levels were higher in hexane-extracted oil than in hot-pressed or cold-pressed oil [7]. Tocopherol levels in flaxseed oil were considerably altered by the roasting procedure. Cold-pressed oil contains 12.2, 43.4, and 508 mg/kg of, and -tocopherols, respectively [1]. Temperatures below 120°C provided the greatest extraction conditions for - and -tocopherols. Flaxseed oil phytosterols were discovered to be -sitosterol, cycloartenol, campesterol, 5-avenasterol, 2,4-methylenecycloartenol, and stigmasterol [2].Flaxseed oil helps to build cell membrane structural components and store lipids, and its hypocholesterolemic action is due to a combination of substances, including omega-3 fatty acids and lignans [8].

Flaxseed oil as traditional medicine with historical evidence:

Flaxseed oil has long been used in a variety of health and therapeutic activities. It was employed in ancient civilizations like as **Egypt, Greece and China**, as well as in **Indian Ayurvedic treatment** [9]. Flaxseed oil was used in Eastern European traditional medicine to

treat respiratory problems and skin disorders [10]. European settlers brought flax farming and oil to North America for therapeutic purposes throughout Colonial America [1&14]. Flaxseed oil acquired popularity as a laxative in the **19th and 20th century** due to its health benefits. Because of its omega-3 fatty acid concentration and bioactive components, flaxseed oil is now widely utilised as a nutritional supplement [19].

Materials and methods:

The extraction and analysis of bioactive components found in flaxseed oil is part of the phytochemical examination of the oil. For column chromatography, high-quality flaxseeds, solvents such as hexane or methanol, and chemicals such as analytical standards and silica gel are used. A Soxhlet extractor, rotary evaporator, chromatography columns, HPLC or GC systems, UV-Visible spectrophotometer, NMR spectrometer, and mass spectrometer are among the instruments used. Glassware, filter papers, membranes, and an analytical balance are examples of laboratory supplies. Grinding flaxseeds, extracting oil with hexane, separating polar components, column chromatography, qualitative analysis, quantitative analysis using HPLC or GC, spectroscopic analysis using NMR and mass spectrometry, data analysis, and presenting results are among the methods used. For reliable quantitative analysis, proper safety precautions, calibration of analytical instruments, and experiment replication are required [15].

Flaxseed oil Extraction method:

Essential oils are chemicals present in plant species that can be extracted into essential oils using various extraction processes. Hydrodistillation is a standard method for extracting essential oils that is environmentally benign, provides high quality, and runs at air pressure[11]. Soxhlet extraction (SE) is a preparative process for concentrating analytes from lattices or isolated compounds. Another technique for extracting essential oils from plant material is ultrasound-assisted extraction (UAE) [12]. In a trial, flaxseed oil yielded 42.0% using the UAE method. Microwave-assisted oil extraction is a basic technology that includes extracting oil from plant material using microwave energy [13]. The researchers utilised a 2.5 g sample of flaxseed powder with varying moisture concentrations and thermally treated it in a microwave oven. An infrared thermometer was used to monitor the temperature, and the oil was evaporated in a water bath before being recovered and weighed. The flaxseed oil production was 10%.

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Fig:1. Processes of extraction ***Source: springer.com***

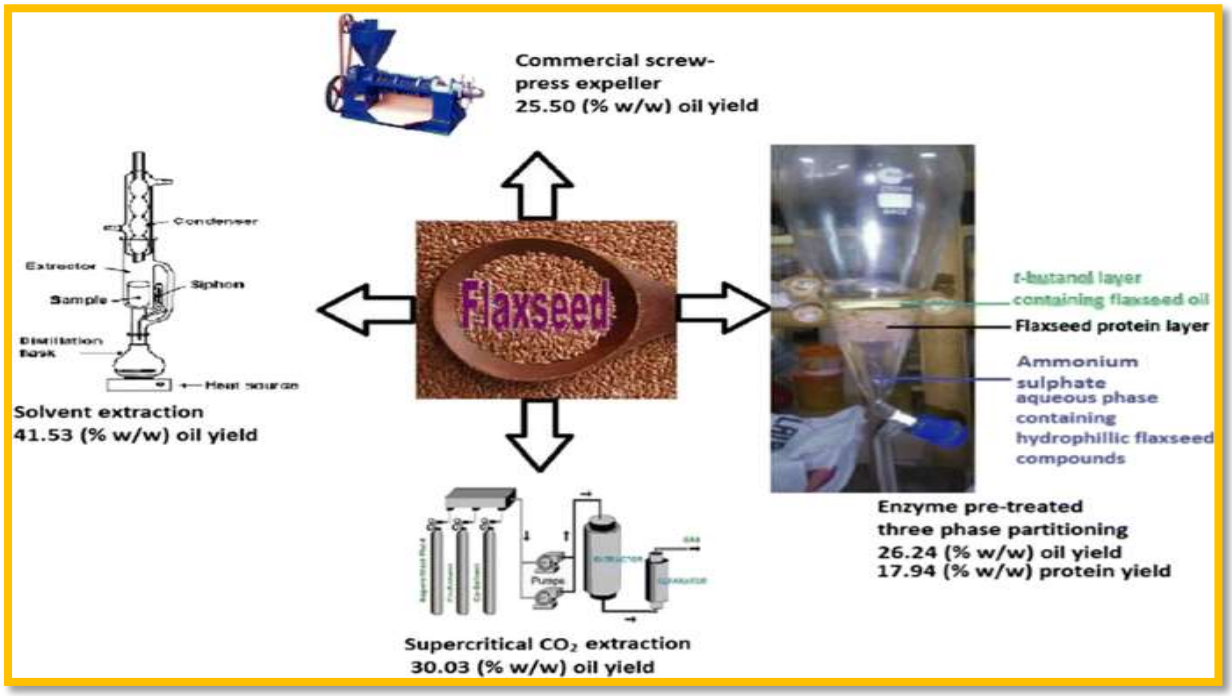

Table : Phytochemical investigations of flaxseed oils :

S .no	Phytochemicals	Test	Availability
1	**Alpha-Linolenic Acid (ALA):**	Gas Chromatography (GC) or High-Performance Liquid Chromatography (HPLC) for fatty acid profiling.	++
2	**Lignans (Secoisolariciresinol Diglucoside - SDG):**	High-Performance Liquid Chromatography (HPLC) or Gas Chromatography-Mass Spectrometry (GC-MS) for lignan quantification. Colorimetric assays can be used for total lignan content.	++
3	**Phytosterols (Beta-Sitosterol, Campesterol, Stigmasterol):**	Gas Chromatography (GC) or High-Performance Liquid Chromatography (HPLC) for phytosterol analysis.	++
4	**Carotenoids (Beta-Carotene)**	High-Performance Liquid Chromatography (HPLC) with UV or visible wavelength detection for carotenoid analysis.	++
5	**Polyphenols:**	Total Polyphenol Content can be determined using spectrophotometric assays such as the Folin-Ciocalteu method. Individual polyphenols may be analyzed using techniques like High-Performance Liquid Chromatography (HPLC) or Liquid Chromatography-Mass Spectrometry (LC-MS).	++
6	**Choline:**	High-Performance Liquid Chromatography (HPLC) or Enzymatic Assays for choline quantification.	++
7	**Phospholipids:**	Thin-Layer Chromatography (TLC) or High-Performance Liquid Chromatography (HPLC) for phospholipid separation and quantification.	++

These tests are standard methods used in laboratories to analyze the composition of flaxseed oil. It's important to note that the choice of test depends on the specific phytochemical being analyzed, and laboratories may employ a combination of techniques for a comprehensive

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characterization of the oil's chemical profile [19]. Additionally, the availability of equipment and expertise in a particular laboratory may influence the selection of analytical methods.

Medicinal properties of flaxseed oils:

Flaxseed oil is rich in alpha-linolenic acid (ALA), a type of omega-3 fatty acid, and other compounds that contribute to its potential health benefits. Here are some methods by which flaxseed oil's chemical composition can be utilized for health benefits:

1. **Omega-3 Fatty Acids for Heart Health:**

Cardiovascular Health: Flaxseed oil is a rich source of ALA, an essential omega-3 fatty acid. Consuming omega-3 fatty acids has been associated with a lower risk of cardiovascular disease. These fatty acids may help reduce inflammation, lower blood pressure, and improve cholesterol levels [20].

2. **Anti-Inflammatory Properties:**

Joint Health: The anti-inflammatory properties of omega-3 fatty acids in flaxseed oil may be beneficial for people with inflammatory joint conditions such as rheumatoid arthritis [21].

3. **Brain Health:**

Cognitive Function: Omega-3 fatty acids are crucial for brain health, and they may contribute to improved cognitive function. Including flaxseed oil in the diet may support brain development and function [22].

4. **Skin Health:**

Moisturization: The fatty acids in flaxseed oil can help maintain skin hydration, potentially reducing dryness and promoting overall skin health [14].

5. **Digestive Health:**

Constipation Relief: Flaxseed oil is a source of soluble and insoluble fiber, which can aid in digestion and promote regular bowel movements. It may help alleviate constipation [23].

6. **Hormonal Balance:**

Menstrual Health: Some studies suggest that flaxseed oil may help regulate hormonal fluctuations and reduce symptoms associated with menstruation, such as breast pain and discomfort [18].

7. **Cancer Prevention:**

Antioxidant Properties: The lignans present in flaxseed oil have antioxidant properties and may have a role in reducing the risk of certain cancers, particularly breast cancer and prostate cancer [17].

8. Weight Management:

Appetite Control: The combination of fiber and healthy fats in flaxseed oil may help promote a feeling of fullness, potentially aiding in weight management [16].

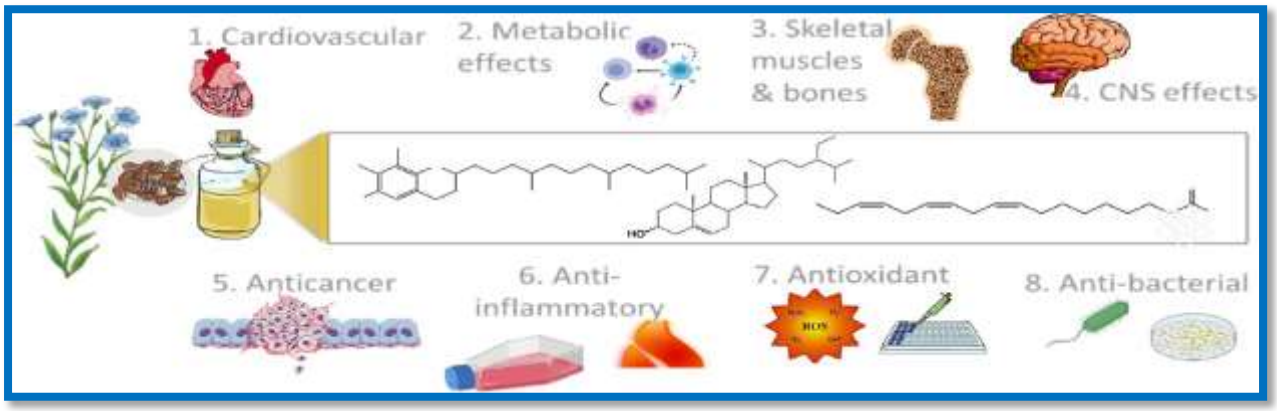
9. Diabetes Management:

Blood Sugar Control: Some studies suggest that flaxseed oil may have a positive impact on blood sugar levels, which could be beneficial for individuals with diabetes [24].

10. Eye Health:

Dry Eyes: The omega-3 fatty acids in flaxseed oil may contribute to maintaining eye health and may be beneficial for individuals experiencing dry eyes [25].

Fig2:The image depicting flaxseed oil's biological benefits and chemical composition



Source : Al -Madhagy et al. 2023

Meanwhile flaxseed oil offers potential health benefits, individual responses can vary. It's always advisable to consult with a healthcare professional before making significant changes to your diet or using supplements, especially if you have pre-existing health conditions or are taking medications [26].

Conclusion: The study concludes that the rich phytochemical composition of flaxseed oil, encompassing lignans, antioxidants, and omega-3 fatty acids, contributes to its notable anti-inflammatory, antioxidant, and cardiovascular advantages. The integration of traditional medicine with contemporary scientific findings highlights the holistic potential of flaxseed oil in promoting preventative and therapeutic healthcare strategies. The review advocates for the integration of flaxseed oil into mainstream healthcare practices based on the growing body of knowledge surrounding its therapeutic benefits.

Availability of data and materials

Available if needed.

Declarations

Ethics approval and consent to participate

Not applicable.

Competing interests

The authors declare that there is no competing interest.

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