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Qualitative and Quantitative Phytochemical Analysis of Flowering Thistle Extract

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ABSTRACT

The flowering thistle has a rich history in traditional medicine, particularly for managing diabetes and other ailments. This study investigates the qualitative and quantitative phytochemical profiles of flowering thistle extracts. Using ethanolic and aqueous extraction methods, phytochemical constituents, including alkaloids, phenolics, flavonoids, and sterols, were identified and quantified. Preliminary phytochemical screening revealed the presence of key bioactive compounds. Total phenolic content was determined to be 56.85 mg GAE/g and 113.12 mg GAE/g for ethanolic and aqueous extracts, respectively. Similarly, flavonoid content measured 6.86 mg QE/g and 8.33 mg QE/g. The findings support the therapeutic potential of flowering thistle and provide a foundation for further pharmacological studies.

Keywords: Flowering thistle, Phytochemical analysis, Phenolic content, Flavonoid content, Traditional medicine

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INTRODUCTION

Medicinal plants have been integral to traditional healing practices for thousands of years. They are known to provide effective treatments for various ailments, ranging from minor issues like digestive problems to more serious conditions such as diabetes, cancer, and heart disease. One of the significant areas of interest in contemporary herbal medicine is the phytochemical composition of these plants, which contributes to their therapeutic effects. Among the many medicinal plants used worldwide, *Cirsium arvense*, commonly known as flowering thistle, has garnered attention for its medicinal properties, particularly in the management of chronic diseases like diabetes and liver disorders. Medicinal plants have been widely utilized in traditional medicine for treating various ailments due to their rich phytochemical compositions [1]. Among these, the flowering thistle is known for its anti-diabetic and other therapeutic properties. The bioactive compounds in such plants, including alkaloids, flavonoids, tannins, and phenolics, are attributed to their medicinal potential [2-4].

The flowering thistle is a perennial plant native to Europe and parts of Asia, and it has spread to various parts of the world due to its hardiness and ability to adapt to diverse environments. This plant has been used extensively in folk medicine, particularly by traditional healers in regions where it grows abundantly. The plant is commonly employed for treating wounds, gastrointestinal disorders, infections, and most notably, diabetes. In traditional practices, both the aerial parts and roots of the flowering thistle are used, although the aerial portions are often favoured for their reported beneficial effects on metabolic disorders.

The plant's purported anti-diabetic properties are particularly significant in regions where access to modern medicine may be limited. Studies have suggested that flowering thistle extracts may help lower blood sugar levels by influencing insulin sensitivity, possibly due to the presence of bioactive compounds like flavonoids, alkaloids, and phenolic acids, which have been linked to antioxidant and anti-inflammatory effects [3, 4]. Additionally, flowering thistle has shown potential for addressing other ailments such as liver diseases, digestive problems, and even bacterial

infections, further cementing its role in traditional medicine.

Phytochemicals are naturally occurring bioactive compounds found in plants. These compounds have diverse biological activities, including anti-inflammatory, antioxidant, antimicrobial, and antidiabetic properties, which are important for therapeutic applications. Understanding the phytochemical profile of a plant is crucial to explaining its pharmacological effects, as the efficacy of medicinal plants often correlates with the concentration and types of phytochemicals they contain. In the case of flowering thistle, several classes of phytochemicals have been identified, including flavonoids, phenolic acids, alkaloids, saponins, and terpenoids. These compounds are thought to work synergistically, providing the plant's therapeutic benefits.

Flavonoids are one of the most studied groups of compounds due to their antioxidant properties. They are believed to help in neutralizing free radicals and reducing oxidative stress, which is a key factor in the development of chronic diseases like diabetes and cardiovascular disorders. Phenolic compounds, particularly phenolic acids, are also abundant in flowering thistle and have shown a strong ability to scavenge reactive oxygen species (ROS), further contributing to the plant's anti-inflammatory and antioxidant actions [5, 6]. These compounds are known to interact with key biological pathways that regulate cellular metabolism, blood sugar, and lipid profiles, making them especially important for managing metabolic diseases like diabetes.

Alkaloids, another significant class of compounds found in flowering thistle, are nitrogenous compounds that often exhibit antimicrobial and anti-inflammatory properties. Some alkaloids also have the potential to affect insulin secretion or insulin sensitivity, offering additional therapeutic benefits for diabetic patients [7]. Saponins and terpenoids, while less extensively studied in the context of flowering thistle, have been implicated in enhancing the absorption of other bioactive compounds and exhibiting anti-inflammatory effects, which may contribute to the plant's overall medicinal properties.

The primary objective of phytochemical analysis is to identify and quantify the various bioactive compounds present in plant extracts. The extraction methods used significantly influence the yield and composition of the extract, with solvent polarity being a key factor. Solvents like ethanol and water are commonly used for extracting compounds from plant materials due to their high efficiency and low toxicity. Ethanol, with its moderate polarity, is particularly effective at extracting a wide range of phytochemicals, including alkaloids, flavonoids, and phenolic compounds. Water, being a polar solvent, is used for extracting hydrophilic compounds like tannins, phenolics, and certain glycosides [8].

The initial phase of phytochemical analysis typically involves qualitative testing, where various reagents are used to detect the presence of specific groups of compounds such as alkaloids, flavonoids, tannins, and saponins. These tests often involve simple chemical reactions that produce a visible colour change, precipitate, or other identifiable characteristics. The next step involves quantitative analysis, where the concentration of key compounds is measured, providing valuable data on the potency and potential therapeutic value of the plant extract. Methods such as the Folin-Ciocalteu assay for phenolic content and the aluminium chloride colorimetric method for flavonoid quantification are commonly used for such purposes.

In the case of flowering thistle, understanding its phytochemical profile is crucial for validating its medicinal uses. The presence of high levels of phenolic and flavonoid compounds suggests that the plant has strong antioxidant potential, which may be responsible for many of its therapeutic effects. Quantifying these compounds also helps establish a benchmark for standardization, ensuring that future pharmaceutical applications of flowering thistle are both safe and effective.

Despite the extensive use of flowering thistle in traditional medicine, there is a lack of comprehensive scientific research into its phytochemical composition and pharmacological effects. This gap in knowledge limits the potential for the plant's clinical applications. The current study aims to fill this gap by performing a detailed qualitative and quantitative analysis of

flowering thistle extracts. By identifying the specific bioactive compounds and quantifying their concentrations, this study will provide a scientific basis for the traditional uses of flowering thistle, especially for managing metabolic disorders like diabetes.

Furthermore, the study's findings could serve as a foundation for future research into the pharmacological activities of flowering thistle, including its potential mechanisms of action in diabetes management. With the growing interest in natural products and the shift towards more sustainable and accessible healthcare solutions, flowering thistle holds significant promise as a therapeutic agent. This research not only supports the plant's traditional uses but also paves the way for further exploration into its pharmacological potential, which could lead to the development of new, plant-based treatments for common diseases.

Phytochemical profiling is crucial for understanding the therapeutic properties and guiding pharmacological applications [5]. Solvent polarity plays a pivotal role in extracting diverse phytoconstituents, with ethanol and water being commonly used for extraction [6,7]. This study focuses on the qualitative and quantitative analysis of flowering thistle extracts to elucidate its bioactive potential and contribute to its scientific validation.

MATERIALS AND METHODS

Plant Material

Flowering thistle plants were collected from roadside areas after proper identification. Aerial parts were cleaned, shade-dried for 15 days, and powdered using a mechanical grinder. The powdered material was stored in nylon bags at -4°C for further use.

Preparation of Extracts

One kilogram of powdered plant material was defatted using petroleum ether and extracted with ethanol (95%) and water in a Soxhlet apparatus. The extracts were evaporated to dryness, yielding approximately 20 g for each solvent. Extracts were stored at 4°C for further phytochemical analysis [8].

Preliminary Phytochemical Screening

Qualitative analysis was conducted to identify alkaloids, flavonoids, phenolics, saponins, tannins, glycosides, and sterols using standard protocols [9-11].

Quantitative Phytochemical Analysis

Total Phenolic Content

Phenolic content was estimated using the Folin-Ciocalteu method [12]. Absorbance was measured at 760 nm, with results expressed as mg gallic acid equivalents (GAE)/g dry weight.

Total phenolics in ethanolic and aqueous extracts of both plant extracts were determined with Folin-Ciocalteu¨ s reagent. One ml of each extract (1mg/ml in distilled water) was taken in the separate volumetric flask and one ml of Folin- Ciocalteu reagent was added in both flasks. After three minutes, three ml of 2% Na_2CO_3 was added. Subsequently, the mixture was shaken for two hours at room temperature and absorbance was read at 760nm and the experiment was performed in triplicate (singleton et al, 1999).

Total Flavonoid Content

Flavonoid content was determined using the aluminium chloride method [13]. Absorbance was measured at 510 nm, with results expressed as mg quercetin equivalents (QE)/g dry weight.

Extracts solution (0.25ml, 1mg/ml) of each plant extract was added to

1.25 ml of distilled water. Sodium nitrite solution (0.075ml, 5%) was then added to the mixture followed by incubation for 5 minutes, after which 0.15ml of 10% aluminium chloride was added. The mixture was allowed to stand for 6min at room temperature before 0.5ml of 1 M sodium hydroxide was finally added and the mixture diluted with 0.275 ml distilled water. The absorbance of the reaction mixture was measured at 510 nm with a UV/VIS spectrophotometer immediately. Quercetin was used as the standard for the calibration curve. Flavonoid contents were expressed as mg quercetin equivalent (QE)/g dry weight.

RESULTS AND DISCUSSION

Preliminary Phytochemical Screening

Phytochemical tests revealed the presence of various bioactive compounds in both ethanolic and aqueous extracts (Table 1). Alkaloids, phenolics, flavonoids, and sterols were prominently present, while carbohydrates and amino acids were absent.

Table 1: Phytochemical Screening of Flowering Thistle Extracts*

		extract	extracts	fraction	fraction
Alkaloids	Mayer's	+	+	+	+
	Dragendorff"s	+	+	+	+
	Wagner's	-	-	-	-
	Hager's	+	+	+	+
saponin	Foam	-	+	-	-
	Hemolytic	-	-	-	-
Phenolic compounds and Tannins	Ferric Chloride Gelatin	+-	+-	+-	+
	Lead acetate test	+	+	+	+
Proteins	Million's	+	-	+	-
	Biuret	+	+	+	-
	Xanthoprotein	-	-	-	-
Flavonoids	Ferric Chloride	+	+	-	+
	Shinoda	-	-	-	-
	Lead Acetate	+	+	+	+
Glycoside	Baljet"s	-	-	-	-
	Legal's	-	-	-	-
	Borntrager"s	-	-	-	-
	Killer killani	-	-	-	-
Fixed oil	Spot	-	-	-	-
Carbohydrate	Molisch"s	-	-	-	-
	Fehling's	+	+	+	+
	Benedict"s	-	-	-	-
	Barfoed"s	+	+	+	+
	Cobalt-chloride	-	-	-	
Gums and mucilage	Swelling Index	-	-	-	-
Amino Acids	Ninhydrin	-	-	-	-
	Tyrosin	-	-	-	-
	Tryptophan	-	-	-	-
Sterols and triterpenes	Liebermann-Burchard's	+	+	+	-
	Salkowski's	+	-	+	-

*Ethanol, Aqueous, Chloroform, Aqueous

Total Phenolic and Flavonoid Content

Phenolic content in aqueous extract (113.12 mg GAE/g) was significantly higher than in ethanolic extract (56.85 mg GAE/g) (Figure 1). Similarly, flavonoid content was 8.33 mg QE/g for aqueous extract and 6.86 mg QE/g for ethanolic extract, indicating higher bioactive compound extraction in water.

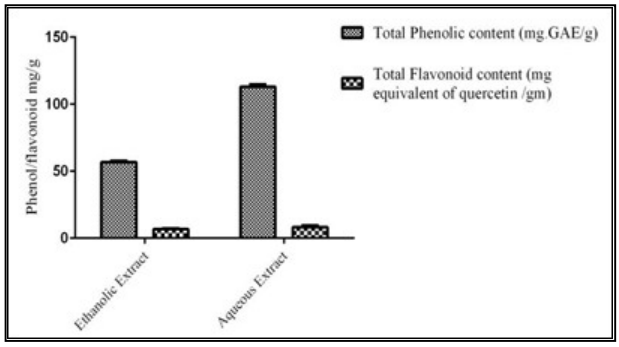

Figure 1: Total Phenolic and Flavonoid Content of Flowering Thistle Extracts

These results align with studies emphasizing the role of solvent polarity in efficient extraction [14-16]. Phenolics and flavonoids are known for their antioxidant and anti-diabetic properties, corroborating the traditional usage of flowering thistle [17,18].

CONCLUSION

The phytochemical analysis of Cirsium arvense (flowering thistle) provides compelling evidence supporting the traditional use of this plant in various therapeutic applications, particularly in the management of chronic conditions like diabetes. The detailed qualitative and quantitative analysis conducted in this study has identified a rich diversity of bioactive compounds in the plant, including flavonoids, phenolic acids, alkaloids, saponins, and terpenoids, which likely contribute to its therapeutic potential.

The preliminary phytochemical screening revealed the presence of important compounds such as flavonoids and phenolic acids, which are known for their antioxidant, anti-inflammatory, and antidiabetic properties. These compounds play a critical role in reducing oxidative stress and inflammation, two key

contributors to the development of metabolic disorders like diabetes and cardiovascular diseases. In particular, the higher phenolic content found in the aqueous extract and the significant flavonoid levels in both the aqueous and ethanolic extracts suggest that Cirsium arvense may act as a potent antioxidant, capable of mitigating the effects of oxidative damage in the body. This finding is especially important considering the growing evidence linking oxidative stress to the pathophysiology of diabetes, where it accelerates complications such as neuropathy, retinopathy, and cardiovascular disease.

The quantitative data from the study, which measured total phenolic content (expressed as gallic acid equivalents) and total flavonoid content (expressed as quercetin equivalents), further supports the plant's antioxidant activity. The observed high phenolic content in the water-based extract (113.12 mg GAE/g) and the higher flavonoid content in both ethanolic and aqueous extracts (ranging from 6.86 mg to 8.33 mg QE/g) positions Cirsium arvense as a promising natural source of therapeutic agents with significant antioxidant and anti-inflammatory activity. This aligns with existing research suggesting that phenolic compounds and flavonoids from plants are crucial in managing oxidative stress, improving insulin sensitivity, and controlling blood glucose levels, making them highly valuable in treating diabetes.

Additionally, the detection of alkaloids and saponins in the plant extracts is noteworthy. Alkaloids, known for their broad pharmacological activities, might contribute to the plant's potential anti-diabetic effects by improving insulin secretion and action. Saponins, with their ability to enhance bioavailability and absorption of other active compounds, could amplify the therapeutic effects of the plant, possibly leading to synergistic interactions with other medicinal components in the plant. These findings reinforce the idea that Cirsium arvense contains a variety of phytochemicals that work together to produce a holistic therapeutic effect, rather than relying on a single compound.

The study also emphasizes the importance of solvent polarity in extraction methods, as both ethanol and water were effective solvents for extracting the bioactive components from Cirsium arvense. The choice of solvent directly impacts the yield and concentration of phytochemicals, influencing the effectiveness of the extracts in pharmacological applications. Ethanol, being more efficient for extracting both hydrophilic and lipophilic compounds, and water, which is effective in extracting water-soluble compounds, both contributed to the successful isolation of the plant's key bioactive ingredients. This highlights the need for careful selection of extraction methods when preparing plant extracts for therapeutic use, especially in the context of natural product-based drug development.

While the current findings provide valuable insights into the phytochemical profile of Cirsium arvense, there are still several areas for further research. Future studies should focus on isolating and characterizing individual compounds responsible for the observed biological activities, as well as conducting in vitro and in vivo experiments to confirm the pharmacological effects, particularly the anti-diabetic properties of the plant. Clinical trials are also needed to evaluate the safety, efficacy, and potential side effects of Cirsium arvense extracts in human populations, which will be essential for its eventual inclusion in therapeutic practices.

Moreover, the integration of Cirsium arvense into modern pharmaceutical formulations may require the standardization of its active compounds. Such efforts could lead to the development of herbal medicines or dietary supplements that could complement conventional treatments for diabetes, offering a more holistic and natural approach to managing the disease. This would be especially beneficial for populations in rural or resource-limited settings where access to expensive pharmaceutical drugs is often restricted.

In conclusion, Cirsium arvense (flowering thistle) demonstrates a promising potential as a medicinal plant, particularly for its anti-diabetic, antioxidant, and anti-inflammatory properties. The detailed phytochemical analysis conducted in this study has provided a solid foundation for further investigation into the therapeutic applications of this plant. With continued research and clinical validation, Cirsium arvense may emerge as a valuable natural product in

the treatment and management of diabetes and other metabolic disorders. Given the increasing shift towards plant-based therapies and the growing interest in sustainable medicine, Cirsium arvense offers a unique opportunity for the development of new, safe, and effective therapeutic agents from nature.

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