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RESEARCH ARTICLE
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DETERMINATION OF CHEMICAL COMPOSITION AND THERAPEUTIC POTENTIAL OF CHICORY (CHICHORIUM INTYBUS) LEAVES POWDER IN MANAGEMENT OF HYPERLIPIDEMIA IN HUMAN SUBJECTS: A RANDOMIZED CONTROL TRIAL

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Abstract:
Introduction: Hyperlipidemia is characterized as elevated lipid profile parameters. These parameters include cholesterol, triglycerides, low- and high-density lipoprotein this research was done to find out how chicory (*Chichorium intybus*) leaves powder affected hyperlipidemia.
Objectives: This study's goal was to analyses the chicory leaves powder's chemical make-up along with phytochemical contents.
Material and methods: Three groups were taken for the study with the name of control and treatment groups. Each group contain the equal no of hyperlipidemic patients on the basis of their inclusion and exclusion criteria. Treatment groups I and II received encapsulated doses of 20 mg and 40 mg of chicory leaves powder while control group were not taking anything. Biochemical profiles with special reference to lipid profile values of studied subjects were assessed and compared at 0 and 8 weeks. In IBM SPSS Statistics 20, ANOVA was used to assess each result.
Results: Proximate tests revealed that chicory leaves powder had 6.50.08 protein, 30.191.02 fiber, 5.010.23 ash, and 8.090.31 moisture, whereas nitrogen free extract comprised 44.311.17. Calcium and manganese were found to be the most abundant minerals in chicory leaf powder, according to mineral analysis. Chicory leaf powder contained 11.9 and 9.01 mg/g of total phenolic and total flavonoids compounds (TCF & TFC), respectively.

Conclusion: Phytochemicals and proximate analysis of chicory leaves confirmed that its use can cause a significant reduction in lipid profile indices triglycerides, cholesterol, and low-density lipoproteins with an increase in high density lipoproteins. At p0.05, all results were considered significant.

Keywords: *Chichorium intybus,* Chicory, hypolipidemic effect, hypercholesterolemia, mineral analysis, lipid profile, phytochemical analysis

INTRODUCTION

The ancient Egyptians used chorium intybus L. to heal liver problems and improve cardiovascular issues. During the Napoleonic era, chicory was a popular coffee substitute, and England used it as the main ingredient in Camp Coffee. The therapeutic advantages of Cichorium intybus L. in the treatment of diabetes, hypercholesterolemia, and liver illnesses, all of which are common conditions worldwide. (Alberta et al., 2006). The risk factors for diabetes and cardiovascular disease are interconnected and make up the complicated condition known as metabolic syndrome. Obesity, dysglycemia, high blood pressure, high triglyceride (TG) levels, and low HDL-cholesterol (Cho) levels are among the risk factors (Nelson, 2013).

In addition, several examples of valuable products made from chicory were provided (Arif et al., 2019). Numerous in vitro and in vivo studies on chicory root extracts have revealed that these compounds may be hepatoprotective, increase satiety, reverse insulin resistance, and improve lipid metabolism. These compounds also contain chlorogenic acid, cichoric acid, and polysaccharides. Among other therapeutic effects, chicory root extracts have shown gastroprotective, anti-inflammatory, analgesic, and anti-diabetic properties (Abd El-Mageed, 2011).

Cichorium intybus L. can be used in a variety of ways to make practical items that are good for one's health. (Wang and Cui, 2011). Additionally, chicory-root extracts are already present in functional foods, and the ease of consumption and rising demand for such goods encourage the creation of new therapeutic options aimed at assisting with the management of liver conditions, diabetes, and hypercholesterolemia as well (Jurgoński et al., 2012).

Novelty of Research

This study has investigated the anti-hypercholesterolemia potential of chicory leaves on human subjects with chicory leaves powder in the replacement of conventional medicines that can cause major complications of different metabolic diseases.

MATERIAL AND METHODS

Raw material collection and preparation of Chicory Leaves powder

We purchased dried chicory leaves from a nursery. They had two washings and cleanings with tap water first, and then distilled water. They were processed separately once they become dried and were grounded into a powder. Following that, powder was placed in gelatin capsules in equal amounts of 20 mg and 40 mg. For dose encapsulation, gelatin capsules were employed, whereas the gelatin capsules were supplied from Halal capsule Pvt. Ltd. which were proven to be safe for human consumption (Gullapalli and Mazzitelli, 2017).

Chemical Composition of Chicory Leaves Powder

Proximate Profile of Chicory Leaves Powder

Using the AOAC method, the following proximate profile of powdered chicory leaves were examined (Garcia-Amezquita et al., 2018).

Multi Minerals Determination
The following minerals utilizing atomic absorption spectroscopy, zinc, magnesium, iron, phosphorus, potassium, and sodium were examined (Hernández et al., 2005).

Phytochemical Features of Chicory Powder
Total flavonoid concentration (TFC) and total phenolic content (TPC) were determined by phytochemical analysis of powdered chicory leaves. Milligrams of quercetin equivalent and gallic acid equivalent were used to assess TPC and TFC, respectively (M'hiri et al., 2015).

Selection of Hyperlipidemic Subjects
Sixty patients with hypercholesterolemia, aged between thirty and sixty, were chosen at random from the general community.

Exclusion Criteria
The study excluded those with other chronic problems in addition to hypercholesterolemia as well as those taking antihyperlipidemic medications and cholesterol-lowering therapies.

Inclusion Criteria
All male hypercholesterolemia individuals between the ages of 30 and 60 who had undergone unpressurized and informed blood biochemical examination to determine their baseline lipid profile were included in the study.

Study Duration
The study was conducted for 8 weeks (2 months).

Treatment Groups and Treatment Plan
The following conditions were applied to three groups of ten male volunteers each. There was no treatment administered to the control group. Both treatment groups I and II received dosages of powdered chicory leaves in an encapsulated form.

Table I. Treatment Groups and Treatment Plan

Treatment Groups	Title	Treatment
G_0	Control (10 patients)	No treatment
G_1	Treatment group 1 (10 patients)	Capsule with chicory leaves powder of 20 mg per day
G_2	Treatment group 2 (10 patients)	Capsule with chicory leaves powder of 40 mg per day

Biochemical Analysis
Lipid profile of all patients was checked before and after the completion of trail and results were compared with control group to check the bio evaluation of chicory leaves powder against hyperlipidemia (Glick, 2009)

Statistical analysis
The study employed a Completely Randomized Design (CRD) and descriptive statistical analysis with the Analysis of Variance Technique (ANOVA) to examine the significance level ($p<0.05$) (Larson, 2008). IBM SPSS Statistics 20 is used for all statistical analysis.

RESULTS
The goal of the study was to determine whether chicory leaves powder's medicinal potential may be used to treat hypercholesterolemia and decrease lipid profiles.

Chemical Characterization of chicory leaves powder

Proximate Composition of Chicory Leaves Powder

Several characteristics of chicory leave powder were examined, including moisture, ash, crude fiber, and crude proteins, fat, and nitrogen-free extract (NFE), which is shown in Table II. The value of the raw materials used was crucially determined by the results of proximate composition. A proximate analysis revealed that chicory leaves powder includes 8.090.31% moisture, 6.50.08% protein, 30.191.02% fibre, 5.010.23% ash, and 44.311.17% nitrogen free extract.

Table II. Mean ± S.D for Proximate % Composition of Chicory Leaves Powder on Dry Weight Basis

Proximate analysis	Composition (%)
Moisture.	8.09±0.34
Ash.	5.01±0.23
Nitrogen Free Extract.	44.31±1.17
Crude protein.	6.5±0.07
Crude Fat.	6.23±0.67
Crude fiber.	30.19±1.02

Mineral Analysis

In the current investigation, the mineral content of chicory leave powder, including Fe, Mg, Ca, and Zn, was also determined. Figure 1 shows that calcium and manganese are the main minerals in chicory leaves powder.

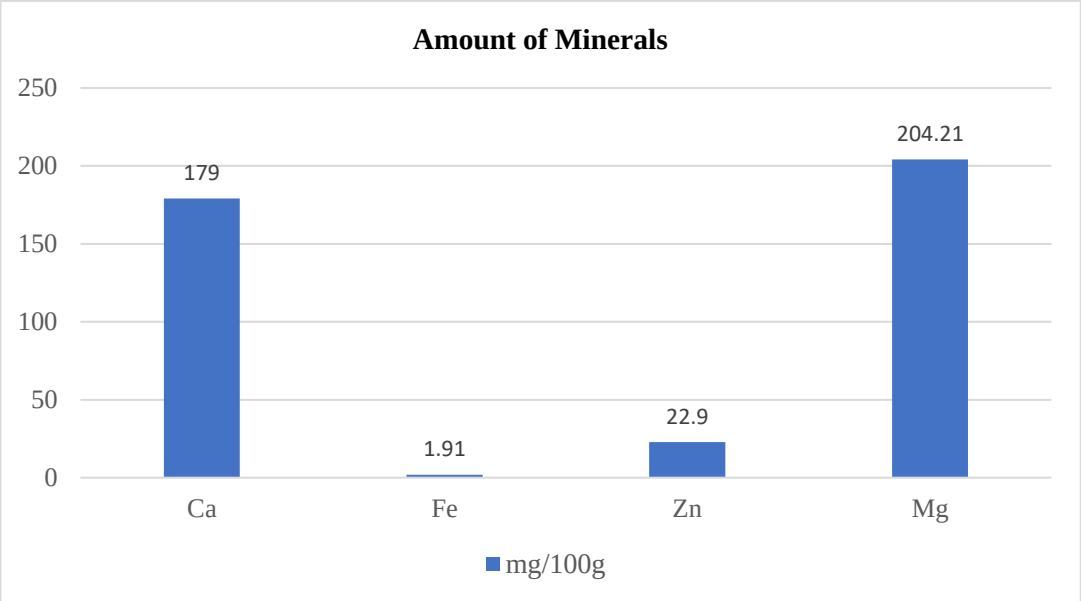

Figure I. Mineral Composition of Chicory Leaves Powder on Dry Weight Basis

Phytochemical Characters of Chicory Leaves Powder

The antioxidant activity of the phenolic compounds of chicory leaves powder was studied. And it has been demonstrated from the study that the potential of chicory to decrease lipid profiles and have an antiatherogenic effect and significant number of phenolic compounds. For TPC and TFC analysis, chicory leaves powder was analyzed in methanolic extract and it has been shown that it carries a significant amount of TPC and TFC depicted in Figure II.

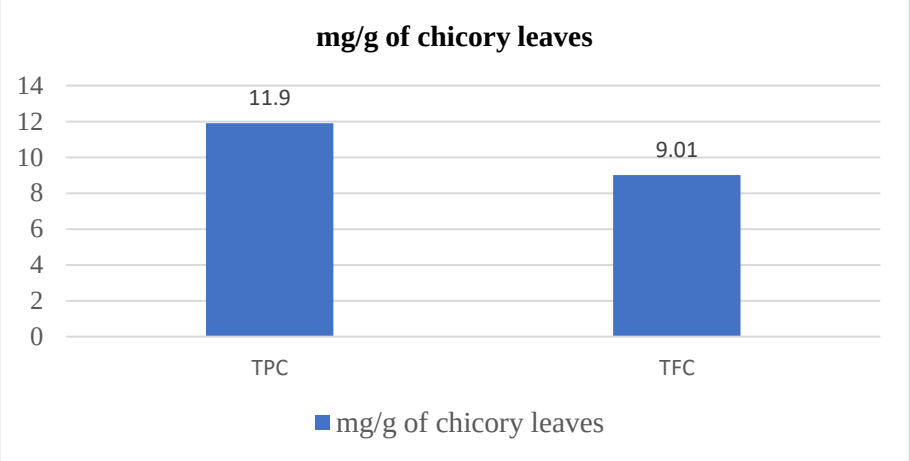

Fig II: amount of TPC and TFC in per gram of chicory leaves

Investigation of Hypolipidemic effects Potential of Chicory Leaves Powder

This study looked at the therapeutic and nutraceutical potential of powdered chicory leaves in lowering elevated lipid profiles in thirty male subjects who were hypercholesterolemic. While those in treatment groups I (G1) and II (G2) got capsulated chicory leaf powder at dosages of 20 mg/d and 40 mg/d, respectively, for eight weeks, those in the control group (G0) did not receive any medication. Blood samples were taken from each participant both before and after the experiment ended to analyze their lipid profiles (HDL, LDL, triglycerides, and total cholesterol).

Serum Cholesterol Level Variations

Table III shows the serum cholesterol levels at the beginning and end of the 10th week. The chicory powder capsules significantly (p0.05) reduced the blood cholesterol levels in both treatment groups. Total cholesterol decreased in treatment group I from 267.1512.78 mg/dl to 251.126.49* mg/dl, whereas serum cholesterol decreased in treatment group II from 271.3218.52 mg/dl to 262.3416.36* mg/dl. Compared to treatment group II, treatment group I was more successful in lowering cholesterol. Conversely, there was no change in cholesterol levels in the control group.

Table III. Mean ± S.D for Serum Cholesterol Level of Male Subjects

Duration	**G_O**	**G_1**	**G_2**
0 week	251.03±11.25	227.15±11.47	229.32±17.88
8th week	251.21±12.27	210.12±6.27*	189.34±14.63*

Results are taken significant at p<0.05. G_0 = No chicory leaves powder, G_1=20mg/day chicory leaves powder, G_2= 40mg per day of chicory leaves powder.

Reduction in Serum Triglycerides Level of Male Subjects

Table IV shows the serum triglyceride levels of all groups at 0 and 8 weeks. Triglyceride levels in both experimental groups decreased significantly, from 229.3116.23 mg/dl to 211.3011.09* mg/dl in G1 and from 227.38 10.88 mg/dl to 201.5610.67* mg/dl in G2. Triglyceride levels were lower in treatment group I than in treatment group II. In this 10-week trial, triglyceride levels in the control group remained unchanged. All results are considered significant at p 0.05.

Table IV. Mean ± S.D for Triglycerides Level in Male Subjects

Duration	**G_O**	**G_1**	**G_2**
0 week	203.89±10.61	229.31±16.23	227.38 ±10.88
10th week	203.70±19.87	211.30±11.09*	201.56±10.67*

Results are taken significant at p<0.05. G_0 = No chicory leaves powder, G_1=20mg/day chicory leaves powder, G_2= 40mg per day of chicory leaves powder

Positive Changes in the Serum HDL Levels

Results for serum HDL for all groups are displayed in table V. The experimental groups G1 and G2 had higher HDL levels than the G0 group. In G1, HDL decreased from 36.879.02 to 48.016.97* mg/dl, while in G2, HDL increased from 34.588.90 to 50.537.32* mg/dl. Treatment group II has shown a greater increase in HDL than Treatment group I. As opposed to G1 and G2, G0 exhibits no discernible difference in the level of serum HDL.

Table V. Mean ± S.D for HDL Level in Male Subjects

Duration	G_O	G_1	G_2
0 week	35.70±3.21	36.87±9.02	34.58±8.90
8th week	35.60±6.89	48.01±6.97*	50.53±7.32*

Results are taken significant at $p<0.05$. G_0 = No chicory leaves powder, G_1=20mg/day chicory leaves powder, G_2= 40mg per day of chicory leaves powder

Reduction in the Serum LDL Levels

Table VI displays the effect of chicory leaf powder on serum LDL levels. After ingesting chicory leaves powder for 60 days, the experimental group showed a considerable reduction. In both G1 and G2, the serum LDL level decreased from 173.60 mg/dl to 163.28 mg/dl and from 169.21 mg/dl to 151.23 mg/dl, respectively. Compared to G1, G2, the serum LDL level exhibited a greater drop. In contrast to the groups receiving chicory leaf powder, G0 exhibits no discernible changes in LDL levels.

Table VI. Mean ± S.D for LDL Level in Male Subjects

Duration	G_O	G_1	G_2
0 week	161.60±10.31	173.60±11.98	169.21±10.09
8th week	161.60±11.17	163.28±11.76*	151.23±10.67*

Results are taken significant at $p<0.05$. G_0 = No chicory p leaves powder, G_1=20mg/day chicory leaves powder, G_2= 40mg per day of chicory leaves powder.

DISCUSSION

The purpose of this study was to examine the therapeutic potential of chicory leaf powder against hyperlipidemia individuals in humans. During the 2-month treatment, two separate dosages of powdered chicory leaves were administered. At 0 and 10 weeks, lipid profile values were evaluated. The serum lipid profile parameters for cholesterol, triglycerides, and low-density lipoproteins decreased in the therapy groups, but high-density lipoprotein levels increased. In all criteria, treatment group II was shown to be more significant than group I. According to a controlled randomized trial that examined the effectiveness of chicory plant to improve liver function, chicory plant can considerably improve liver function by enhancing the body's lipid profile and enzymes that support liver function. study's findings (Hameed, A. et. al., 2022).. Dietary components in chicory called inulin and oligofructose enhance metabolism. They also contain chemicals that mimic polyphenols, which may be the source of chicory's antioxidant benefits. The hydroalcoholic extract of dried powdered chicory leaves has been investigated in vivo in mice to see how it impacts various levels of CCl4-induced hepatotoxicity. When the mice were four weeks old, they were randomly separated into five groups (seven in each). Over the course of three days, the mice were given three different oral doses of chicory leaves extract (CLE) before receiving CCl4 injections. Jani, Dejan, and colleagues (2017) According to the findings, CCl4 enhanced serum GOT, GPT, and ALP activity in mice but not total protein or albumin levels. Mice treated with 75, 150, and 300 mg/kg/bwt CLE exhibited livers that were resistant to CCl4 cytotoxicity. CLE considerably (p0.05) reduced high levels of cholesterol and triglycerides in the drug-treated group of mice (150 mg/kg); 145 1.3, 243 1.3, and 34 1.2 mg/dl, respectively, compared to the negative control group (185 1.4,

290 1.4, and 21 1.3 mg/dl, respectively). The greatest risk factor for cardiovascular disease is hypercholesterolemia (CVD). Because it affects physiological and biochemical processes in rats and humans, inulin is regarded as a functional food component that reduces the risk of numerous diseases and promotes improved health. Chicory is a major source of inulin used in the food industry. In comparison to the positive control group and other treated groups, treatments containing 1g of inulin considerably (p 0.05) improved the lipid profile. Insulin therapy decreased LDL, VLDL-cholesterol, faecal lipid profile, bile acid, serum, and liver lipid profiles (TC, TG, and TL), while boosting HDL in hypercholesterolemic rats' serum. A.C. Saddam, 2021). A.A. Khedr et al., 2021). CLE may be a good natural source of antioxidants, a natural hepatoprotectant, and beneficial to hypercholesterolemic patients.

CONCLUSION

Numerous researches have looked into the powders or extracts of chicory stems, roots, and leaves for a variety of health advantages. In various research, chicory had demonstrated its hypolipidemic, anti-carcinogenic, antioxidant, and anti-diabetic potential. When the lipid profile characteristics were looked at in this investigation, it also demonstrated its therapeutic impact against hypercholesteremia. Secondary metabolites that were abundant in chicory leaf powder were also helpful in decreasing the lipid profile. It has been shown to be beneficial to reduce the lipid profile parameters, including triglycerides, cholesterol, and LDL levels, at dosages of 20 mg/d and 40 mg/d. These dosages were discovered to be helpful in raising the body's levels of high-density lipoprotein, also known as "good fat."

Safety profile

Chicory powder was found safe for oral consumption in safe limits. However, people with FODMAP insensitivity can experience bloating, flatulence, and abdominal discomfort. It can also trigger allergic reactions (Micka et al., 2017).

Conflict of Interest

The authors declared that there is no conflict of interest in this paper.

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