



ORIGINAL ARTICLE

Therapeutic Effect of Curry Leaves (*Murraya koenigii*) on Type 2 Diabetes: Biochemical and Clinical Investigations

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A B S T R A C T

Nowadays, diabetes has been increased due to changes in lifestyle that endorse sedentary behavior, lack of exercise, and aging. Herbal medication has attracted significance in recent years as a holistic practice. Curry leaves (*Murraya koenigii*) contain numerous properties such as anti-oxidant, anti-microbial, anti-diabetic, anti-fungal, anti-inflammatory, and anti-carcinogenic. The aim of current study was to investigate the chemical composition and therapeutic efficacy of *Murraya koenigii* powder on individuals with type 2 diabetes. Results showed that the powder contained minerals (calcium, iron, and magnesium), phytochemical (phenolic and flavonoid contents). Three groups are formed from thirty female diabetes patients according to exclusion and inclusion criteria. G0 served as a control group receiving no dosage whereas G1 and G2 were treatment groups that received oral dosages of 1000mg/day and 2000mg/day of *Murraya koenigii* powder daily for 60 days. At 60th day, the blood glucose sugar was significantly decreased ($p < 0.05$). Additionally, reductions in blood pressure and BMI were noted. These findings support the therapeutic potential of *Murraya koenigii* as a dietary supplement for diabetes management.

Keywords: Curry Leaves, Diabetes Mellitus, Random Blood Sugar, HbA1c, Blood Pressure.

1. INTRODUCTION

Diabetes is a prevalent chronic metabolic disorder that disrupts normal glucose regulation, leading to extended periods of elevated or reduced blood sugar levels, which in turn affects various bodily functions. Chronic conditions like stroke, retinopathy, foot ulcers, heart problems, and eventually organ failure can occur in diabetics who do not receive the proper therapy at the appropriate time. It is a major contributor to early mortality and disability. Type 1 diabetes, often referred as juvenile diabetes, is an autoimmune disease that impacts just one organ and manifests in the early years of life. In people with diabetes, beta cells are destroyed by lymphocytic inflammation in the pancreatic islets, which results in insulin deficiency. The prevalence of type 1 diabetes has more than doubled in the last 20 years. Diabetes mellitus, commonly referred to as type 2 diabetes, is brought on by the body's ineffective response to insulin (Gaikwad, 2018). Type 2 diabetes is much more common than the other type, making up more than 90% of all cases of diabetes worldwide.

According to the International Diabetes Federation, the number of persons with diabetes has increased dramatically over the last few decades, and as of 2021, over 537 million people worldwide were affected. The main causes of this escalating public health emergency are lifestyle choices like eating poorly and not exercising. Diabetes can cause serious side effects such kidney damage, neuropathy, and cardiovascular disorders if it is not treated. Although insulin therapy and oral medicines are common conventional therapies, long-term dependence on these medications frequently has negative side effects.

Furthermore, it may be challenging to sustain lifestyle modifications, necessitating the use of alternative or complementary therapies.

Herbs have drawn attention as a supplemental strategy to help blood sugar control and enhance insulin sensitivity in the quest for more sustainable and all-encompassing diabetes management strategies. Many herbs provide a natural, less intrusive, and less harmful way to manage the illness than synthetic medications. Natural products of traditional medicine have been used for hundreds of years in every culture on the planet (Singh *et al.*, 2014). Everyone can get medicinal herbs easily because they are not so expensive and have minimal side effects (Arya *et al.*, 2011). The herbs, containing vital nutrients, are utilized by healthy individuals as well as by ill persons. Curry leaves (*Murraya koenigii*) have been used for centuries in this manner. It is a very common spice and is used for its sweet smell because of its special volatile oil and digestive properties. It is highly rich in fiber, minerals, protein, carbs, carotene, and nicotinic acid, amongst other nutrients. Similarly, it is high in oxalic acid and essential phytochemicals like crystalline glycosides, phebalosin, koenigii, carbazole alkaloids, mahanimbicine, and iso-mahanimbicin (Handral *et al.*, 2012).

Curry leaves have numerous medicinal applications including liver protection, anti-fungal, antioxidant, anti-diabetic, anti-inflammatory, anti-carcinogenic and anti-microbial properties. It has several medicinal properties that exert a soothing effect on individuals' health (Bhandari, 2012; Izionworu, 2014). The objective of this study is to explore the potential effect of curry leaves on type 2 diabetic patients in view of these findings.

2. MATERIALS AND METHODS

2.1. Area of Research

The study was carried out in the post-graduate laboratory of the University of Faisalabad's Department of Dietetics and Nutritional Sciences.

2.2. Collection of Raw Material

We purchased curry leaves from the marketplace of Faisalabad. In this investigation, analytical-grade chemicals and reagents were used (Sigma Aldrich, Germany).

2.3. Preparation of Raw Material

The fresh leaves were weed out from the spoilt and damaged ones. The impurities were then washed away with running water, allowed to dry in the sun for six hours, and then placed in the shade for two to four days to finish drying. Lastly, the material was ground into a powder using a mortar and pestle (Parnami and Varma, 2019). To achieve a consistent particle size (less than 250 μm), the powder was run through sieves. For future research, the powder was stored at room temperature (25°C) in polythene bags.

2.4. Characterization of Curry Leaves

The proximate composition (moisture, fat, fiber, protein, ash and carbohydrates contents) of curry leaves powder according to the AOAC 2000 method, reported in literature (Matsuo *et al.*, 2019). Moisture contents were measured by drying leaves powder in hot air oven at 105 °C for 24 hours. The fat contents were determined through Soxhlet apparatus with completion of 6 cycle using n-hexane. Protein contents of powder were determined via acid digestion of powder employ the Kjeldahl method for nitrogen determination. Subsequently, nitrogen percentage was multiplied with conversion factor (6.25) to find the protein contents. Similarly, fiber contents of powder were examined by treating leaves powder with sulfuric acid and sodium hydroxide to produce the acid and alkali free in Labconco Fibertech. Ash was measured, acid and alkali free sample was charred and placed in a muffle furnace at 600°C for 5-6 hours. Carbohydrates were calculated through a mass balance.

2.5. Minerals Analysis

The atomic absorption spectrophotometer (Model AA240, Varian K, Australia) was used to measure the mineral content of curry leaf powder. This procedure involved adding 0.5 g of dried curry leaf powder, 5 mL of HClO₄, and 10 mL of HNO₃ to a digestion flask, which was then cooked on a hot plate until the contents were transparent. Once the sample had been filtrated, it was moved to a volumetric flask where 100mL of distilled water was added. For every mineral, the sample was run. By comparing the standard curves created for each element, the mineral compositions were determined (Naqvi *et al.*, 2023).

2.6. Total Phenolic Compounds

The total phenolic content of curry leaf powder was ascertained through Folin Ciocalteu (FC) reagents employing the Turkmen *et al.* (2005) process. The 1g of sample was dissolved in 5mL of 70% methanol solution and agitated at a speed of 200 rpm for 4 hours. The mixture was

centrifuged at 5000 rpm for 30 minutes, and the supernatant was transferred into polypropylene tubes using a pipette. The supernatant was centrifuged using Whatman filter paper 1. 125 μL of FC reagent and 500 μL of distilled water were mixed with the extract. The extract was then left under room temperature (25°C) for 90 minutes after adding 7% sodium bicarbonate. Absorbance was checked at 760 nm using the UV-Visible spectrophotometer and compared with gallic acid. Gallic acid milligrammes per 100 grammes of dry weight were used to present the results (Turkmen *et al.*, 2005).

2.7. Total Flavonoid Contents

According to the AlCl₃ colorimetric method, the content of total flavonoids in curry leaf powder was measured. Briefly, after extract and methanol containing potassium acetate and aluminium (1:3) were added in 5.6 millilitres of distilled water, the mixture was stored at room temperature (25 °C) for 30 minutes. Subsequently, the sample's absorbance was determined with the spectrophotometer 752D (UV Visible, China) at a wavelength of 415 nm. The results were measured in terms of QE/100g, based on the quercetin standard curve (Asif *et al.*, 2023).

2.8. Anti-Diabetic Potential of Curry Leaves Powder

2.8.1. Human Study Criterion

In this study, 30 female patients were selected, divided into 3 groups equally. The different dosage concentration was provided to each group as mentioned in Table 1 for 60 days or 2 months. The analysis was performed at 0 day and 60th day to check that how much curry leaves powder effect on the diabetes.

Table 1. Experimental Plan for Diabetic Patients.

No. of Patients	Treatment Groups	Dosage of Curry Leaves Powder
10	Control Group (G ₀)	No Treatment
10	Treatment Group (G ₁)	1000 mg/ day
10	Treatment Group (G ₂)	2000 mg/ day

2.8.2. Biomarkers Measurements

Before the study plan started and at the end of the trial, blood was collected to compare the findings of the HbA_{1c} test with the random blood sugar level. The glucometer Accu-Chek (Roche) was used to measure random blood sugar in accordance with the procedure of Jadhav and Dhudum (2019).

2.9. Ethical Approval

The study was permitted by the Institutional review board of The University of Faisalabad. Informed consent was obtained from all the participants.

2.10. Statistical Analysis

All the analysis were performed in triplicates and results are presented as mean values along standard deviations using Statistix 8.1 (Analytical Software USA).

3. RESULT AND DISCUSSION

3.1. Proximate Composition

Proximate composition of curry leaves powder was determined and results are reported in Table 2. Results showed that curry leaves powder contained the highest carbohydrate contents. It also contains rich source of protein, which can be used for the product development to reduce the malnutrition. The findings of the present study was in line with the results of (Parnami and Varma, 2019).

Table 2. Proximate Composition of Curry Leaves Powder.

Proximate Composition	Concentrations (%)
Moisture Contents	4.8±0.7
Crude Fat	8.1±0.3
Crude Fiber	14.0±0.5
Crude Protein	17.5±0.5
Crude Ash	14.5±0.5
Carbohydrate Contents	42.9±0.6

3.2. Minerals Composition

Mineral (calcium, iron and magnesium) contents of curry leaves powder were determined and results are depicted in Figure 1. Results showed that curry leaves powder significant concentration of minerals. Among the minerals, iron concentration was observed as 15.39 mg/100g followed by the calcium 13.8 mg/100g and magnesium 1.69 mg/100g. Previous study showed that minerals in diet improve the glycemic control and blood lipid in diabetic patient. Similarly, magnesium improves the insulin resistance and other minerals (calcium and iron) supportive for osteoporosis and post menopause. These findings are associated with prior reported literature (Nyo *et al.*, 2019).

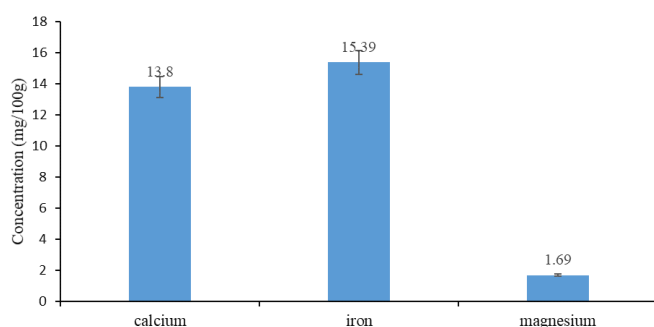


Figure 1. Mineral composition of curry leaves powder.

3.3. Phytochemical Characterization

The phytochemical characterization of curry leaves powder was measured and results are presented in Figure 2. Total phenolic contents in curry leaves powder were 164.5 mg GAE/100g and total flavonoid contents were 35.4 mg QE/100g. Curry leaves, like other plants, contain a variety of bioactive phytochemicals, polyphenols, and flavonoids that, by regulating glucose metabolism, lipid profile, and hepatic enzyme activity, lessen the pathophysiology of diabetes and its effects. Total phenolic content has been shown to have antibacterial and antifungal qualities. They treat many illnesses and lessen the body's inflammation. The high concentrations of phenolic and flavonoid contents in curry

leave powders are beneficial for the cure of various metabolic disorders including diabetes (Igara *et al.*, 2016).

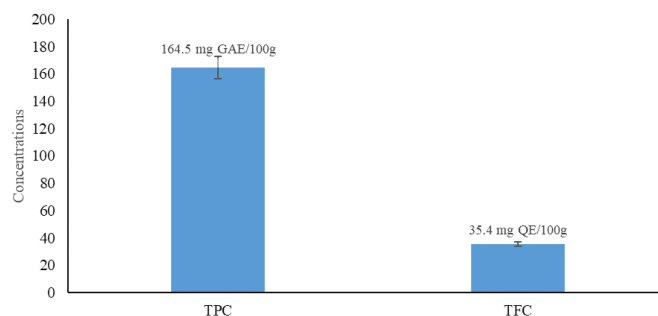


Figure 2. Phytochemical characterization curry leaves powder.

3.4. Experimental Study Design for Human Female Subjects

The aim of this research was to check the therapeutic efficacy of curry leaf powder against female diabetic patients. The total study duration was 2 months/60 days, and curry leaves powder was provided according to the Table 1. Participants were given 1000 mg and 2000 mg of curry leaf powder in capsules, taken twice a day after meals, in the morning and evening. The curry leaf powder capsules resulted in a remarkable decrease in Random Blood Sugar and HbA1c levels in treatment groups G₁ and G₂.

3.4.1. Changes in Random Blood Glucose Level

When comparing groups G₁ and G₂ to the control group G₀, the mean values show a substantial difference (Figure 3). The random blood glucose level dropped from 235±1 in group G₁, and from 225±1 to 175±1 in group G₂. Only slight alterations were noted in group G₀, where the random blood glucose level dropped from 251±1.51 to 235.2±0.7. The findings are in line with a study that looked at the anti-diabetic effects of curry leaf powder in patients with type 2 diabetes. Blood sugar levels while fasting and after meals showed a substantial change (Kirupa and Kavitha, 2013).

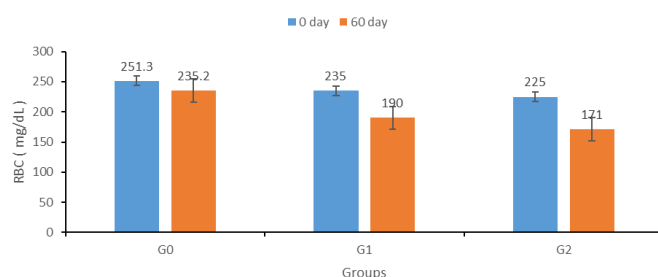


Figure 3. Effect of curry leaves powder on RBC.

3.4.2. Changes in Hb1Ac

Groups G₁ and G₂ showed a significant decrease in Hb1Ac levels when compared to G₀ (Figure 4). The level of Hb1Ac dropped from 8.7±0.8 to 8.5±0.5 in G₁ and from 8.5±0.5 to 7.2±0.7 in G₂. Levels in G₀ decreased from 9.5±0.5 to 8.2±0.4. Another study using diabetic rats showed similar outcomes, with an aqueous extract of curry leaves lowering blood glucose levels and lowering increased HbA1c levels. Curry leaf extract's antioxidant potential was also investigated in the

study, and the results indicated that it might lessen the harm that oxidative stress causes to the islets of Langerhans (Al-Ani *et al.*, 2017).

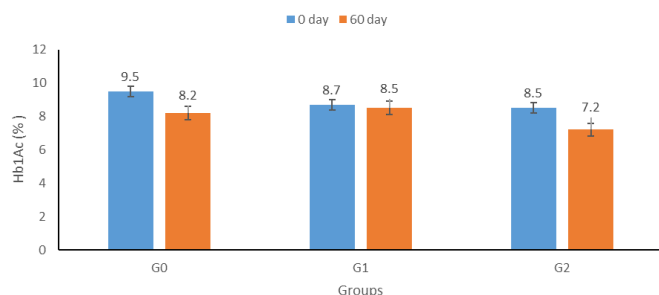


Figure 4. Effect of curry leaves powder on Hb1Ac.

4. CONCLUSION

The objective of current research was proximate, mineral and phytochemical analysis of curry leaves powder and its impact on diabetic patients. Result indicated that curry leaves powder has the good source of mineral (calcium, iron, magnesium) and phytochemical like total phenolic contents and total flavonoid contents. Results indicated that the random blood glucose level and HbA1c in female diabetic patients significantly reduced ($p < 0.05$). Therefore, in summary, the results stated that powdered leaves of curry have the potential to assist diabetics with managing their hyperglycemia. Curry leaves can be considered safe food supplements whose properties can treat diabetes.

5. CONFLICT OF INTEREST

Authors declares there are no conflict of interest.

6. FUNDING

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