Antioxidant and Hypoglycemic Effect of *Flacourtia jangomas*

By

Md Rakibul Hasan
19146066

A thesis submitted to School of Pharmacy in partial fulfillment of the requirements for the degree of
Bachelor of Pharmacy (Hons.)

School of Pharmacy
Brac University
Spring 2019

Declaration

It is hereby declared that

1. The thesis submitted is my own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

Md. Rakibul Hasan
19146066

Approval

The project titled "Antioxidant and Hypoglycemic Effect of *Flacourtia jangomas*" submitted by Md Rakibul Hasan (19146066) of spring-2019 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy.

Examining Committee:

Supervisor:
(Member)

_____
Farhana Alam Ripa, PhD
Associate professor, School of Pharmacy,
Brac University.

Deputy chair:
(Member)

_____
Hasina Yasmin, PhD
Professor, Assistant Dean and Program Director School of Pharmacy,
Brac University

Departmental Head:
(Chair)

_____
Eva Rahman Kabir
Professor and Dean, School of Pharmacy,
Brac University

Ethics Statement

Ethical permission has been achieved from the department of pharmacy, Jahangirnagar university.

Abstract

Flacourtia jangomas known as lukluki fruits is assuming to have antioxidant and hypoglycemic profile. In order to prove that, we have chosen the methanolic extract of *Flacourtia jangomas* fruits for assessing the antioxidant and hypoglycemic activity. So, DPPH (1, 1 diphenyl-2-picryl hydrazyl) test was done for percentage scavenging of methanolic extract of F.jangomas in contrast to Ascorbic acid for antioxidant activities. This study found that the IC50 value for methanolic extract of *F.jangomas* fruits was 53.71µg/ml as compared to strong antioxidant ascorbic acid IC50 46.71µg/ml which is indicator towards its antioxidant properties. In terms of hypoglycemic study, oral glucose test was conducted for 1-3 hours on swiss albino mice taking 10% glucose as a reference drug and the declination of glucose level for MFJ600 is 11.17±2.36g which is close to standard 9.48±1.84g after 1 hour and the rest of the result were sequential. So, *Flacourtia jangomas* fruit has antioxidant and hypoglycemic properties which may direct revolution in medicinal science in assessing diabetes.

Keywords: Antioxidant, Hypoglycemia, DPPH, Ascorbic acid, *Flacourtia jangomas*

Dedication

Dedicated to my parents who has enlighten my world from my childhood to every step of my life

Acknowledgement

Alhamdulillah, all the praising belongs to Allah S.W.T. who has given me physical strength and mental health to complete this project paper with great patience.

I would like to express my heartfelt gratitude and honor to work with the very dedicated, kind hearted and friendly faculty of our department, my supervisor Dr. Farhana Alam Ripa (Associate professor, school of pharmacy, Brac University). Without the immense support from my supervisor and her kind guidance I couldn't have been complete my project paper so easily.

I would plead to acknowledge my gratitude to the head of our department Dr. Eva Rahman Kabir (Dean, School of Pharmacy, Brac University) and my respected faculty members.

I seek thankfulness to the laboratory authority, Ayesha Abed Library, Brac University and the rest of the university facilities to allow me to conduct my experimental research works without hindrances.

Above ground I am indebted to my family who enlightened my spirit to work harder and finish this final paper. May Allah S.W.T bless us forever.

Md. Rakibul Hasan
February, 2023

Table of Contents

List of Tables

List of Figure

List of Acronyms

DPPH – 1,1 diphenayl-2-picryl hdryzyl

ICDDRB- International Centre for Diarrheal Disease Research, Bangladesh

MFJ- Methanolic flesh extract values of *F.jangomas*

Conc.- Concentration

WHO- World Health Organization

FE- Fruit ethanol extract

Chapter 1

1.1 Introduction

New technologies are developing in tandem with the rapid progress of modern science. Thus, new syndromes are recognized, and the cure for the condition is found, all of which contribute to a growing need for novelty and cutting-edge technology in daily life. However, humans chronic drug usage has resulted in resistance to various treatments(Salehi et al., 2019a). Because of this, the difficulty of developing and introducing new pharmaceuticals for both new and established therapies fall on the shoulders of innovation(Mettupalayam Kaliyannan Sundaramoorthy & Kilavan Packiam, 2020). There are numerous pharmaceutical options available, but due to concerns about the side effects of synthetic pharmaceuticals, many people prefer to use natural remedies instead. The purpose of investigation is to measure hypoglycemic and antioxidant properties of methanolic extract of *F.jangomas* fruits in order to implement those result in human body for a better anti-diabetic and anti-oxidant drug(Pisoschi et al., 2016) . For this purpose, the initial experiment on swiss albino rats were done and the result has been discussed below for further clarification. The antioxidant properties help preventing Alzeimers disaeses and hypoglycemic profile helps in control of diabetes.

1.1.1 Herbal medicines

Plants have been used as medicines in both ancient and modern times. Folk or ethano medicine, which was commonly practiced in places like China, Middle East as well in Africa also in South America in addition to India, was mostly composed of these practices at the outset(Salehi et al., 2019). For time being the Ayurveda, the Chinese, the Yunani, the Sidha, the Tibetan, and other systems codified and documented a large percentage of this traditional knowledge to create modern medicine(Shankar & Liao, 2004). Despite much development of urban health care management, many villagers still rely on folk medicines for the treatment of everyday ailments like coughs sometimes colds, fever, headaches, body aches as well as constipation, respiratory issues, and more(Iriyama et al., 1974). The use of phytopharmaceuticals, however, has been increasingly popular in recent years as an important medicine for the treatment or prevention of various diseases(Shankar & Liao, 2004).

1.1.2 Ancient History of herbal medicines

Around 5 hundred years ago, a Sumerian clay slab was unearthed in Nagpur with the oldest known as the evidence of the use of useful herbs in the production for medications(Adame-Miranda et al., 2021). Poppy, henbane, and mandrake were just a few of the alkaloids mentioned in the more than 250 plants used in the 12 drug production techniques included(Petrovska, 2012). The Vedas, the Indian scriptures, recommend using the country's plethora of medicinal plants for various ailments. India is the birthplace of several popular spices including cardamom, nutmeg, pepper, clove, etc(Gras et al., 2017). In the seventh century A.D., the Slavic people used *Aconitum napellus* as a poison in hunting and used *Rosmarinus officinalis*, *Ocimum basilicum*, *Iris germanica*, and *Mentha viridis* in cosmetics; *Alium sativum* as a remedy; and *Veratrum album, Cucumis sativus*, *Urtica dioica*, *Achilea millefolium*, *Artemisia maritime L., Lavandul*(Gras et al., 2017). New plants employed in pharmacology were inherited from India, a place with whom the Arabs had commercial contacts; the vast majority of these plants had actual therapeutic efficacy and are still used today(Petrovska, 2012). Some powerful medications like Heleborus odorus and Euphorbium were switched out for weaker ones like the laxative Sennae folium(Lipp, 1996).

1.1.3 Medicinal plants

Ancient societies had to rely heavily on the natural environment for sustenance, particularly on the plants and animals that flourished back then.(Petrovska, 2012)

"A medicinal plant is any plant in which one or more of its parts, comprises compounds that are utilized as healing reasons, or which are pioneers for chemo therapeutic semi-synthesis" according to the World Health Organization(Petrovska, 2012).

When a plant is described as "medicinal," it is implying that the plant or some portion of it has therapeutic value(Fernando, 1992). Thus, we can think of medicinal plants as a group of plants that have retained unique features or characteristics that mark them as possible elements of medications and therapeutic intermediaries used in the treatment of illness and injury(Phillipson, 2001)

1.1.4 Bangladesh's stand in Medicinal plants

Due to its subtropical location, Bangladesh is a rich source of therapeutic plants and roughly 5,000 different kinds of angiosperms can be broken down into 200 different families(Shankar & Liao, 2004). Roughly 500 of these are currently being utilized as traditional medicines for the treatment of a wide range of illnesses and more than 500 of the subcontinent's 2,000 medicinal plants are grown in Bangladesh and this includes cities like Dhaka, Rajshahi, Sylhet, and Chittagong (Malek et al., 2012)

In Bangladesh, the plant parts used for medicinal purposes vary. The leaves of medicinal plants are the most commonly utilized portion, although other parts such as bark, stems, fruits, seeds, rhizome, the entire plant, and inflorescence are also put to good use(Shankar & Liao, 2004)

1.2 Literature Review

1.2.1 *Flacourtia jangomas* and its morphology

F. Jangomas also known as Paniala, Indian plum and coffee plum, is a tiny deciduous tree that was once classified in the family Flacourtiaceae but is now included in the family Salicaceae(T. S. Singh et al., 2021). It grows a height of 6-10 meters . The trunk and branches of mature trees have lost their wooden thorns, yet immature trees still have them(Fernando, 1992). The peeling bark is a pale brown to copper red or pinkish buff color and has a smooth, lenticelled texture. The Yung tree has white branches that are either puberulous or mostly glabrous and are covered in many suborbicular lenticels(Zhang et al., 2019). The leaves are alternate, deciduous, pale pink when young, spirally arranged, occasionally ovate-lanceolate, long point toothed, extremely thin, both surfaces glossy, blade elliptic, serrate, 7.0 cm-11.0 cm x 3.5 cm-4.0 cm, pappery, and display 3-6 pairs of secondary nerves(Phillipson, 2001). Male flowers are 1.5–3.0 cm long, whereas female flowers are shorter, measuring just 1.0–1.5 cm and the inflorescence consists of subcorymbose, glabrous axillary racemes(Lock et al., 2016).

Figure1- *Flacourtia jangomas fruits*(George et al., 2017)

White to greenish in color, with 4 or 5 ovate triangular petals and a honey scent, the dioecious flowers appear before or alongside the new foliage. The average diameter of a pedicellate is only 0.5-1 (-1.5 cm) and Four to five sepals measure 2 millimeters each and are oblong, obtuse, bluish green, and hairy on both sides(Gras et al., 2017). White or yellow (orange) disk that is fleshy and either whole or somewhat lobed. The male flowers are filamentous, glabrous, and found either singly or in small groups, while the female flowers always bloom alone. Both male and female flowers grow on their own individual trees and there are numerous long to suborbicular anthers in the androecium(Lipp, 1996). The ovary has four to six follicles; each follicle contains two ovules that are initially flask-shaped but become subglobular as they mature; and four to six styles that are connate into a distinct, 1 mm high column, not or slightly free at their apices and each bearing a dilate, bilobed, recurved stigma(Shankar & Liao, 2004). From December through April, not only do the flowers and new, vibrantly green foliage emerge, but also the winter season(Petrovska, 2012).

1.2.2. Taxonomical Classification and its origin

The exact extent to which *F. jangomas* remains wild in lowland areas is unknown. However, it is assumed to found in India and spread to the tropical zones of East Africa and Asia as well as the states of Uttar Pradesh, Bihar, Maharashtra, Bengal, Assam, and Orissa, as well as some of South India, are its native range(Džamić & Matejić, 2022).

Kingdom	Plantae
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta (Land plants)
Super division	Embryophyta
Division	Tracheophyta (Vascular plants)
Subdivision	Spermatophytina (Spermatophyes)
Class	Magnoliopsida
Order	Malpighiales
Family	Salicaceae (Willows)
Genus	*Flacourtia*
Species	*jangomas*

Table 1: Taxonomical classification of *F.jangomas*(Shankar & Liao, 2004)

1.2.3 Traditional use of *F. jangomas*

The juicy fruits of *F. jangomas* are widely consumed due to their deliciously tangy taste. When the fruit is ready, it turns a deep crimson or purple color and can be used to make jams and preserves. The meat has a solid texture and is a brownish green color. For dessert, it can be cooked in a sauce or syrup, and it can also be used to make juice, syrup, jam, marmalade, pickles, and sauces.(Capasso, 1985) The astringency of some fruits can be mitigated by simply rolling them in one's hands. Just before it reaches full ripeness, it is used to make jellies. Fruits are highly prized in Indian cuisine and Keralan medicine. In Indonesia, the young, acidic shoots are a popular food. The wood has a crimson or scarlet color, has a close grain, is hard and brittle, lasts a long time, and takes a good polish(Florence et al., 2014). It can be shaped into blocks or tools for the farm. It is sometimes cut down in Tamil Nadu, Kerala, and Karnataka for use as lumber. Use it as a substitute for more expensive materials like Teak(A. K. Singh & Singh, 2010a). One of the most important roles the plant plays is as a host for the Queensland fruit fly, Bactrocera tryoni.(A. K. Singh & Singh, 2010b)

Chapter2

Methodology

2.1.1 Collection of plant parts and identification

In November 2022, the fruits of this plant were gathered from the grounds of Gazipur, Bangladesh. It was recognized by Bangladesh National Herbarium, Mirpur, Dhaka where the DACB accession No 87043 has been deposited.

2.1.2 Extraction of plant

The collected fruits were cut into little pieces, the collected fresh pulp and cut into pieces and they were submerged in ethanol in a container which was sealed by cotton plug and aluminum foil and was kept for minimum 7 days in a cool dark airtight container.

In a cold extraction method two liters of methanol were each used to extract one kilogram of finely cut fruits. Each sample was stored for about 72 hours while being continually agitated. There was a 0.25% yield from the methanol (ME) extract.

2.2 Experimented animal

Swiss-albino mice were chosen as the test subjects in order to look into the pharmacological effects of the substance being investigated. Animals for the study were obtained from the animal research institute at Jahangirnagar University in Savar. Each mouse was between 4-5 weeks old and weighed between 30-35 grams. The study was reviewed and authorized by the "International Centre for Diarrheal Disease Research, Bangladesh" (ICDDR,B). The setting was set up in a way that was conducive to the well-being of the mice, and they were given ICDDR, which is B's

preferred diet for rodents, as well as access to water on a continuous basis. In order to house the animals, several polyvinyl cages sourced from BIK companies in India were utilized, and in order to provide bedding, soft wood shavings procured from neighborhood timber stores were utilized. Every mouse was kept in a cage with a light and dark cycle that alternated every 12 hours at a temperature of 23.2 degrees Fahrenheit and a relative humidity of 60.10 percent. The mice spent one week getting used to the conditions of the laboratory before the actual experiments began. These protocols were carried out in accordance with the ethical approval granted by the committee for the ethical study of animals at the institute .

2.3 Design of the experiment

2.3.1 Free radical scavenging activity by DPPH method

Antioxidant activity was done following the DPPH free radical scavenging assay, based on the updated method. (Brand Williams et al. 1995)

Hydrogen peroxide reduction potential (DPPH) steady-state assay was used to evaluate the radical scavenging activity of methanol extracts *of F.jangomas* fruits and ascorbic acid was set as standard for antioxidant properties(Penkov et al., 2018).

In order to determine the DPPH scavenging capacity, the following equation was used:

DPPH scavenged (%) = [A (count) - A (test)/ A (count)] x 100
Here,

A (count) = absorbance of the control reaction
A (test) = absorbance of the presence of extracts

The IC50 value was calculated with the help of a equation by plotting a graph against the used concentrations.

2.3.2

Hypoglycemic activity of *F. jangomas*

For proving the hypoglycemic activity of *F. jangomas* a glucose tolerance test was performed. Typically, the results of a glucose tolerance test will indicate how quickly the glucose is removed from the blood after being injected. While the subjects were fasting, blood samples were taken and a 10% glucose solution was given to ensure accurate results. After the glucose load, the blood glucose levels of each animal were monitored at 1, 2 and 3 hours using a glucometer. The following equation can be used to get the percentage of blood glucose reduction.:

$$\%\text{reduction in blood glucose} = \frac{\text{BG control} - \text{BG test} \times 100}{\text{BG control}}$$

Here, BG is the average blood glucose level for each group

Chapter 3

Result

3.1 Result of antioxidant activities

The percentage scavenging of DPPH radical was found to be concentration dependent. The result of DPPH scavenging activity with IC50 value of methanolic extract of *F.jangomas* and standard ascorbic acid is shown below in the graphs and table.

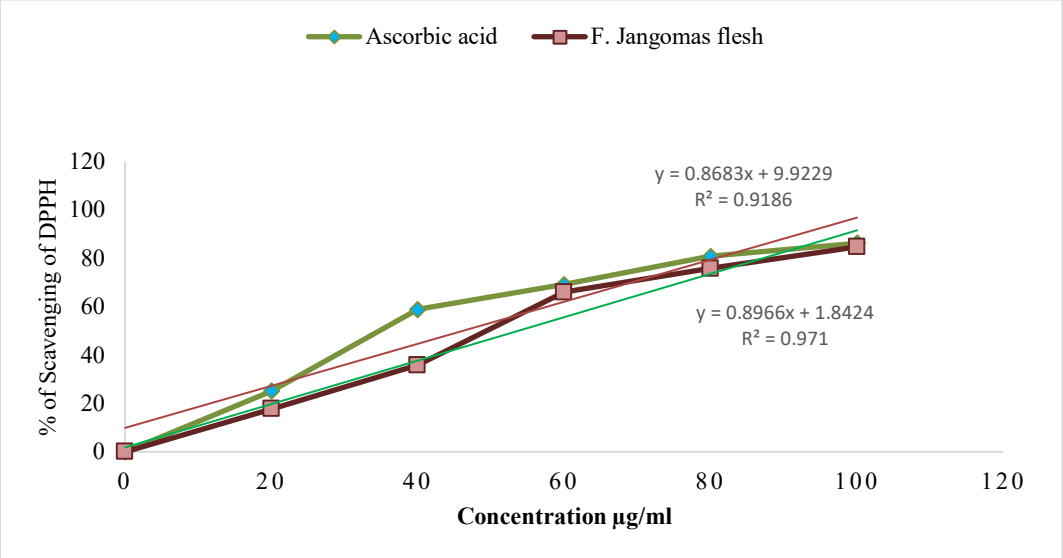

Figure -02- percentage scavenging assay of DPPH

The IC50 value of standard ascorbic acid is 46.15 µg/ml and methanolic extract of *F. jangomas* is 53.711 µg/ml which emphasis on the greater antioxidant properties.

IC50 STD	46.15 µg/ml
IC50 FJF	53.711 µg/ml

Table 02: IC50 values of *F. jangomas* methanolic extract and standard ascorbic acid

3.2 Result of hypoglycemic activity:

This table shows the glucose level by time control group, standard and the experimental mice which were injected 10% glucose. And as the time passes by these data of the hypoglycemic effect of methanolic extract of *F. jangomas* are observed.

Group	1 Hr	2 Hr	3 Hr
Normal Control	19.27±1.49	14.07±2.23	11.2±1.64*
Standard	9.48±1.84*	7.43±0.94*	4.8±0.44
Diabetic MFJ 200	15.75±4.4*	14.38±3.79*	13.23±3.8
Diabetic MFJ 400	12.28±2.29*	11.7±2.87	8.73±2.82
Diabetic MFJ 600	11.17±2.36	8.58±1.8*	6.9±1.49*

Table 03: Hypoglycemic activity data of different mice

3.3. Discussion

DPPS scavenging method

DPPH is stable nitrogen centered free radical which accepts electron easily in order to become a stable diamagnetic molecule. When the experiment was on process we noticed this activity to be increased as compared to the increase of the sample *F.jangomas* methanolic extract. The DPPH contains one odd electron which is responsible for its absorbance at 517nm and deep purple color. So, when the DPPH accepts electron it causes change in the absorbance for its becoming decolorized. After plotting the absorbance in accordance of the concentration in the graph the DPPH scavenging activity of *F. jangomas* methanolic extract (IC50 53.71 µg/ml as compared to ascorbic acid IC50 46.15 µg/ml). So, the methanolic extract of F.jangomas has more antioxidant activity than ascorbic acid.

Hypoglycemic activity

Diabetes mellitus is a complex disease which is generally caused by hyperglycemia which is due to ineffective insulin secretion or insulin action and this may lead to impaired breakdown of glucose, lipids, and protein(Shori, 2015). Currently, it is estimated that there will be 366 million people living with diabetes worldwide by the year 2030 (Kumar et al., 2021).People with diabetes who want to minimize their health risks are increasingly turning to herbal remedies. From the experiment we observed significant decrease in serum glucose level in hypoglycemic rats. 10% glucose was administered in the (200 mg/kg, 400mg/kg and 600mg/kg and the result for 1,2, and 3 hours showed significant decrease in their glucose level and these were recorded ($p<0.05$ & $p<0.01$). On progression of the experiment with the methanolic extract of *F.jangomas* , the diabetic 600mg/kg body weight produced maximum reduction to 6.9±1.49mmol/L which is near to the standard value. So, from this experiment we can assume that the methanolic extract of *F. jangomas* acquire insulin by promoting glucose consumption.

Chapter 4

Conclusion:

Medicinal plants are being used as the remedies for decades. From ancient time, medicinal plants have been used as wide range of conditions. Among all the medicinal plants *Flacourtia jangomas* shows antidiabetic, antifungal, antioxidant properties, thrombolytic and anti-arthritic activities(Huang & Huang, 2020). In our research we found that methanolic extract of *Flacourtia jangomas* shows better antioxidant activity than ascorbic acid and also shows better hypoglycemic activities. So, this fruit extract can be a revolutionary step towards diabetes control and antioxidant properties which can lower the risk of stress related disease like cardiovascular disease heart attack, cancer, cell death(Soelberg et al., 2015). Antioxidant substances slow down the damage of cell death, prevents arthritis, Parkinson's disease. So, medicinal plant has been one of the cheapest and affordable type of medicine source. Urban people can easily afford the medicines and thus the impact of proper treatment can be easily implemented.

Future aspect of *Flacourtia jangomas*

Flacourtia jangomas has great antioxidant and hypoglycemic effect and this fruits extract can be used as the medicine for Alzeimer disease, Parkinson's disease and diabetes management(Stephen Irudayaraj et al., 2012). This project work will pave the way towards newer invention of drug at more effective way and the clinical aspect can be distinguished among patients of different profile. So, combination of this fruit flesh extract with other chemical constituents can provide remedies of wide variety.

References

Adame-Miranda, S. J., Granados-Guzmán, G., Silva-Mares, D. A., Acevedo-Fernández, J. J., Waksman-Minsky, N., & Salazar-Aranda, R. (2021). Evaluation of antihyperglycemic activity of plants in northeast mexico. *Cellular and Molecular Biology (Noisy-Le-Grand, France)*, *67*(1), 212–218. https://doi.org/10.14715/cmb/2021.67.1.30

Capasso, F. (1985). Medicinal plants: an approach to the study of naturally occurring drugs. *Journal of Ethnopharmacology*, *13*(1), 111–114. https://doi.org/10.1016/0378-8741(85)90065-0

Džamić, A. M., & Matejić, J. S. (2022). Plant Products in the Prevention of Diabetes Mellitus. *Mini Reviews in Medicinal Chemistry*, *22*(10), 1395–1419. https://doi.org/10.2174/1389557521666211116122232

Fernando, A. (1992). Medicinal plants. *The Ceylon Medical Journal*, *37*(3), 90–95.

Florence, N. T., Benoit, M. Z., Jonas, K., Alexandra, T., Désiré, D. D. P., Pierre, K., & Théophile, D. (2014). Antidiabetic and antioxidant effects of Annona muricata (Annonaceae), aqueous extract on streptozotocin-induced diabetic rats. *Journal of Ethnopharmacology*, *151*(2), 784–790. https://doi.org/10.1016/j.jep.2013.09.021

George, S. A., Bhadran, S., Sudhakar, M., & Harini, B. P. (2017). Comprehensive in vitro evaluation of pharmacological activities of selected mass spectrometry profiling of flacourtia jangomas flower extract. *Asian Journal of Pharmaceutical and Clinical Research*, *10*(5). https://doi.org/10.22159/ajpcr.2017.v10i5.17419

Gras, A., Garnatje, T., Ibáñez, N., López-Pujol, J., Nualart, N., & Vallès, J. (2017). Medicinal plant uses and names from the herbarium of Francesc Bolòs (1773-1844). *Journal of Ethnopharmacology*, *204*, 142–168. https://doi.org/10.1016/j.jep.2017.04.002

Huang, H., & Huang, G. (2020). Extraction, separation, modification, structural characterization, and antioxidant activity of plant polysaccharides. *Chemical Biology & Drug Design*, *96*(5), 1209–1222. https://doi.org/10.1111/cbdd.13794

Iriyama, K., Ogura, N., & Takamiya, A. (1974). A simple method for extraction and partial purification of chlorophyll from plant material, using dioxane. *Journal of Biochemistry*, *76*(4), 901–904.

Kumar, S., Mittal, A., Babu, D., & Mittal, A. (2021). Herbal Medicines for Diabetes Management and its Secondary Complications. *Current Diabetes Reviews*, *17*(4), 437–456. https://doi.org/10.2174/1573399816666201103143225

Lipp, F. J. (1996). The efficacy, history, and politics of medicinal plants. *Alternative Therapies in Health and Medicine*, *2*(4), 36–41.

Lock, O., Perez, E., Villar, M., Flores, D., & Rojas, R. (2016). Bioactive Compounds from Plants Used in Peruvian Traditional Medicine. *Natural Product Communications*, *11*(3), 315–337.

Malek, I., Islam, T., Hasan, E., Akter, S., Rana, M., Das, P. R., Samarrai, W., & Rahmatullah, M. (2012). Medicinal plants used by the Mandais--a little known tribe of Bangladesh. *African Journal of Traditional, Complementary, and Alternative Medicines : AJTCAM*, *9*(4), 536–541. https://doi.org/10.4314/ajtcam.v9i4.10

Mettupalayam Kaliyannan Sundaramoorthy, P., & Kilavan Packiam, K. (2020). In vitro enzyme inhibitory and cytotoxic studies with Evolvulus alsinoides (Linn.) Linn. Leaf extract: a plant from Ayurveda recognized as Dasapushpam for the management of Alzheimer's disease and diabetes mellitus. *BMC Complementary Medicine and Therapies*, *20*(1), 129. https://doi.org/10.1186/s12906-020-02922-7

Penkov, D., Andonova, V., Delev, D., Kostadinov, I., & Kassarova, M. (2018). Antioxidant Activity of Dry Birch (Betula Pendula) Leaves Extract. *Folia Medica*, *60*(4), 571–579. https://doi.org/10.2478/folmed-2018-0035

Petrovska, B. B. (2012). Historical review of medicinal plants' usage. *Pharmacognosy Reviews*, *6*(11), 1–5. https://doi.org/10.4103/0973-7847.95849

Phillipson, J. D. (2001). Phytochemistry and medicinal plants. *Phytochemistry*, *56*(3), 237–243. https://doi.org/10.1016/s0031-9422(00)00456-8

Pisoschi, A. M., Pop, A., Cimpeanu, C., & Predoi, G. (2016). Antioxidant Capacity Determination in Plants and Plant-Derived Products: A Review. *Oxidative Medicine and Cellular Longevity*, *2016*, 9130976. https://doi.org/10.1155/2016/9130976

Salehi, B., Ata, A., v Anil Kumar, N., Sharopov, F., Ramírez-Alarcón, K., Ruiz-Ortega, A., Abdulmajid Ayatollahi, S., Tsouh Fokou, P. V., Kobarfard, F., Amiruddin Zakaria, Z., Iriti, M., Taheri, Y., Martorell, M., Sureda, A., Setzer, W. N., Durazzo, A., Lucarini, M., Santini, A., Capasso, R., … Sharifi-Rad, J. (2019a). Antidiabetic Potential of Medicinal Plants and Their Active Components. *Biomolecules*, *9*(10). https://doi.org/10.3390/biom9100551

Salehi, B., Ata, A., v Anil Kumar, N., Sharopov, F., Ramírez-Alarcón, K., Ruiz-Ortega, A., Abdulmajid Ayatollahi, S., Tsouh Fokou, P. V., Kobarfard, F., Amiruddin Zakaria, Z., Iriti,

M., Taheri, Y., Martorell, M., Sureda, A., Setzer, W. N., Durazzo, A., Lucarini, M., Santini, A., Capasso, R., … Sharifi-Rad, J. (2019b). Antidiabetic Potential of Medicinal Plants and Their Active Components. *Biomolecules*, *9*(10). https://doi.org/10.3390/biom9100551

Shankar, K., & Liao, L. P. (2004). Traditional systems of medicine. *Physical Medicine and Rehabilitation Clinics of North America*, *15*(4), 725–747, v. https://doi.org/10.1016/j.pmr.2004.03.006

Shori, A. B. (2015). Screening of antidiabetic and antioxidant activities of medicinal plants. *Journal of Integrative Medicine*, *13*(5), 297–305. https://doi.org/10.1016/S2095-4964(15)60193-5

Singh, A. K., & Singh, J. (2010a). Evaluation of anti-diabetic potential of leaves and stem of Flacourtia jangomas in streptozotocin-induced diabetic rats. *Indian Journal of Pharmacology*, *42*(5), 301–305. https://doi.org/10.4103/0253-7613.70238

Singh, A. K., & Singh, J. (2010b). Evaluation of anti-diabetic potential of leaves and stem of Flacourtia jangomas in streptozotocin-induced diabetic rats. *Indian Journal of Pharmacology*, *42*(5), 301–305. https://doi.org/10.4103/0253-7613.70238

Singh, T. S., Roy, S. S., Kshetri, P., Ansari, M. A., Sharma, S. K., Verma, M. R., Singh, I. M., Prakash, N., & Kandpal, B. (2021). Comparative study on phenolic, flavonoids and in vitro antioxidant activity of wild edible plants from Loktak Lake wetland ecosystem under North East Indian Himalayan Region. *Natural Product Research*, *35*(24), 6045–6048. https://doi.org/10.1080/14786419.2020.1817014

Soelberg, J., Asase, A., Akwetey, G., & Jäger, A. K. (2015). Historical versus contemporary medicinal plant uses in Ghana. *Journal of Ethnopharmacology*, *160*, 109–132. https://doi.org/10.1016/j.jep.2014.11.036

Stephen Irudayaraj, S., Sunil, C., Duraipandiyan, V., & Ignacimuthu, S. (2012). Antidiabetic and antioxidant activities of Toddalia asiatica (L.) Lam. leaves in streptozotocin induced diabetic rats. *Journal of Ethnopharmacology*, *143*(2), 515–523. https://doi.org/10.1016/j.jep.2012.07.006

Zhang, X., Liu, S., Tian, Y., Li, Y., Zhang, J., & Wang, Z. (2019). The complete chloroplast genome sequence of Flacourtia jangomas. *Mitochondrial DNA. Part B, Resources*, *4*(2), 3232–3233. https://doi.org/10.1080/23802359.2019.1668731

Antioxidant and Hypoglycemic Effect of Flacourtia jangomas

ORIGINALITY REPORT

15%	12%	6%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	innovareacademics.in Internet Source	6%
2	hdl.handle.net Internet Source	2%
3	www.ncbi.nlm.nih.gov Internet Source	2%
4	M. Habibur Rahman, M. Badrul Alam, N.S. Chowdhury, M.K. Jha, M. Hasan, M.M. Khan, M.S. Rahman, M. Ekramul Haque. "Antioxidant, Analgesic and Toxic Potentiality of Stephania Japonica (Thunb.) Miers. Leaf", International Journal of Pharmacology, 2011 Publication	1%
5	Mohammad Rashedul Haque, Mirazul Islam, Md. Ruhul Kuddus. "In vitro and in vivo evaluation of pharmacological potential of Begonia barbata Wall", Future Journal of Pharmaceutical Sciences, 2020 Publication	1%
6	cyberleninka.org Internet Source	1%

7	Submitted to Manchester Metropolitan University Student Paper	1 %
8	www.idosi.org Internet Source	1 %
9	Akter, Raushanara, SM Raquibul Hasan, Md Mokarram Hossain, Taksim Ahmed, Muntasir M Majumder, and Masuda Akter. "In vitro Evaluation of Antioxidant Potential of Leaves of *Opuntia dillenii* Haw.", Stamford Journal of Pharmaceutical Sciences, 2010. Publication	<1 %
10	N.K.V.M. Ruvin Kumara, R.N. Pathirana, C. Pathirana. " Hypoglycemic Activity of the Root and Stem of . var. β- . in Alloxan Diabetic Rats ", Pharmaceutical Biology, 2008 Publication	<1 %
11	Achut Manandhar, Alex Fischer, David J. Bradley, Mashfiqus Salehin, M. Sirajul Islam, Rob Hope, David A. Clifton. "Machine Learning to Evaluate Impacts of Flood Protection in Bangladesh, 1983–2014", Water, 2020 Publication	<1 %
12	Akhileshwar Kumar Srivastava. "Significance of medicinal plants in human life", Elsevier BV, 2018 Publication	<1 %

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		