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A Review to Study the Potential Role of Calyx and Flower Extract of Hibiscus sabdariffa in the Management of Diabetes and Hepatic Steatosis

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Abstract

Lifestyle diseases such as obesity, type 2 diabetes mellitus (T2DM), and non-alcoholic fatty liver disease (NAFLD) have become major contributors to global morbidity and mortality. Chronic lifestyle-related conditions like obesity, type 2 diabetes mellitus (T2DM), and non-alcoholic fatty liver disease (NAFLD) have emerged as significant contributors to global health burdens. Plant-based therapies are increasingly being explored as complementary strategies to conventional treatments. Hibiscus sabdariffa (HS), widely consumed as teas and herbal decoctions, contains bioactive compounds in both its calyces and flowers that may offer therapeutic benefits against diabetes and hepatic steatosis. Calyx extracts are particularly rich in anthocyanins, conferring antioxidant, hypoglycaemic, and anti-steatosis effects. In contrast, flower extracts provide higher flavonoid diversity and polysaccharides with anti-inflammatory, enzyme-inhibitory, and gut microbiota-modulating properties.

This review summarizes the phytochemical differences between calyx and flower extracts, their mechanistic roles in glycaemic control and liver health, and comparative evidence from preclinical and experimental studies. Findings suggest calyx extracts exhibit stronger direct efficacy, while flower extracts serve as valuable adjuncts, particularly through gut–liver axis modulation. An integrated use of both extracts may represent a promising therapeutic approach for the prevention and management of diabetes and NAFLD.

Keywords: Hibiscus sabdariffa, calyx, flower extract, anthocyanins, flavonoids, diabetes, NAFLD, hepatic steatosis

Introduction

The global burden [1]of non-communicable diseases (NCDs) has risen sharply in recent decades, with T2DM and NAFLD ranking among the most prevalent metabolic disorders. The pathophysiology of these conditions is multifactorial, involving insulin resistance, chronic inflammation, oxidative stress, and lipid dysregulation. Despite pharmacological advances, the demand for safe, cost-effective, and plant-derived therapeutic options continues to grow.

Stress is an important but less emphasised factor influencing metabolic health. Psychological and physical stress can initiate or exacerbate T2DM through neuroendocrine mechanisms involving both the central and peripheral nervous systems. Cortisol, the primary stress hormone, promotes insulin resistance in peripheral tissues via multiple pathways:
(a) increased lipolysis leading to elevated non-esterified fatty acids (NEFAs), which impair insulin signalling in muscle and liver;
(b) altered phosphorylation of insulin signalling intermediates, such as enhanced serine phosphorylation of IRS-1, reducing insulin-stimulated glucose uptake;

(c) redistribution of fat towards visceral depots, which strongly promote insulin resistance.

Collectively, these molecular and tissue-level alterations drive systemic insulin resistance, a key mechanism underlying the development of T2DM.

NAFLD is another major lifestyle-associated disorder and currently represents the frequently encountered chronic liver diseases worldwide, affecting up to one-third of adults. In India, prevalence estimates range[2]from 9% to 53%. NAFLD is expound as the accumulation of excess fat in hepatocytes in even if the person is non-alcoholic. Normally, the liver contains some fat, but if more than 5% of its weight is composed of fat, it is considered steatosis.

The progression of NAFLD typically follows three stages:

1. **Simple steatosis** – accumulation of fat in hepatocytes without inflammation or cell injury; often asymptomatic.
2. **Non-alcoholic steatohepatitis (NASH)** – signifies by fat accumulation and inflammation with hepatocellular injury.
3. **Fibrosis and cirrhosis** – in individuals with NASH, chronic inflammation and hepatocellular damage may lead to fibrosis, cirrhosis, and eventually liver failure.

Role of *Hibiscus sabdariffa L.*

Hibiscus sabdariffa L (family Malvaceae), is scientific name for roselle, is cultivated globally and traditionally consumed as teas, decoctions, and extracts. Both calyces and flowers are rich in polyphenolic compounds, though their phytochemical profiles vary significantly. These differences influence their pharmacological activities.

This review emphasises on the comparative role of calyx and flower extracts of *H. sabdariffa* in hyperglycaemia caused in diabetes (T2DM) and hepatic steatosis, with emphasis on their bioactive components, mechanisms of action, and therapeutic potential.

1.**Morphology of *Hibiscus sabdariffa***

The plant is cultivated mainly for its bright red calyces, which are fleshy, cup-shaped structures surrounding the seed capsule. The flowers, though less frequently utilized in herbal medicine, also contain bioactive compounds. Both plant parts are consumed across Africa, Asia, and Latin America.

Comparative4 Phytoconstituents of Calyx vs. Flower Extracts:

Table I Comparative[4] Phytoconstituents of Calyx vs. Flower Extracts:

Chemical Class	Calyx (Main Constituents)	Flower (Main Constituents)	Key Role in Diabetes & Hepatic Steatosis
Anthocyanins	Delphinidin-3-sambubioside, Cyanidin-3-sambubioside (high concentration)	Lower anthocyanin levels compared to calyx	Potent antioxidants, improved insulin sensitivity, inhibition of hepatic gluconeogenesis
Flavonoids	Quercetin, Hibiscetin-3-glucoside,	Higher flavonoid diversity (e.g., luteolin,	Inhibition of α-glucosidase and α-amylase, regulation of

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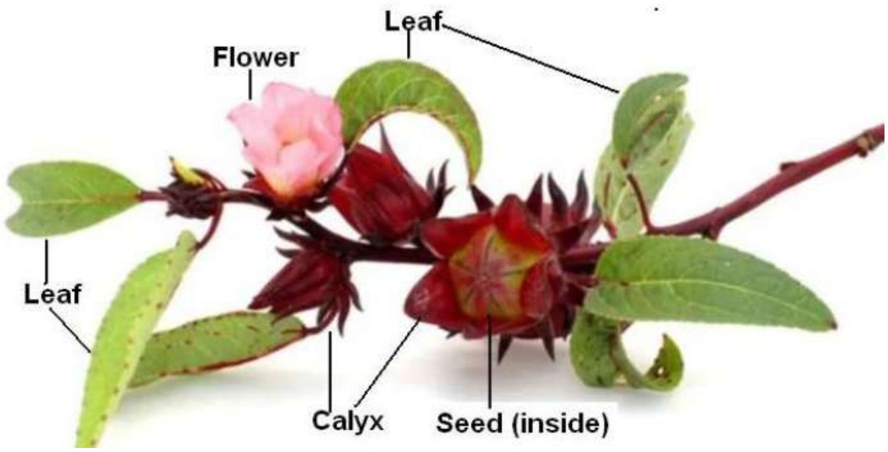
	Sabdaritrin, Gossypitrin	apigenin derivatives)	lipid metabolism
Phenolic Acids	Chlorogenic acid, Protocatechuic acid (abundant)	Caffeic acid, Ferulic acid, Syringic acid	Attenuation of oxidative stress, reduction of lipid peroxidation
Organic Acids	Hydroxycitric acid, Hibiscus acid	Present in lower concentrations	Regulation of adipogenesis and fat storage

Hibiscus sabdariffa[3] Linn plant and its various parts



Basic review of Carbohydrate metabolism, Role [3]of Insulin and glucose modulation

Figure I

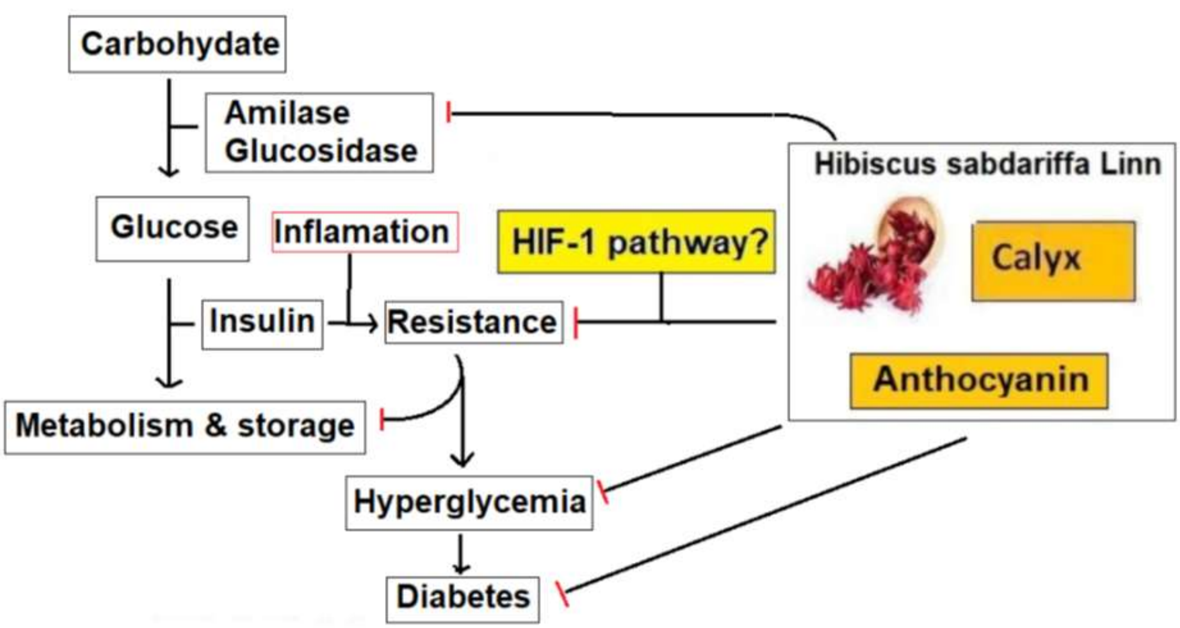


Figure II

Carbohydrate Metabolism

1.2 Role of Anthocyanins:

For liver steatosis, the anthocyanins, phenolic acids, and organic acids provide hepatoprotective and fat-lowering effects, with research showing reduced hepatic fat on supplementation.

1.3. Insulin & Glucose Modulation:

Calyx: Enhancement of Glucose Tolerance and Insulin Secretion possibly with Pancreatic Islet Preservation in Streptozotocin-Induced Diabetic Rats.

Flowers: Beneficial in postprandial glucose regulation but less effective in long-term glycaemic control

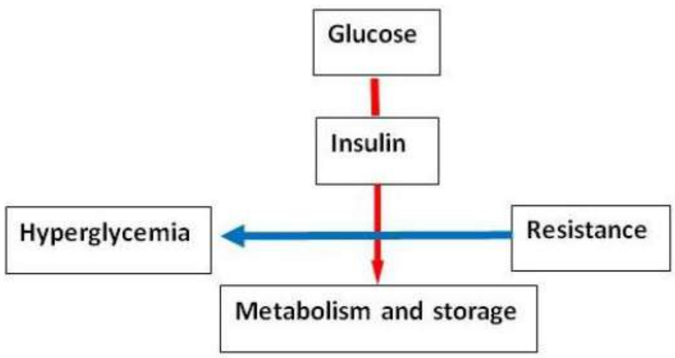


Figure III

1.4 Pathogenesis of Diabetes:

Diabetes is not a disease which is developed by single factor. No doubt Insulin is key factor but insulin concentration and secretions, Insulin resistance which contribute to lipid metabolism, and Liver function has key role -make it is a complex process. The stress and Cortisol secretion further effect Insulin resistance and diabetes Commencement.

So, if we want ourself to protect from T2DM we have to make life style changes or follow a protocol which will keep our Circadian Rhythm of Insulin secretion and utilization optimum.

Various factors like lack of Insulin secretion, Insulin resistance caused by number of factors including Obesity, NAFDL, Stress induced diabetes with role of cortisol are chief contributors for Type 2 Diabetes:

Stress and Glucocorticoid-Mediated Metabolic Dysregulation

1.Stress, whether acute or chronic, shows an impact on physiological response primarily mediated by glucocorticoids (GCs) and catecholamines. Chronic stress, in particular, causes the development of type II diabetes mellitus. GCs play a decisive role in metabolic regulation by enhancing hepatic gluconeogenesis, impairing peripheral glucose uptake, and promoting insulin resistance. Uninterrupted increase of GCs levels disrupts glucose homeostasis, contributing to hyperglycaemia and increasing Predisposition to metabolic disorders such as obesity and type II diabetes.

Cortisol, the primary stress hormone, promotes insulin resistance in peripheral tissues via multiple

pathways:

1.6 Phytochemical Profile:

Active Components of *Hibiscus sabdariffa* Calyx and Flowers:

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Although both calyces and flowers share several phytochemical classes, their relative composition differs, thereby influencing therapeutic potential.

1.7 Experimental Data: Serum Insulin and Glucose modulation: Role of *Hibiscus sabdariffa* :

Calyx (HS-EE): In streptozotocin (STZ)-induced diabetic rats, calyx ethanolic extract shows improved glucose tolerance, increased insulin secretion, and preserved pancreatic islet morphology.

1.8. Role in Diabetes Management:

Calyx Extracts: Improve insulin sensitivity, reduce HbA1c, inhibit α-amylase and α-glucosidase, and protect β-cells from oxidative stress.

Flower Extracts: Rich in flavonoids, strongly inhibit carbohydrate-digesting enzymes, improve postprandial glucose, and polysaccharides enhance gut microbiota diversity

Flowers: Comparable animal studies revealed improvement in postprandial glucose but weaker long-term hypoglycaemic effects compared to calyx.

Calyx is especially rich in anthocyanins and organic acids responsible for glucose lowering and liver protection.

Flower contains more flavonoids, which add anti-inflammatory and antidiabetic effects.

For diabetes management, these components work via antioxidant mechanisms and insulin sensitivity improvement.

In non-diabetic glucose control, anthocyanins and polysaccharides from both parts decrease post-meal glucose spikes.

1.9. Role in Hepatic Steatosis:

Calyx Extracts: Activate[5] IRS-1/Akt and Nrf2 pathways, reduces hepatic triglycerides, improve ALT/AST, and normalises liver histology in NAFLD models.

Flower Extracts: Show milder lipid regulation but provide anti-inflammatory and antifibrotic effects due to luteolin, apigenin, and polysaccharides.

Calyx extracts: exert stronger direct anti-steatosis effects, while flower extracts provide adjunctive anti-inflammatory and gut-mediated support.

2.Structure Elucidation of Anthocyanins:

Spectrophotometric and chromatographic studies confirm that calyces are the primary source of anthocyanins, particularly delphinidin and cyanidin glycosides. A recent study reported a prominent absorbance peak at 535 nm in calyx ethanolic extracts, consistent with anthocyanin signatures.

Table II: UV Analysis of HS-EE Extract ISFAL Analytical Report[8]

Extract	Wave length	Bio -Compound Shown
Raw HS-EE	252 nm (Peak 1)	Hydro benzoic acid and flavanols
Raw HS-EE	535 nm (Peak II)	Anthocyanin
Raw HS-EE	664 nm (Peak I)	Cyanidin -3-glucoside

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Spectrum Active Graph

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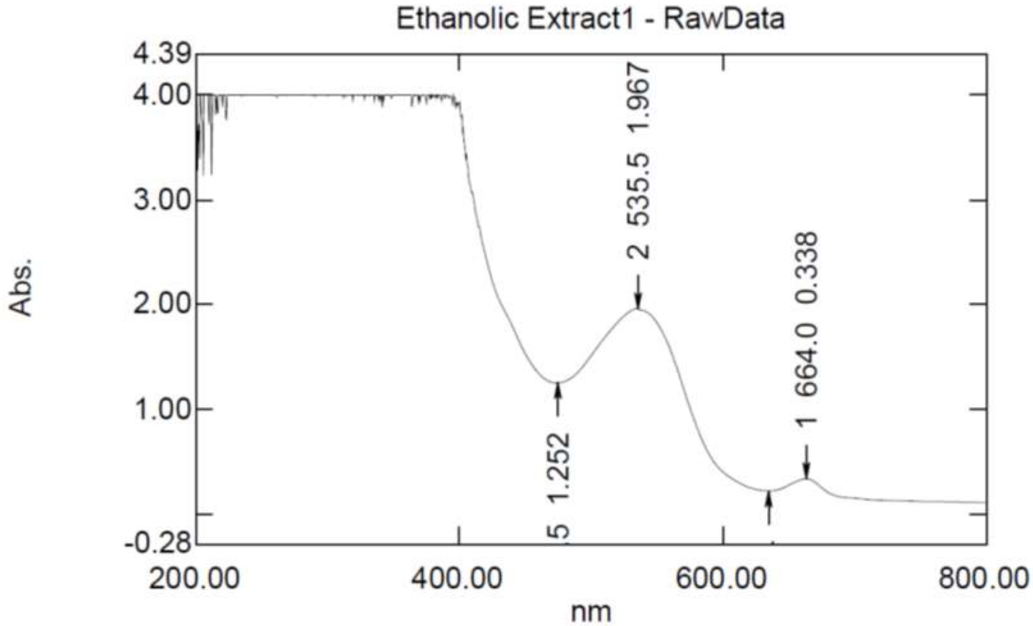


[Summary]

Data Information	
Data is:	Measurement Data
Data Set Name:	RawData
Sample Name:	Ethanolic Extract
Sample ID:	
Option:	
Analyst:	Atul Verma
Date/Time:	09/24/2024 10:41:04 AM
Comments:	
Parameter File Name:	D:\UVVis-Data\Parameter\Ethanolic Extract.vspm
Report File Name:	
Software Information	
Software Name:	LabSolutions UV-Vis
Version:	1.12
Instrument Information	
Instrument Name:	UV
Instrument Type:	UV-1900 Series
Model (S/N):	1900i (A12535981950)

[Measurement Parameters]

[Measurement]	
Start:	800 nm
End:	200 nm
Data Interval:	0.5 nm
Scan Speed:	High speed
Spectrum Type:	Absorbance
[Accessories]	
Accessories:	None
[Advanced]	
Slit Width:	1.0 nm
Light Source Switch Wavelength:	340.00 nm
S/R Switch:	Standard
[Repeat]	
Repeat Measurement:	OFF
[Post-processing]	
Spectrum Transformation:	OFF
Data Processing Table:	OFF
Print:	OFF

Page 1 / 1

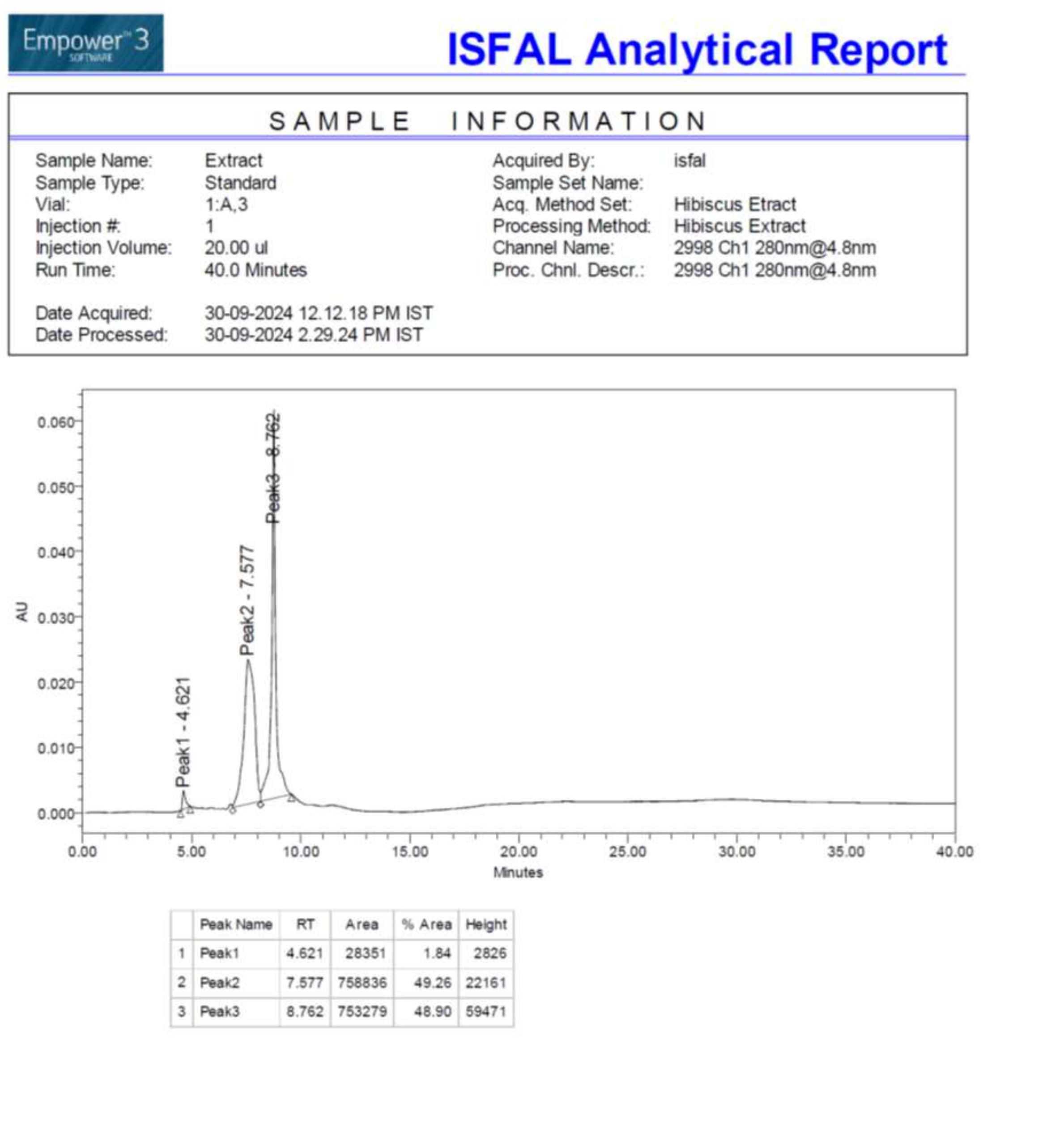
The absorption spectra of anthocyanin extracts from *Hibiscus sadariffa* often shows maximum absorption at wavelength between 505-535nm accordingly[6] to a study published by IOP sciences. A UV peak at 535 nm[7] in *Hibiscus sabdariffa is* indicative of presence of anthocyanins. Specifically, this wavelength is within absorption range of anthocyanin which are the pigments responsible the red colour of *Hibiscus sabdariffa*.

Table 3: HPLC Analysis ISFAL Analytical Report

Extract	RT (Retention time	Bio - Compound Shown	
Extract HS-EE Peak 1	4.62	delphinidin-3-O sambubioside	
Extract HSEE Peak 2	7.57	chlorogenic acid	
Extract HS-EE Peak3	8.76	cinnamic derivative or a related phenolic compound	

In HPLC [8]analysis of *Hibiscus sabdariffa* calyces, a retention time (RT) of 4.62 minutes is commonly associated with quercetin.

In *Hibiscus sabdariffa*, an HPLC retention time (RT) of 7.57 often indicates the presence of the compound quercetin. Quercetin is a flavonoid with antioxidant and anti-inflammatory properties, commonly found in various plant extracts. While a retention time (RT) of 8.72 minutes often corresponds to the presence of delphinidin 3-O-sambubioside, a major anthocyanin compound, along with other related compounds like gossypetin, hibiscetin, quercetin, and sabdaretin (flavonoids).



Empower 3 SOFTWARE

ISFAL Analytical Report

SAMPLE INFORMATION

Sample Name:	Extract	Acquired By:	isfal
Sample Type:	Standard	Sample Set Name:	
Vial:	1:A,3	Acq. Method Set:	Hibiscus Etract
Injection #:	1	Processing Method:	Hibiscus Extract
Injection Volume:	20.00 ul	Channel Name:	2998 Ch1 280nm@4.8nm
Run Time:	40.0 Minutes	Proc. Chnl. Descr.:	2998 Ch1 280nm@4.8nm
Date Acquired:	30-09-2024 12.12.18 PM IST		
Date Processed:	30-09-2024 2.29.24 PM IST		

	Peak Name	RT	Area	% Area	Height
1	Peak1	4.621	28351	1.84	2826
2	Peak2	7.577	758836	49.26	22161
3	Peak3	8.762	753279	48.90	59471

Calyx extracts are anthocyanin-rich, conferring strong antioxidant, antidiabetic, and anti-steatosis properties.

Flower extracts are richer in flavonoids and polysaccharides, supporting enzyme inhibition, lipid regulation, and gut microbiota–mediated metabolic improvements.

2.1 Comparative Scope in Diabetes Cure and Prophylaxis:

Calyx Extracts

Rich in anthocyanins → Improve insulin sensitivity, reduce fasting glucose, and lower HbA1c in preclinical models.

Inhibit α-amylase and α-glucosidase → Attenuate postprandial glucose spikes.

Protect- pancreatic β-cells from oxidative stress–induced dysfunction.

Flower Extracts

Higher flavonoid content → Strong inhibition of carbohydrate-digesting enzymes, indicating utility in postprandial hyperglycaemia control.

Polysaccharides → Enhance gut microbiota diversity and may indirectly improve insulin sensitivity.

Preliminary evidence suggests possible synergistic effects with probiotics for glycaemic regulation.

2.2. Role in Diabetes Management:

Calyx Extracts: Improve insulin sensitivity, reduce HbA1c, inhibit[3] digestive enzymes (α-amylase and α-glucosidase), and protect β-cells from oxidative stress.

Flower Extracts: Rich in flavonoids and polysaccharides, strongly inhibit carbohydrate-digesting enzymes, improve postprandial glucose tolerance, and enhance gut microbiota diversity.

Evidence from carbohydrate metabolism studies further supports these findings.

Hibiscus[9]protocatechuic acid (PCA), a phenolic acid isolated from Hibiscus sabdariffa L.

Figure IV

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Protocatechuic acid (PCA) Ethanol and aqueous extraction (flower)[10] Antioxidant, hepatoprotective, hypoglycaemic properties.

2.3 Pharmacological activity of protocatechuic acid:

The review has systematically evaluated the affirmation from clinical trials the hypoglycaemic activity of HS. A random effect model is a type of statistical model used to analyse data where observations are grouped and where those groups may influence the outcome in unpredictable ways. Main 5 namely total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoproteins (LDL), and triglyceride (TG) fasting plasma glucose (FPG were estimated in the study. The result of this meta-analysis clearly shows that HS has antidiabetic activity, whereas its lipid-lowering effect needs further study.

The study[11] infers that possible antidiabetic mechanism in STZ diabetes is by induction of β-cell regeneration along with its strong antioxidant potential of Hibiscus sabdariffa L.

2.4. Integrated Use and Future Directions:

Recent literature highlights the potential of combining calyx and flower extracts for synergistic therapeutic effects:

1. Calyx: Predominantly hypoglycaemic, anti-obesity, and anti-steatosis activity.
2. Flowers: Immunomodulatory, anti-inflammatory, and microbiota-enhancing effects.

Future clinical trials are needed to test standardized formulations, particularly in populations with prediabetes and non-alcoholic fatty liver disease (NAFLD).

Notably, the lack of standardization in phytochemical characterization has limited comparability across studies. While more recent research reports concentrations of presumed active principles, complete extract profiling remains uncommon, which is essential for therapeutic validation.

Although both calyces and flowers share phytochemical similarities, their relative composition differs, influencing therapeutic potential.

Calyx extracts are anthocyanin-rich, making them potent in antioxidant, antidiabetic, and anti-steatosis activity.

Flower extracts are relatively richer in flavonoids and polysaccharides, contributing to enzyme inhibition, lipid regulation, and potential gut-mediated metabolic benefits.

2.5. Role in Diabetes Management:

Calyx Extracts: Improve insulin sensitivity, reduce HbA1c, inhibit α-amylase and α-glucosidase, and protect β-cells from oxidative stress.

Flower Extracts: Rich in flavonoids, strongly inhibit carbohydrate-digesting enzymes, improve postprandial glucose, and polysaccharides enhance gut microbiota diversity.

The lack of standardization[12] of phytochemical components of the extracts of Hibiscus sabdariffa L. (HS-EE and water extract) make it difficult to conduct comparative studies between calyx and flowers. However recent studies are trying to mention the concentration of active components.

Future clinical studies are required to test standardized formulations in prediabetic and NAFLD populations.

Conclusion:

In current study we tried to enlist the bio-active components of Hibiscus sabdariffa calyx and flowers.

We have seen that Anthocyanins present on Hibiscus sabdariffa calyx extract Delphinidin-3-sambubioside, Cyanidin-3-sambubioside in high concentration than flowers.

It has been proven by animal experiments and human trials that Hibiscus sabdariffa calyx is useful as anti-diabetic by virtue of its high anthocyanin contents produces its action by different modes like by reducing post prandial blood glucose levels, reducing insulin resistance or by increasing insulin production. The flowers are less useful for same.

The flowers are good for improving gut microbiota and strategy of reducing carbohydrate digestibility by controlling the activity of two hydrolysing enzymes α-glucosidase and α-amylase which has linkage for whole cereal foods on prevention of hyperglycaemia is considered as viable prophylactic measure in T2DM and prediabetics.

The Phenolic acids Chlorogenic acid, Protocatechuic acid (abundant)in calyx and Caffeic acid, Ferulic acid, Syringic acid Attenuation of oxidative stress, reduction of lipid peroxidation while organic acids

Hydroxycitric acid, Hibiscus acid cause regulation of adipogenesis and fat storage and hence has role in fat metabolism and reduces obesity and liver steatosis.

References:

1. Ward, Z. J. (2025). Estimating trends in non-communicable disease mortality: implications for global health data and policy research. The Lancet.
2. Bhawan, N. (2011). Government of India Ministry of Health & Family Welfare. Np, Dec.
3. Suhartika, J. A. P. (2024). Pharmacological effect of Hibiscus sabdariffa Linn to prevent insulin resistance. JMPAS, 13(I3), 6525.
4. Jamini, T. S., Islam, A. K. M. A., Mohi-ud-Din, M., & Saikat, M. (2019). Phytochemical composition of calyx extract of roselle (Hibiscus sabdariffa L.) genotypes. J Food Tech Food Chem, 2(102), 2.
5. Prasomthong, J., et al. (2022). Hibiscus sabdariffa extract improves hepatic steatosis in HFD rats. Scientific Reports, 12, 7022. https://doi.org/10.1038/s41598-022-10957-7
6. Maciel, L. G., do Carmo, M. A. V., Azevedo, L., Daguer, H., Molognoni, L., de Almeida, M. M.& Rosso, N. D. (2018). Hibiscus sabdariffa anthocyanins-rich extract: Chemical stability, in vitro antioxidant and antiproliferative activities. Food and Chemical Toxicology, 113, 187-.
7. Yuniati, Y., Elim, P. E., Alfanaar, R., &, H. S. (2021). Extraction of anthocyanin pigment from hibiscus sabdariffa l. by ultrasonic-assisted extraction. In IOP Conference Series: Materials Science and 197Engineering (Vol. 1010, No. 1, p. Kusuma 012032). IOP Publishing.
8. Sharma, R., & Malhotra, R. Hibiscus Sabdariffa L.(Malvaceae): Phytochemical Study of Indigenously Grown and Biologically Authenticated Variety.
9. Tseng, T. H., Hsu, J. D., Lo, M. H., Chu, C. Y., Chou, F. P., Huang, C. L., & Wang, C. J. (1998). Inhibitory effect of Hibiscus protocatechuic acid on tumor promotion in mouse skin. Cancer letters, 126(2), 199-207.
10. 10.Hindawi Publishing Corporation ISRN Pharmacology Volume 2014, Article ID 952943, 9 pages http://dx.doi.org/10.1155/2014/952943
11. Adeyemi, D. O., & Adewole, O. S. (2019). Hibiscus sabdariffa renews pancreatic β-cells in experimental type 1 diabetic model rats. Morphologie, 103(341), 80-93. Keep 12 th reference4 it is gfood study on standardization of herbal products.
12. Pathrikar, S. Y., Mukhmale, V. S., Deshmukh, N. B., & Deshmukh, S. P. (2025). Standardization extraction and phytochemical screening for herbal drugs. 1Carvajal-Zarrabal O, Barradas-Dermitz DM, Orta-Flores Z, Hayward-Jones PM, Nolasco-Hipólito C, Aguilar-Uscanga MG, Miranda-Medina A, Bujang KB. Hibiscus sabdariffa L., roselle calyx, from ethnobotany to pharmacology. J Exp Pharmacol. 2012 Feb 28;4:25-39.

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