

Isolation and Establishment of Quantitative Scale for Anti-Diabetic Nutrients Present in Fruits and Vegetables

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Abstract: *Diabetes Mellitus is a chronic metabolic disorder associated with the persistent hyperglycaemia and represents a significant global health challenge due to its increasing prevalence and long term complication, In recent years, growing attention has been directed towards naturally derived antidiabetic agents owing to their potential safety and multi-targeted mechanism of action. Fruits and Vegetables are known to contain diverse bioactive compounds that may contribute to glucose regulation. However, systematic quantitative characterisation of these constituents remains limited. The present study aims to isolate, characterise and quantitatively evaluate antidiabetic components from selected fruits and vegetables. Fourier Transform Infrared Spectroscopy was employed to identify characteristic functional groups. The analytical profiling of plant-derived samples were compared with standard antidiabetic drugs, including metformin hydrochloride, Sitagliptin phosphate, glimepiride and glibenclamide. The FTIR Spectra revealed the presence of functional groups commonly associated with bioactive phytochemicals, indicating potential anti-diabetic relevance..*

Keywords: Antidiabetic, plantbioactives, FTIR Spectroscopy, functional group analysis, drug samples

I. INTRODUCTION

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia, posing a significant global health challenge due to its increasing prevalence and long-term complications [1, 2]. The World Health Organization (WHO) estimates that the global prevalence of diabetes has risen substantially over the past decades and is projected to become one of the leading causes of mortality worldwide [2, 3].

Current treatment strategies for DM often involve synthetic antidiabetic agents such as metformin, glimepiride, and glibenclamide [4, 7]. Although these pharmacological agents are clinically effective, they may be associated with adverse effects, secondary treatment failure, and economic burden [5, 8].

In recent years, growing attention has been directed toward naturally derived antidiabetic agents owing to their potential safety, multi-targeted mechanism of action, and cost effectiveness [9, 10]. Several medicinal plants and dietary sources have demonstrated promising glucose-modulating activity through enzyme inhibition, antioxidant activity, and improvement of insulin sensitivity [11, 18].

Fruits and vegetables such as bhindi (*Abelmoschus esculentus*), jamun (*Syzygiumcumini*), bitter gourd (*Momordica charantia*), tomato (*Solanum lycopersicum*), cabbage (*Brassica oleracea* var. *capitata*), palak (*Spinacia oleracea*), blueberry (*Vaccinium corymbosum*), and cherry contain diverse bioactive compounds including flavonoids, phenolic acids, alkaloids, and terpenoids, which may contribute to glucose regulation and metabolic balance [6, 11, 16].

Despite the therapeutic potential of plant-derived compounds, systematic quantitative characterization of these bioactive constituents remains limited. Analytical identification and structural evaluation of antidiabetic components from natural sources are essential for developing safe and effective therapeutic alternatives [14, 15]. The identification of phytochemicals in fruits and vegetables may further promote their role in the management of DM and provide



additional benefits due to their antioxidant, anti-inflammatory, cardioprotective, and immunomodulatory properties [12, 13].

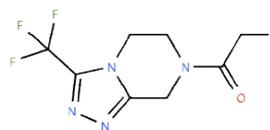
II. METHODOLOGY

2.1 Plant sample selected:

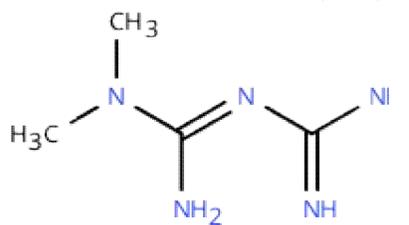
Fresh fruits and vegetables including bhindi (*Abelmoschus esculentus*), jamun (*Syzygiumcumini*), bitter gourd (*Momordica charantia*), tomato (*Solanum lycopersicum*), cabbage (*Brassica oleracea* var. *capitata*), palak (*Spinacia oleracea*), blueberry (*Vaccinium corymbosum*), and cherry were procured from local markets. Jamun seeds and pulp were separated manually and processed independently. All plant materials were cleaned thoroughly with distilled water prior to processing.

2.2 Drug sample selected

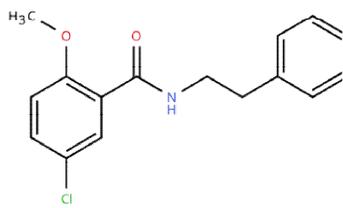
Standard antidiabetic drugs including Sitagliptin, metformin, glimepiride, and glibenclamide were obtained as active pharmaceutical ingredients. Due to solubility considerations, metformin hydrochloride and sitagliptin phosphate were included as water-soluble reference compounds for comparative Fourier Transform Infrared (FTIR) analysis.



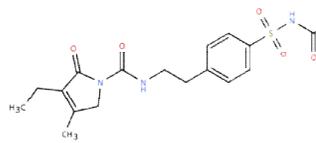
Structure of Sitagliptin



structure of Metformin



Structure of Glibenclamide



Structure of Glimepiride

2.3 Processing of samples

Selected samples were soaked overnight in water to obtain aqueous extracts, while others were subjected to sun drying, oven drying, and ashing to obtain powder. Both liquid and solid fractions were retained for analysis. Bhindi samples were processed as soaked material, sun-dried material, and ash. Palak and cabbage were processed as both liquid and solid fractions. Jamun was analyzed in the form of seeds and pulp. All the samples were analysed using Fourier Transform Infrared (FTIR).

III. EXPERIMENTAL DETAILS

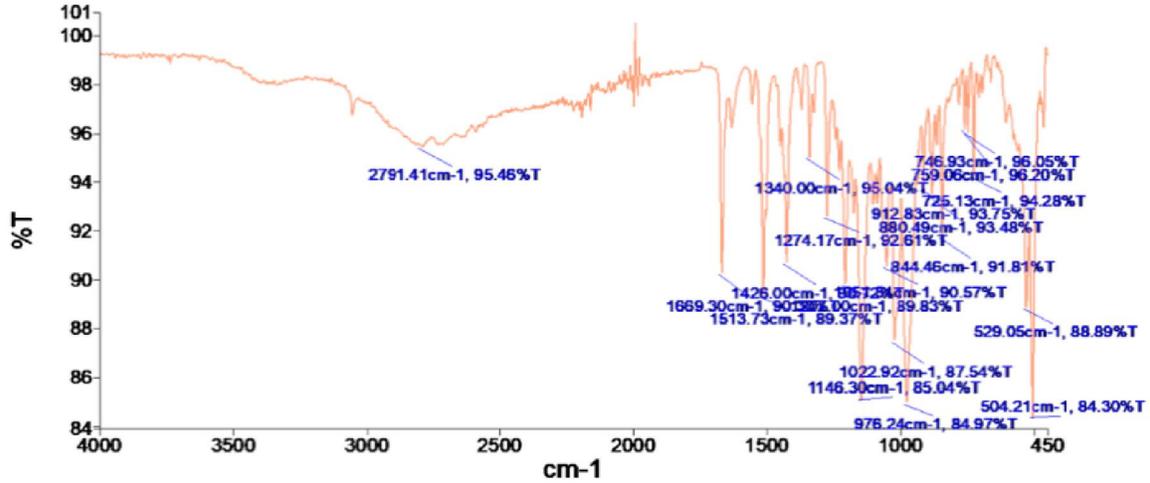
3.1 FTIR Analysis

Fourier Transform Infrared (FTIR) spectroscopy was employed to identify functional groups present in the plant extracts and standard antidiabetic drugs. Samples were prepared using appropriate sample preparation techniques, and spectra were recorded over a defined wavelength range. The obtained spectra were analyzed to identify characteristic absorption bands corresponding to functional groups commonly associated with bioactive phytochemicals.



3.2 FTIR results of drug samples

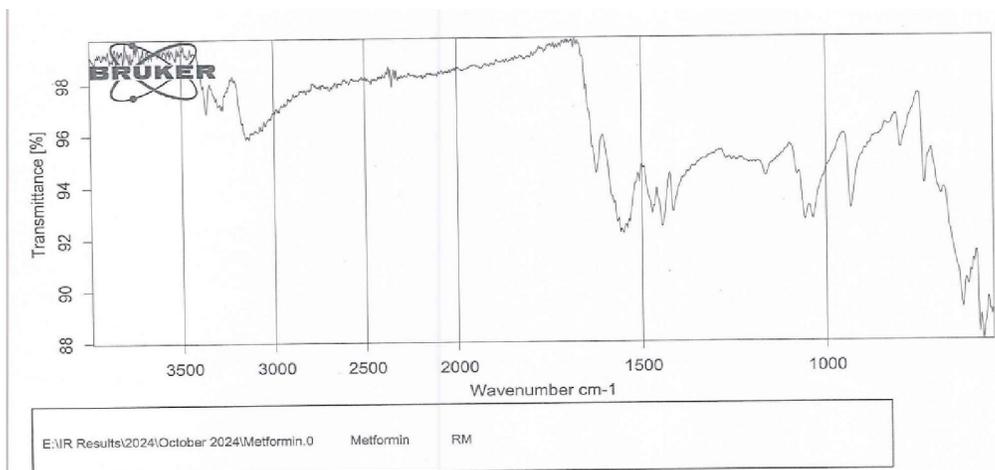
Figure 3.2.1: FTIR of Sitagliptin Phosphate with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	2791.41	95.46
2	1669.3	90.3
3	1513.73	89.37
4	1426	90.72
5	1340	95.04
6	1274.17	92.61
7	1207	89.83
8	1146.3	85.04
9	1051.51	90.57
10	1022.92	87.54
11	976.24	84.97
12	912.83	93.75
13	880.49	93.48
14	844.46	91.81
15	759.06	96.2
16	746.93	96.05
17	725.13	94.28
18	529.05	88.89
19	504.21	84.3



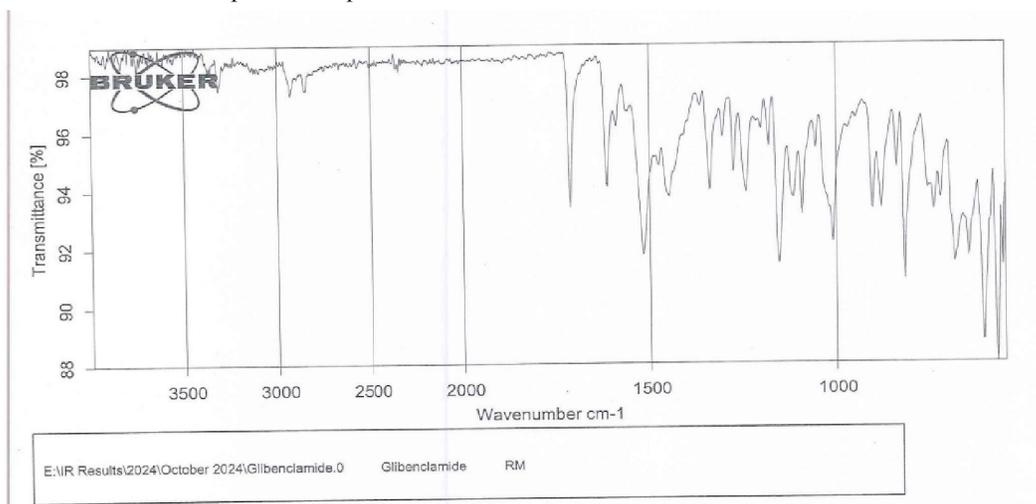
Figure 3.2.2 FTIR of Metformin Hydrochloride with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	3360	95
2	3280	94
3	3060	94
4	2920	93
5	2850	93
6	1705	76
7	1670	78
8	1595	76
9	1540	79
10	1490	88
11	1450	90
12	1375	82
13	1320	87
14	1240	84
15	1160	92
16	1100	90
17	1030	93
18	970	94
19	840	92
20	760	83
21	690	74
22	510	71



Figure 3.2.3: FTIR of Glimepiride with peak table:

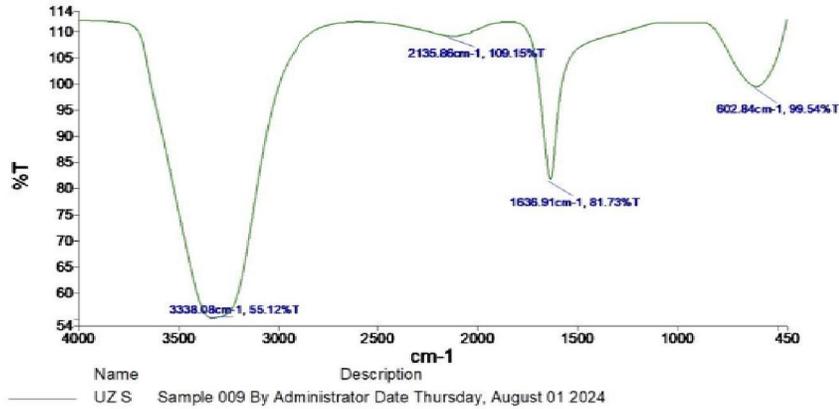


Peak Number	X (cm ⁻¹)	Y (%T)
1	3365	98
2	3310	97.8
3	3065	97.5
4	2925	97
5	2855	96.8
6	1715	94
7	1680	95
8	1595	92
9	1545	93
10	1495	94.5
11	1450	95
12	1375	94
13	1325	96
14	1250	93.5
15	1170	92
16	1105	94
17	1030	93.5
18	980	95
19	840	94
20	760	91.5
21	700	92.5
22	620	89



3.3: FTIR result for samples

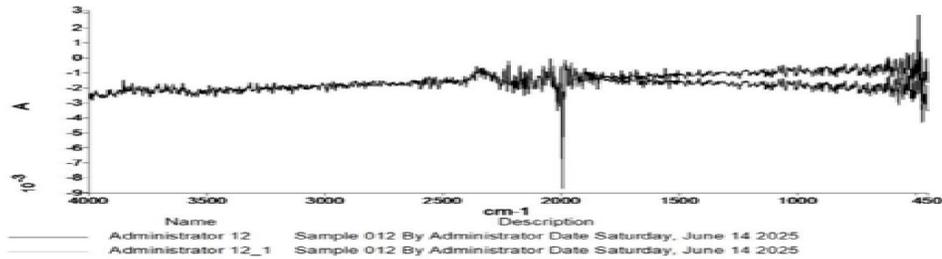
3.3.1: FTIR of Bhendi soaked overnight in water with peak table:



Peak Table

Peak Number	X (cm-1)	Y (%T)
1	3338.08	55.12
2	2135.86	109.15
3	1636.91	81.73
4	602.84	99.54

3.3.2: FTIR of Jamun seed with peak table:

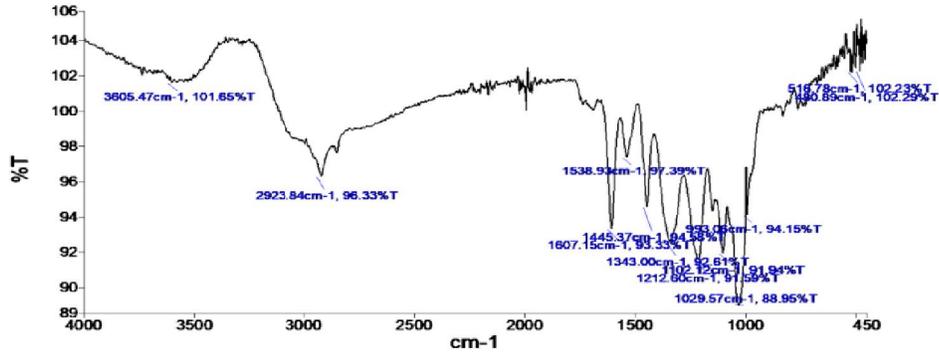


Summary

Sample Name	Description	Saved or unsaved State	Spectrum quality check summary
Administrator 12	Sample 012 By Administrator Date Saturday, June 14 2025	Not saved	The Quality Checks give rise to multiple warnings for the sample.
Administrator 12_1	Sample 012 By Administrator Date Saturday, June 14 2025	Not saved	The Quality Checks give rise to multiple warnings for the sample.

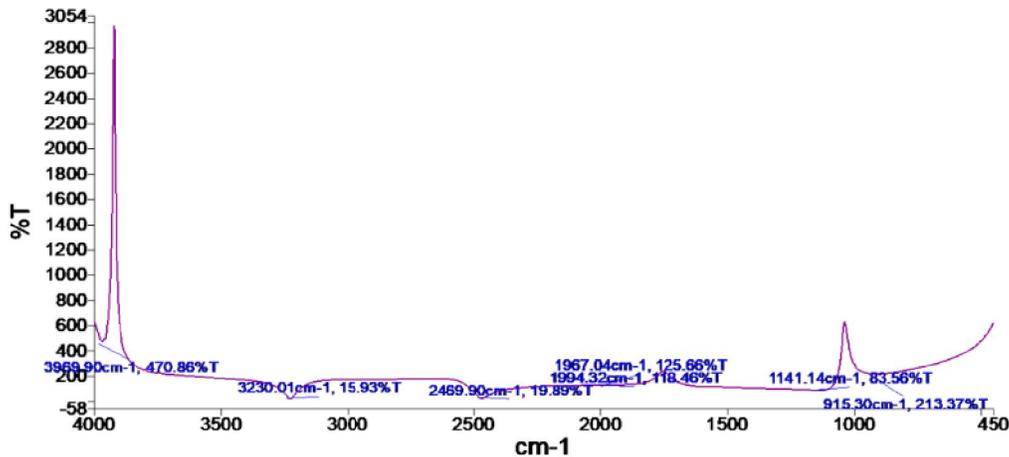


3.3.3: FTIR of Jamun pulp with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	3605.47	101.65
2	2923.84	96.33
3	1607.15	93.33
4	1538.93	97.39
5	1445.37	94.58
6	1343	92.61
7	1212.6	91.59
8	1102.12	91.94
9	1029.57	88.95
10	993.06	94.15
11	516.78	102.23
12	480.89	102.29

3.3.4: FTIR of Bhindi sundried with peak table:

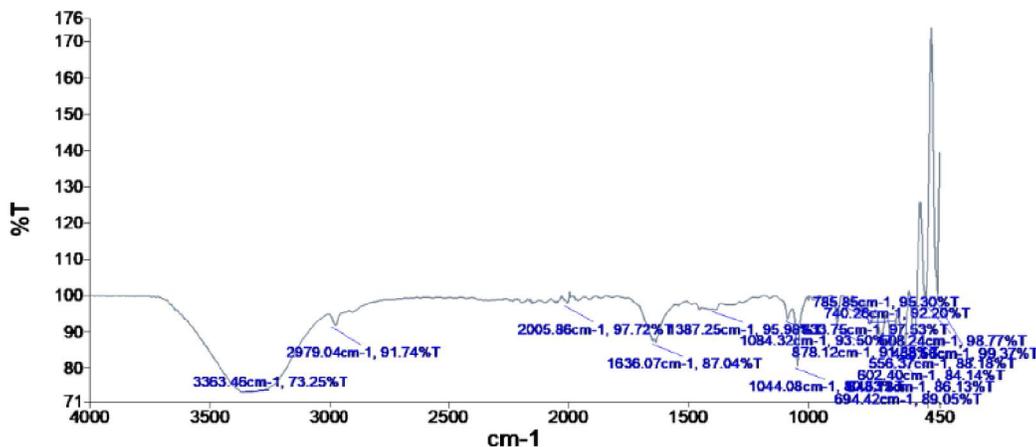


Peak Number	X (cm ⁻¹)	Y (%T)
1	3969.9	470.86
2	3230.01	15.93



3	2469.9	19.89
4	1994.32	118.46
5	1967.04	125.66
6	1141.14	83.56
7	915.3	213.37

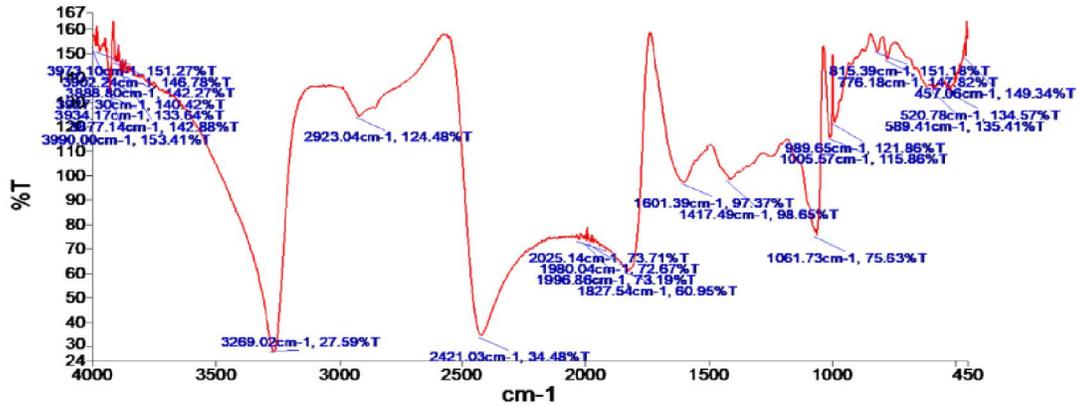
3.3.5: FTIR of Palak liquid with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	3363.46	73.25
2	2979.04	91.74
3	2005.86	97.72
4	1636.07	87.04
5	1387.25	95.98
6	1084.32	93.50
7	1044.08	80.53
8	878.12	91.83
9	833.75	97.53
10	785.85	95.30
11	740.26	92.20
12	694.42	89.05
13	648.13	86.13
14	602.40	84.14
15	556.37	88.18
16	508.24	98.77
17	458.56	99.37



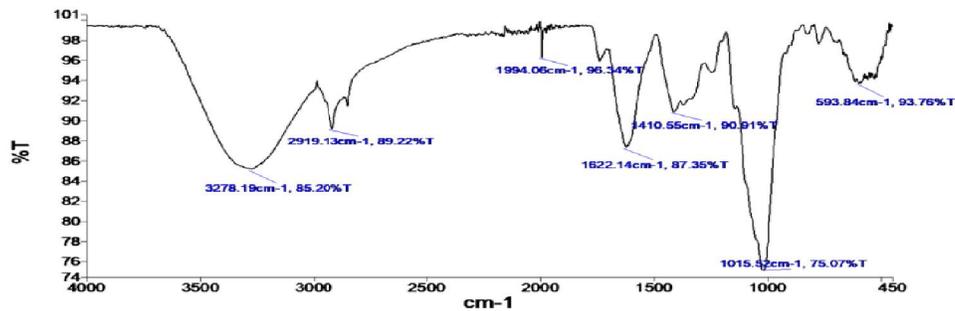
3.3.6: FTIR of Tomato sundried with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	3990	153.41
2	3973.1	151.27
3	3934.17	133.64
4	3927.3	140.42
5	3902.24	146.78
6	3888.8	142.27
7	3877.14	142.88
8	3269.02	27.59
9	2923.04	124.48
10	2421.03	34.48
11	2025.14	73.71
12	1996.86	73.19
13	1980.04	72.67
14	1827.54	60.95
15	1601.39	97.37
16	1417.49	98.65
17	1061.73	75.63
18	1005.57	115.86
19	989.65	121.86
20	815.39	151.18
21	776.18	147.82
22	589.41	135.41
23	520.78	134.57
24	457.06	149.34

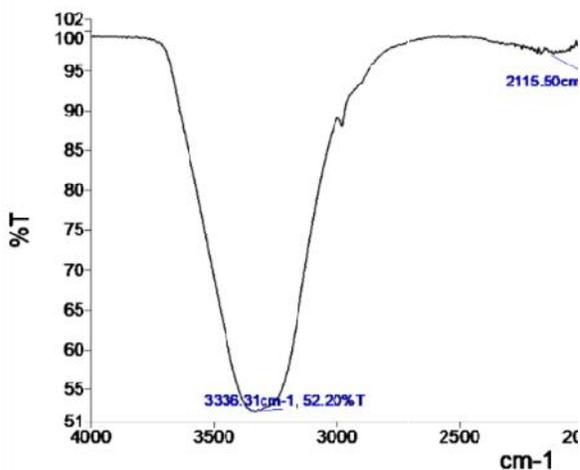


3.3.7: FTIR of Cabbage powder with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	3278.19	85.2
2	2919.13	89.22
3	1994.06	96.34
4	1622.14	87.35
5	1410.55	90.91
6	1015.52	75.07
7	593.84	93.76

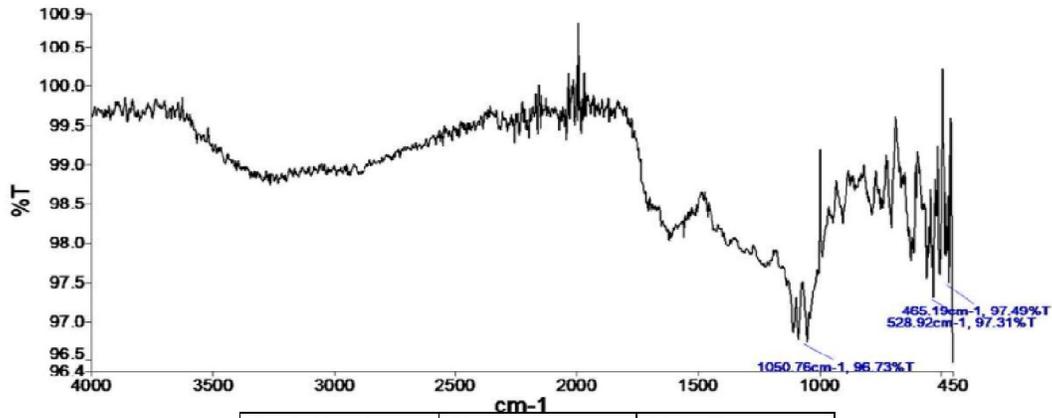
3.3.8: FTIR of Cabbage liquid with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	3336.31	52.2
2	2115.5	97.25
3	1638.09	74.12
4	1084.54	94.32
5	1044.63	85.18
6	877.94	95.83
7	627.73	86.24

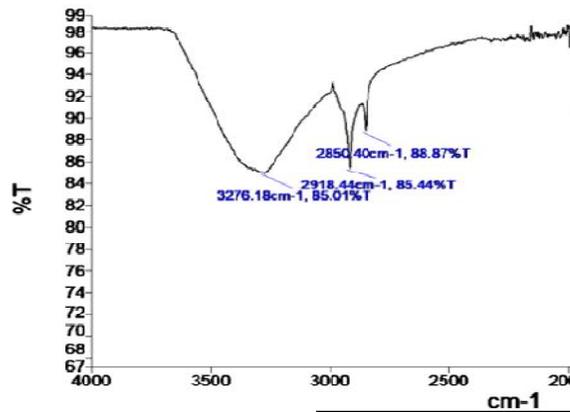


3.3.9: FTIR of Bhindi Ash with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	1050.76	96.73
2	528.92	97.31
3	465.19	97.49

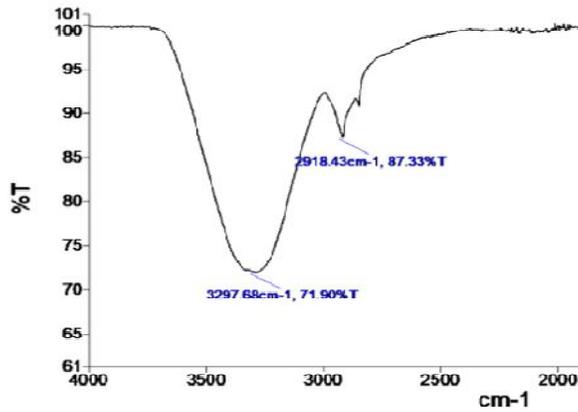
3.3.10: FTIR of Palak powder with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	3276.18	85.01
2	2918.44	85.44
3	2850.4	88.87
4	1739.77	92.66
5	1623.19	68.00
6	1440.57	86.14
7	1312.02	79.06
8	1240.12	86.49
9	1026.57	74.14
10	774.42	92.39
11	620.58	93.79
12	512.91	90.49

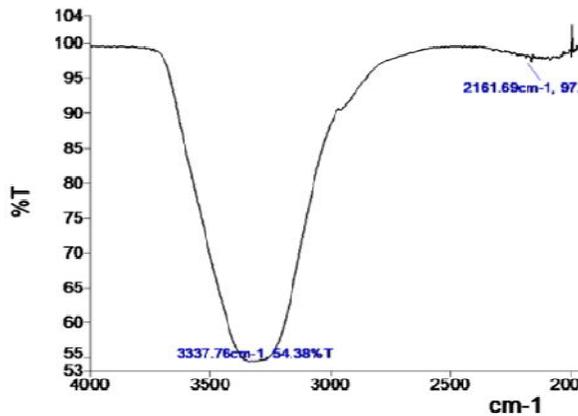


3.3.11: FTIR of Blueberry Liquid with peak table:



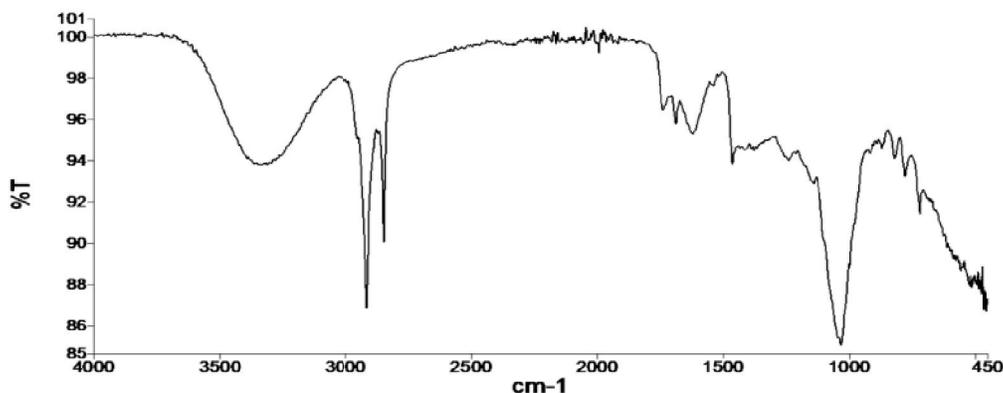
Peak Number	X (cm ⁻¹)	Y (%T)
1	3297.68	71.9
2	2918.43	87.33
3	1634.41	87.57
4	1420.92	91.88
5	1030.23	62.22
6	818.73	96.83
7	777.57	95.41
8	585.74	90.44

3.3.12: FTIR of Cherry with peak table:



Peak Number	X (cm ⁻¹)	Y (%T)
1	3337.76	54.38
2	2161.69	97.41
3	1637.45	73.56
4	1419.52	93.62
5	1031.46	84.47
6	591.28	85.89
7	557.97	86.88
8	500.06	89.83
9	486.14	92.79
10	473.64	92.09
11	451.73	97.52

3.3.13: FTIR of Blueberry oven dried with peak table:



Summary

Sample Name	Description	Saved or unsaved State	Spectrum quality check summary
Administrator 13	Sample 013 By Administrator Date Saturday, June 14 2025	Saved	The Quality Checks give rise to a Weak Bands warning for the sample.

IV. RESULTS

IV(A): FTIR Spectral Characterization

FTIR analysis of the plant extracts revealed the presence of characteristic functional groups, including hydroxyl (–OH), carbonyl (C=O), amine (–NH), and aromatic groups. These functional groups are commonly associated with polyphenols, flavonoids, and other bioactive phytochemicals. Comparative evaluation of the FTIR spectra of plant



extracts and standard antidiabetic drugs demonstrated notable similarities in functional group patterns, suggesting potential pharmacological relevance of the plant-derived components.

Bhindi extracts exhibited prominent hydroxyl and carbonyl absorption bands, while jamun seed extracts showed distinct spectral features indicative of a rich phytochemical composition. Palak, cabbage, tomato, blueberry, and cherry extracts displayed varied spectral profiles, reflecting differences in their bioactive content based on plant type and processing method.

IV (B): Comparative FTIR Analysis with Standard Drugs:

Comparative analysis of FTIR spectra revealed similarities between functional group patterns observed in plant extracts and those present in standard antidiabetic drugs. These similarities suggest potential overlap in chemical functionalities that may contribute to glucose-modulating activity. Jamun seed extracts, in particular, demonstrated functional group profiles closely aligned with those of the reference drug samples.

Table 1: Comparison with Sitagliptin Drug

Sitagliptin Peak (cm ⁻¹)	Matching food IR	Functional group	Match Classification
3400	Jamun pulp, Palak liquid, cabbage liquid	O-H/N-H stretching	Most match
2920	Jamun pulp, Tomato sundried, Blueberry liquid	C-H stretching	Moderate match
1700	Palak liquid, Tomato sundried, Cabbage liquid	C=O stretching	Most match
1600	Jamun pulp, Bhindi sundried, Cherry	Aromatic C=C stretching	Moderate match
1400	Bhindisundried, Palak solid	C-N stretching/CH ₂ Stretching	Moderate match
1150	Blueberry liquid, Cabbage Solid	C-O Stretching	Moderate match
850	Bhindi ash	Out-of-plane C-H bending	Least match

Table 2: Comparison with Metformin Drug

Metformin Peak (cm ⁻¹)	Matching Food IR	Functional Group	Match Classification
3822.2	Jamun Pulp, Tomato sundried, Cabbage Solid, Cherry	Other/fingerprint region	Most Match
3924.9	Cabbage solid	Other/fingerprint region	Moderate match
471.1	None	Other/fingerprint region	Least match
3561.4	Tomato sundries, Cabbage solid, Okra ash	O-H/N-H stretching	Most Match
1190.3	None	C-O stretching/fingerprint	Least match



Table 3: Comparison with Glimepiride Drug

Glimepiride Peak (cm ⁻¹)	Matching Food IR	Functional Group	Match Classification
447.6	None	Other/fingerprint region	Least Match
3789.9	Bhindi sundried, Palak liquid, Tomato sundried, Cabbage solid	Other/fingerprint region	Most Match
3893.0	Cabbage solid, Okra ash, Blueberry liquid	Other/fingerprint region	Most Match
3742.3	Jamun pulp, Palak liquid, Tomato sundried, Cabbage liquid	Other/fingerprint region	Most Match
3702.6	Bhindi sundried	Other/fingerprint region	Moderate Match

V. CONCLUSION

This study presents a systematic FTIR-based comparative evaluation of selected fruits and vegetables against established antidiabetic drug standards to assess functional group convergence at the molecular level. Spectral profiling confirmed the widespread presence of hydroxyl, carbonyl, amine, and aromatic functionalities across the investigated plant matrices—chemical environments frequently associated with metabolically active phytoconstituents.

Comparative vibrational analysis demonstrated consistent overlap between plant-derived samples and reference pharmaceuticals within critical spectral regions, particularly 3200–3400 cm⁻¹ (–OH/–NH stretching), 1700–1600 cm⁻¹ (carbonyl and conjugated systems), and 1300–1000 cm⁻¹ (C–O/C–N stretching). Among the evaluated samples, *Syzygiumcumini* (jamun) seed exhibited the closest functional group alignment with the drug spectra, indicating a structurally dense phytochemical composition with potential pharmacophoric relevance. Bhendi (*Abelmoschus esculentus*) and palak (*Spinacia oleracea*) also demonstrated notable spectral correspondence.

Processing conditions were observed to influence spectral intensity and definition. Dehydrated samples showed enhanced peak resolution, suggesting concentration of organic constituents, whereas ash samples displayed reduced organic signatures, confirming degradation of bioactive frameworks. These findings emphasize the importance of controlled preprocessing in phytochemical characterization.

Although FTIR analysis does not confirm molecular identity or biological activity, the demonstrated functional group convergence provides structural evidence supporting the biochemical plausibility of selected plant matrices in metabolic modulation. The study establishes a preliminary analytical benchmark for correlating plant-derived chemical environments with synthetic antidiabetic pharmacophores.

Further investigations incorporating chromatographic separation, quantitative profiling, and bioactivity validation are warranted to translate these spectroscopic observations into therapeutic relevance. The present work contributes an analytical foundation for rational exploration of plant-based matrices in the context of diabetes research and phytopharmaceutical development.

VI CONFLICT OF INTEREST

If research is sponsored

VII. ACKNOWLEDGMENT

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