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Determination of pH, calcium oxide and ascorbic acid content from banana leaf, fruit and peel - their FTIR and SEM analysis

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Abstract

A banana is an elongated, edible fruit – botanically a berry produced by several kinds of large herbaceous flowering plants in the genus Musa. Raw bananas (not including the peel) are 75% water, 23% carbohydrates, 1% protein, and contain negligible fat. Banana fiber is used in the production of banana paper. The leaves contain apiin which is used to make nanoparticle products. Apiin is a natural flavonoid, a diglycoside of the flavone apigenin found in banana leaf. Present paper deals with determination of pH of Banana Leaf ash, Banana fruit powder and Banana Peel powder; determination of CaO content in a Banana Leaf Ash; determination of Ascorbic acid from Banana fruit powder and Banana peel powder. FTIR spectra of Banana Leaf Ash, Banana fruit powder, Banana Peel Powder, 1% solution of Banana Leaf Ash, Banana fruit powder, Banana Peel Powder was obtained at room temperature by using an FTIR Spectrophotometer - Shimadzu - IR Affinity – 1. The spectra are collected in range from 350 - 4700 cm^{-1}. Morphological graphs of the 1 % solution of Banana Leaf Ash, Banana fruit powder, Banana Peel Powder is provided by scanning electron microscopy (Digital Scanning Electron Microscope - JSM 6100 - JEOL) with a Link analytical system operating at 10 KV (acceleration voltage).

Keywords: pH, Calcium Oxide, Ascorbic Acid, Banana Leaf, Banana Fruit, Banana Peel, FTIR Analysis, SEM Analysis.

Introduction

Banana is an elongated, edible fruit – botanically a berry produced by several kinds of large herbaceous flowering plants in the genus Musa. Raw bananas (not including the peel) are 75% water, 23% carbohydrates, 1% protein, and contain negligible fat. A 100-gram reference serving supplies 89 Calories, 31% of the US recommended Daily Value (DV) of vitamin B6, and moderate amounts of vitamin C, manganese and dietary fiber, with no other micronutrients in significant content.

Although bananas are commonly thought to contain exceptional potassium content[1,2] their actual potassium content is not high per typical food serving, having only 8% of the US recommended Daily Value for potassium, and their potassium-content ranking among fruits, vegetables, legumes, and many other foods is relatively moderate.

Banana fiber is used in the production of banana paper. Banana paper is made from two different parts: the bark of the banana plant, mainly used for artistic purposes, or from the fibers of the stem and non-usable fruits. The paper is either hand-made or by industrial process[3].

Banana peel may have capability to extract heavy metal contamination from river water, similar to other purification materials[4,5]. In 2007, banana peel powder was tested as a means of filtration for heavy metals and radionuclides occurring in water produced by the nuclear and fertilizer industries (cadmium contaminant is naturally present in phosphates ores). When added and thoroughly mixed for 40 minutes, the powder can remove roughly 65% of heavy metals, and this can be repeated.

Waste bananas can be used to feed livestock[6]. The leaves contain apiin which is used to make nanoparticle products[7]. Apiin is a natural flavonoid, a diglycoside of the flavone apigenin found in banana leaf[7].

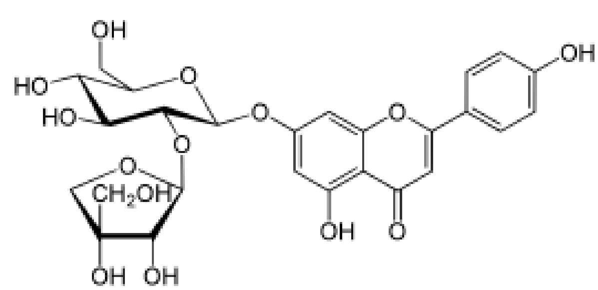


Figure-1: Apiin.

Weighted least square regression models were built for (i) estimating aboveground vegetative dry biomass (ABGVD) and corm dry biomass (cormD) and (ii) forecasting bunch fresh weight (bunchF), based on non-destructive parameters for two cultivars, Mchare Huti-Green Bell (HG, AA) and Cavendish Grande Naine (GN, AAA), under two irrigation regimes: full irrigation (FI) and rainfed (RF). Banana fruit is one of the commonly taken foods in many parts of the world[8]. The fruit is known for its high potassium content. The potassium content of eleven types of ripe banana fruit available in the cauvery delta region of South India was studied[9]. Review of 75 full-text articles published between 1985 and 2021 for information on mathematical models related to banana growth and, fruit and fibre yield was done. Results were analysed in order to provide a descriptive synthesis of selected studies[10]. A light detection and ranging sensor (LiDAR) laser scanner, emitting at 660 nm, was employed to analyse banana fruit (n = 180) with 0.9 m distance during fruit ripening for 8 d. A sample of 120 respondents were selected by multistage random sampling procedure from the study area[11]. The cost of cultivation and returns were estimated using various cost concepts viz; cost A, cost B, cost C1 and cost C2 [12]. Banana peels have attracted the attention of researchers due to their bioactive chemical components, so focused on the antioxidant and antimicrobial activities of banana peels that can be used as good sources of natural antioxidants and for pharmaceutical purposes in treating various diseases was done[13]. To predict the maturity of bananas, non-destructive methods to analyze changes in the sweetness and color of the stalks, middles, and tips of bananas during ripening was used[14].

Present paper deals with determination of pH of Banana Leaf ash, Banana fruit powder and Banana Peel powder; determination of CaO content in a Banana Leaf Ash; determination of Ascorbic acid from Banana fruit powder and Banana peel powder. FTIR spectra of Banana Leaf Ash, Banana fruit powder, Banana Peel Powder, 1% solution of Banana Leaf Ash, Banana fruit powder, Banana Peel Powder was obtained at room temperature by using an FTIR Spectrophotometer - Shimadzu - IR Affinity – 1.

The spectra are collected in range from 350 - 4700cm^{-1}. Morphological graphs of the 1% solution of Banana Leaf Ash, Banana fruit powder, Banana Peel Powder is provided by scanning electron microscopy (Digital Scanning Electron Microscope - JSM 6100 - JEOL) with a Link analytical system operating at 10 KV (acceleration voltage).

Methodology

Determination of pH: Determination of pH of Banana Leaf ash sample: Banana leaf was burned to get ash. Banana leaf ash was taken in varying amount of 1, 2, 3…..20 g. To it 100 ml distilled water was added and heated for 20 minutes. Solution was cooled and allowed to settle. And clear solution was filtered and its volume was made upto 100 ml. Then pH was noted.

Determination of pH of Banana fruit powder sample: Banana fruit was dried and crushed to get fine powder. 1g Banana fruit powder was taken. To it 100 ml distilled water was added and heated for 20 minutes. Solution was cooled and allowed to settle. And clear solution was filtered and its volume was made upto 100 ml. Then pH was noted.

Determination of pH of Banana Peel powder sample: Banana Peel was dried and crushed to get fine powder. 1g Banana peel powder was taken. To it 100 ml distilled water was added and heated for 20 minutes. Solution was cooled and allowed to settle. And clear solution was filtered and its volume was made upto 100 ml. Then pH was noted.

Table-1: Determination of pH.

System No.	Sample, g	Distilled Water	pH
Banana Leaf ash			
1	1	100 ml	8.0
2	2	100 ml	8.2
3	3	100 ml	8.3
4	4	100 ml	8.3
5	5	100 ml	8.3
6	6	100 ml	8.4
7	7	100 ml	8.4
8	8	100 ml	8.4
9	9	100 ml	8.4
10	10	100 ml	8.4
11	11	100 ml	8.8
12	12	100 ml	8.8
13	13	100 ml	8.9
14	20	100 ml	9.3
Banana fruit powder			
15	1	100 ml	6.1
Banana peel powder			
16	1	100 ml	14.0

Determination of CaO content in a Banana Leaf Ash: 10 ml solution of system No. 1 was taken in the conical flask. To it half test tube pH 10 buffer solution and 1-2 drops of Eriochrome Black T indicator was added. This solution was titrated with the 0.1N solution EDTA. End point was noted when wine red colored solution turns to blue. Similar titration was done with System No. 2 to 14.

Determination of Ascorbic acid from Banana fruit powder sample: 10ml solution of system No. 15 was taken in 100ml conical flask. To this 10ml of 0.1N iodine solution was added and shaken for 2 minutes. This solution was titrated with 0.1 Sodium thiosulphate till the solution become faint yellow colour. To this 1ml of freshly prepared starch solution was added, the solution becomes blue. Then titration was continued till the colour changes from blue to colourless. End point was noted. Procedure was repeated till 2 constant readings are obtained.

Blank Titration: In 100ml conical flask10ml of 0.1N iodine solution was taken and shaken for 2minutes. This solution was titrated with 0.1 Sodium thiosulphate till the solution become faint yellow colour. To this 1ml of freshly prepared starch solution was added, the solution becomes blue. Then titration was continued till the colour changes from blue to colourless. End point was noted. Procedure was repeated till 2 constant readings are obtained.

Determination of Ascorbic acid from Banana peel powder sample: 10ml solution of system No. 16 was taken in 100ml conical flask. To this 10ml of 0.1N iodine solution was added and shaken for 2 minutes. This solution was titrated with 0.1 Sodium thiosulphate till the solution become faint yellow colour. To this 1ml of freshly prepared starch solution was added, the solution becomes blue. Then titration was continued till the colour changes from blue to colourless. End point was noted. Procedure was repeated till 2 constant readings are obtained.

Blank Titration: In 100ml conical flask10ml of 0.1N iodine solution was taken and shaken for 2 minutes. This solution was titrated with 0.1 Sodium thiosulphate till the solution become faint yellow colour. To this 1ml of freshly prepared starch solution was added, the solution becomes blue. Then titration was continued till the colour changes from blue to colourless. End point was noted. Procedure was repeated till 2 constant readings are obtained.

FTIR Analysis: FTIR can be routinely used to identify the functional groups. FTIR spectra of Banana Leaf Ash, Banana fruit powder, Banana Peel Powder, Banana Leaf Ash system No. 1, Banana fruit powder system No. 15, Banana Peel Powder system No. 16 was obtained at room temperature by using an FTIR Spectrophotometer - Shimadzu - IR Affinity – 1. The spectra is collected in range from 350 - 4700 cm^{-1}.

SEM Analysis: The Electron Microscope is an essential component for scientific analysis of a variety of materials. Scanning Electron Microscope (SEM) comprises a powerful tool in studying (cell and molecular biology, anatomy, microbiology, pathology and forensic science) biological specimens, food stuffs and several other areas of material sciences (electronics, metallurgy, polymer and surface science).Morphological graphs of the Banana Leaf Ash system No. 1, Banana fruit powder system No. 15, Banana Peel Powder system No.16 is provided by scanning electron microscopy (Digital Scanning Electron Microscope - JSM 6100 - JEOL) with a Link analytical system operating at 10 KV (acceleration voltage).

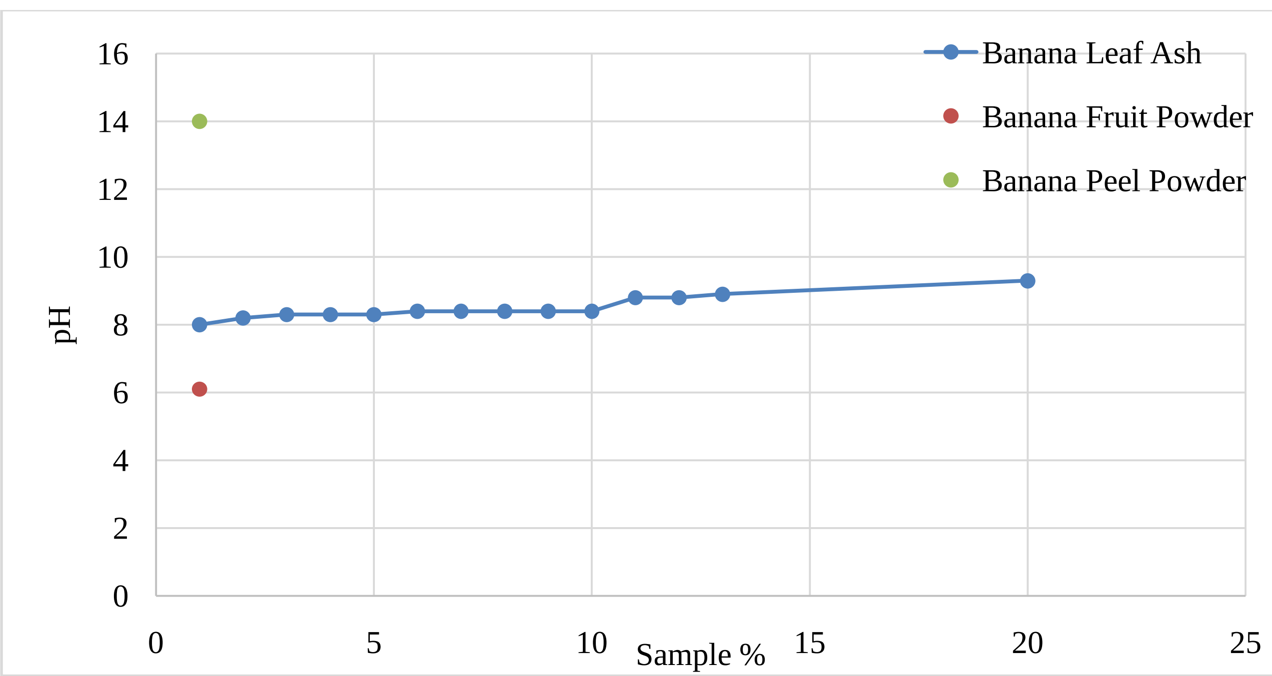


Figure-2: Determination of pH.

Table-2: Determination of CaO content in a Banana Leaf Ash.

System No.	0.1 N EDTA required for titration	System No.	0.1 N EDTA required for titration	System No.	0.1 N EDTA required for titration
1	7.5	6	6	11	4.7
2	8	7	5.5	12	4.7
3	9	8	7.3	13	4.3
4	4.5	9	5.2	14	6.3
5	9	10	7		

Table-3A: Determination of Ascorbic acid from Banana fruit powder sample.

Volume of System No. 15	Volume of 0.1N Iodine taken	Volume of 0.1N Sodium thiosulphate	End Point
10 ml	10 ml	10.8 ml	10.7ml
10 ml	10 ml	10.7 ml	
10 ml	10 ml	10.7 ml	

Table-3B: Blank Titration.

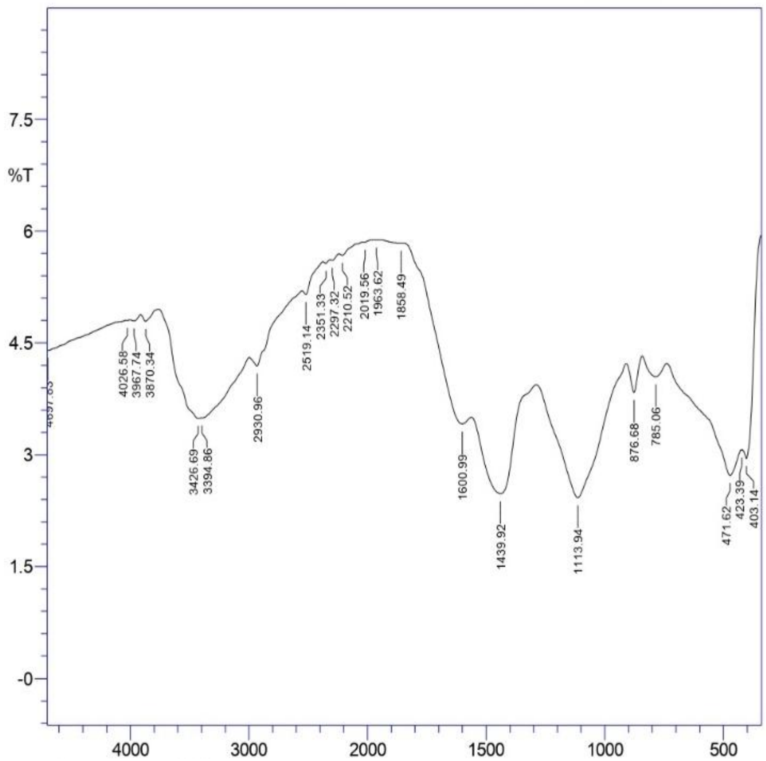
Volume of System No. 15	Volume of 0.1N Iodine taken	Volume of 0.1N Sodium thiosulphate	End Point
0ml	10 ml	11.1 ml	11.0 ml
0ml	10 ml	11.0 ml	
0ml	10 ml	11.0 ml	

Table-4A: Determination of Ascorbic acid from Banana peel powder sample.

Volume of System No. 16	Volume of 0.1N Iodine taken	Volume of 0.1N Sodium thiosulphate	End Point
10 ml	10 ml	10.6 ml	10.5 ml
10 ml	10 ml	10.5 ml	
10 ml	10 ml	10.5 ml	

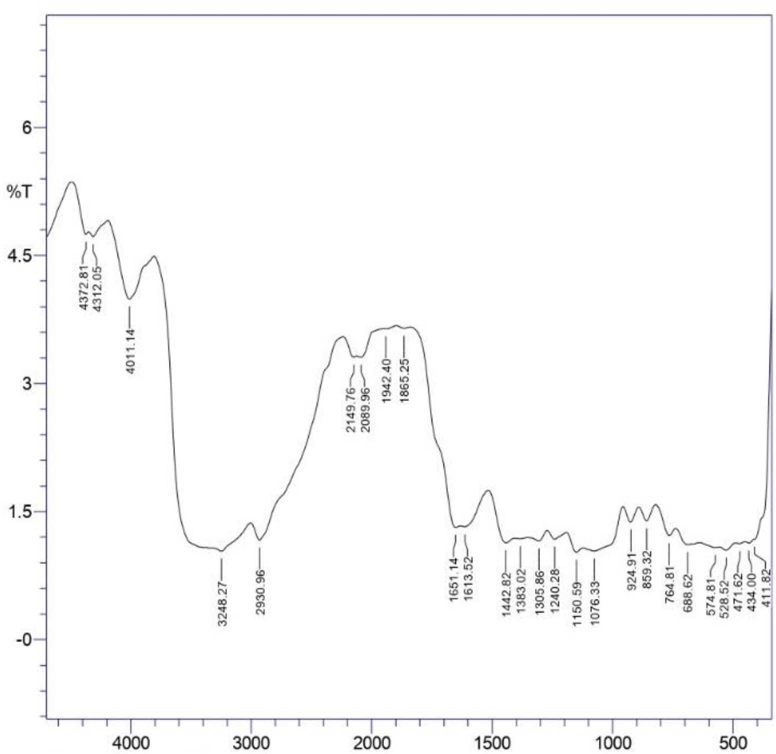
Table-4B: Blank Titration.

Volume of System No. 16	Volume of 0.1N Iodine taken	Volume of 0.1N Sodium thiosulphate	End Point
0 ml	10 ml	11.1 ml	11.0 ml
0 ml	10 ml	11.0 ml	
0 ml	10 ml	11.0ml	



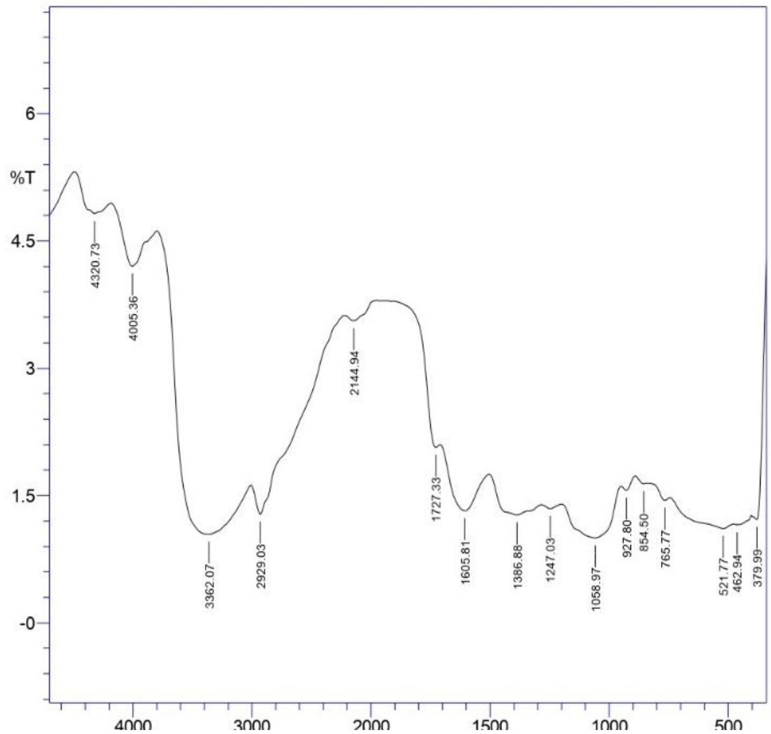
No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	403.14	2.953	0.725	419.54	342.38	108.06	2.964
2	423.39	3.065	0.002	425.32	420.5	7.298	0.001
3	471.62	2.722	0.515	737.8	425.32	457.565	6.336
4	785.06	4.048	0.22	841	738.77	141.442	1.446
5	876.68	3.84	0.43	909.48	841.96	93.853	1.404
6	1113.94	2.426	1.643	1287.54	910.44	563.055	39.061
7	1439.92	2.48	1.218	1562.41	1288.5	412.683	21.005
8	1600.99	3.414	0.397	1848.85	1563.37	385.574	4.006
9	1858.49	5.838	0.004	1951.08	1849.81	124.803	0.036
10	1963.62	5.882	0.001	1975.19	1952.05	28.481	0.001
11	2019.56	5.849	0.012	2036.92	1976.16	74.849	0.02
12	2210.52	5.676	0.041	2238.49	2037.88	248.476	0.128
13	2297.32	5.609	0.025	2314.68	2239.45	93.923	0.081
14	2351.33	5.568	0.031	2375.44	2315.64	74.911	0.07
15	2519.14	5.149	0.119	2550	2376.4	220.406	0.396
16	2930.96	4.191	0.244	2995.58	2550.97	589.635	2.083
17	3394.86	3.494	0.012	3400.65	2996.54	572.815	2.554
18	3426.69	3.489	0.107	3759.42	3401.61	498.611	5.13
19	3870.34	4.792	0.107	3910.84	3760.39	197.486	0.632
20	3967.74	4.795	0.038	3999.57	3911.81	115.577	0.179
21	4026.58	4.803	0.001	4031.4	4000.54	40.686	0.002
22	4697.83	4.399	0.002	4700.73	4032.36	893.124	0.068

Figure-3: FTIR spectra of Banana Leaf Ash.



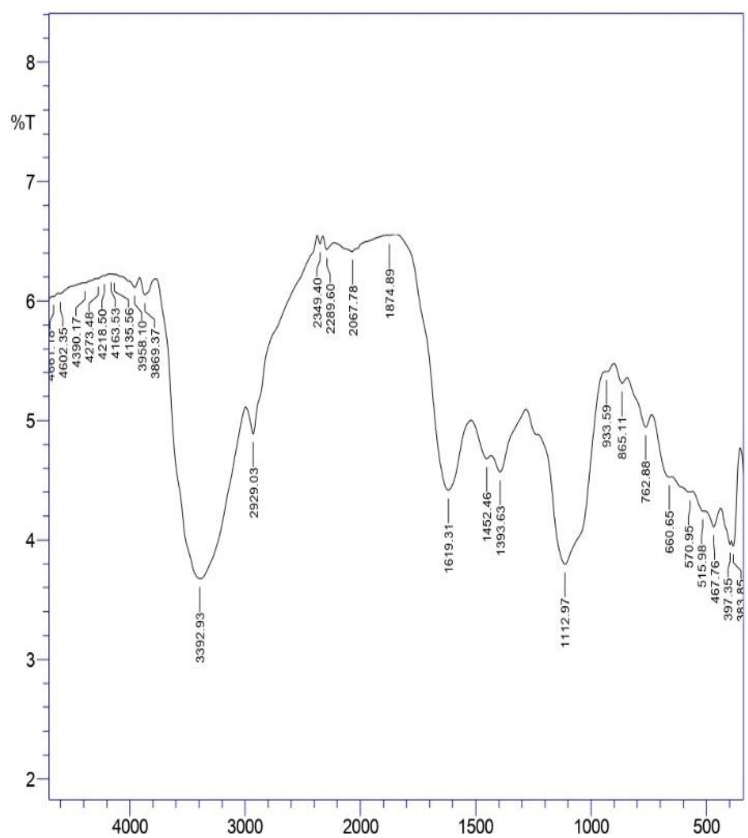
No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	411.82	1.1742	0.0773	413.75	339.49	131.4913	8.7207
2	434	1.1325	0.027	451.36	414.71	71.1282	0.1984
3	471.62	1.1251	0.013	488.98	452.33	71.323	0.0919
4	528.52	1.0472	0.0569	556.49	489.94	130.85	0.7195
5	574.81	1.0771	0.0189	638.47	557.45	158.6603	0.3241
6	688.62	1.1126	0.108	736.84	639.43	188.6845	2.1489
7	764.81	1.2198	0.1727	820.75	737.8	155.0004	2.0957
8	859.32	1.3919	0.1725	890.19	821.71	125.3087	1.694
9	924.91	1.3763	0.1792	955.77	891.15	118.5708	1.729
10	1076.33	1.0396	0.1679	1121.65	956.73	320.7541	9.4569
11	1150.59	1.024	0.1226	1192.06	1122.62	135.9964	1.5899
12	1240.28	1.1776	0.0902	1271.14	1193.02	149.5406	1.2788
13	1305.86	1.1563	0.0862	1352.16	1272.11	153.942	1.2062
14	1383.02	1.182	0.0096	1404.24	1353.12	98.4217	0.0917
15	1442.82	1.1335	0.245	1516.11	1405.2	208.5009	4.3367
16	1613.52	1.3226	0.0724	1630.88	1517.08	208.2257	1.657
17	1651.14	1.3143	0.2349	1838.24	1631.85	336.9729	1.8714
18	1865.25	3.6474	0.0208	1897.07	1839.2	83.1401	0.0736
19	1942.4	3.64	0.0057	1950.12	1898.04	74.85	0.031
20	2089.96	3.3056	0.0758	2121.79	1951.08	249.4587	0.744
21	2149.76	3.309	0.0661	2237.52	2122.75	168.4476	0.4345
22	2930.96	1.1643	0.4114	3004.26	2238.49	1291.645	27.3396
23	3248.27	1.0358	1.2806	3804.75	3005.22	1457.933	174.7035
24	4011.14	3.9882	0.7274	4188.6	3805.72	521.6166	13.0057
25	4312.05	4.7219	0.0859	4347.74	4189.57	208.4649	0.5056
26	4372.81	4.7478	0.1313	4487.58	4348.7	180.3769	0.6133

Figure-4: FTIR spectra of Banana fruit powder.



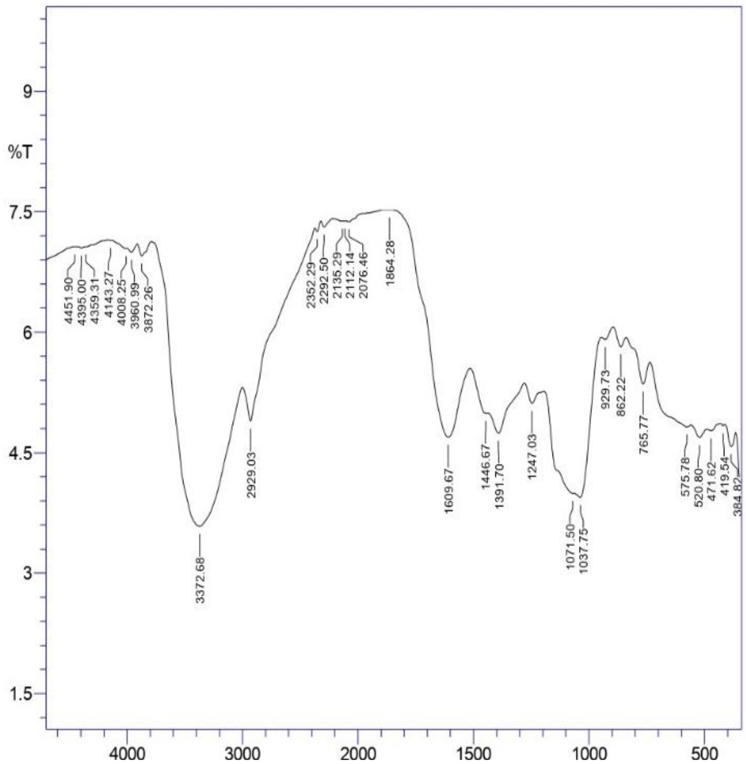
No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	379.99	1.2173	0.913	396.39	339.49	98.4332	5.6852
2	462.94	1.1558	0.0254	476.44	404.1	139.4203	0.7974
3	521.77	1.1117	0.1026	743.59	477.4	510.4761	9.1593
4	765.77	1.4436	0.0702	835.21	744.55	164.2417	0.5922
5	854.5	1.6398	0.0351	890.19	836.18	96.0339	0.2892
6	927.8	1.5621	0.0918	949.02	891.15	103.5671	0.7248
7	1058.97	1.0016	0.5155	1198.81	949.98	482.4566	28.677
8	1247.03	1.3456	0.049	1283.68	1199.78	156.3209	0.6401
9	1386.88	1.2721	0.286	1504.54	1284.65	409.7569	12.4203
10	1605.81	1.32	0.6022	1709	1505.51	367.3961	17.8614
11	1727.33	2.0664	0.1437	1976.16	1709.97	394.4041	0.6184
12	2144.94	3.5607	0.1161	2220.16	1977.12	349.813	2.1035
13	2929.03	1.2813	0.5367	3006.19	2221.13	1287.676	23.7574
14	3362.07	1.0465	1.9232	3796.07	3007.15	1416.199	183.8613
15	4005.36	4.2043	0.5888	4183.78	3797.04	520.8207	10.011
16	4320.73	4.8241	0.2857	4488.55	4184.75	396.5517	4.569

Figure-5: FTIR spectra of Banana Peel Powder.



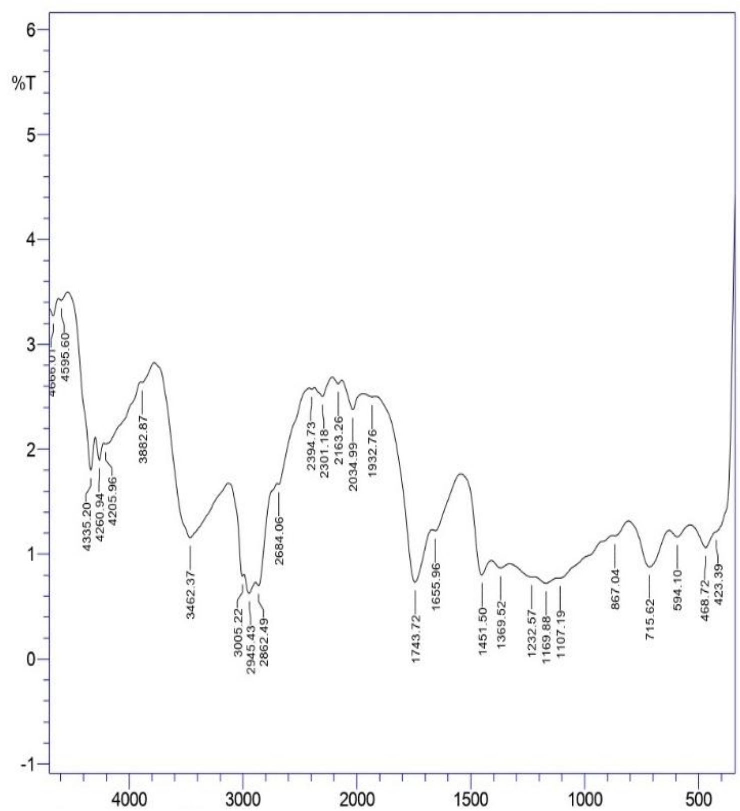
No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	383.85	3.9507	0.199	391.57	353.95	51.4874	0.4112
2	397.35	3.9628	0.0564	437.86	392.53	62.8857	0.1267
3	467.76	4.1104	0.1464	511.16	438.82	99.6394	0.4602
4	515.98	4.2417	0.0146	559.38	512.12	64.5034	0.0454
5	570.95	4.3992	0.0214	649.07	560.35	119.9587	0.1734
6	660.65	4.5267	0.0665	735.87	650.04	113.849	0.5129
7	762.88	4.946	0.1771	842.93	736.84	136.9505	0.7214
8	865.11	5.3134	0.0886	900.8	843.89	72.2595	0.2034
9	933.59	5.4086	0.0075	937.44	901.76	45.1342	0.0251
10	1112.97	3.7966	1.4514	1280.79	938.41	461.7292	23.5177
11	1393.63	4.5705	0.233	1431.24	1281.75	196.9664	1.1328
12	1452.46	4.6816	0.0927	1519.97	1432.21	115.6886	0.367
13	1619.31	4.4173	1.0559	1845.96	1520.94	413.2572	10.3214
14	1874.89	6.5514	0.002	1882.61	1846.92	42.232	0.0032
15	2067.78	6.4153	0.1032	2225.95	1883.57	407.0997	1.1413
16	2289.6	6.432	0.0913	2324.32	2226.91	115.8264	0.2941
17	2349.4	6.4796	0.0652	2373.51	2325.29	57.207	0.1062
18	2929.03	4.8877	0.3761	2993.65	2374.47	767.1681	2.6592
19	3392.93	3.6741	1.9907	3770.03	2994.62	1049.749	80.5178
20	3869.37	6.0539	0.1388	3913.74	3771	173.1656	0.702
21	3958.1	6.1143	0.0874	4123.99	3914.7	253.0764	0.486
22	4135.56	6.2231	0.0018	4159.67	4124.95	41.8687	0.002
23	4163.53	6.2268	0.0002	4173.17	4160.63	15.1171	0.0001
24	4218.5	6.2114	0.0038	4230.07	4174.14	67.4791	0.0066
25	4273.48	6.1895	0.0042	4282.16	4231.04	61.732	0.0091
26	4390.17	6.15	0.0071	4407.53	4283.12	150.5196	0.0257
27	4602.35	6.0633	0.0094	4616.82	4408.5	252.8574	0.0242
28	4661.18	6.0363	0.0089	4674.69	4617.78	69.327	0.0187

Figure-6: FTIR spectra of Banana Leaf Ash system No. 1.



No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	384.82	4.576	0.216	410.86	365.53	60.265	0.48
2	419.54	4.836	0.021	429.18	411.82	22.821	0.016
3	471.62	4.773	0.041	489.94	434.97	72.457	0.094
4	520.8	4.689	0.125	557.45	490.9	88.03	0.367
5	575.78	4.821	0.097	735.87	558.42	230.638	3.024
6	765.77	5.354	0.357	839.07	736.84	127.63	1.027
7	862.22	5.82	0.167	895.01	840.04	67.512	0.336
8	929.73	5.913	0.065	946.12	895.97	61.401	0.129
9	1037.75	3.943	0.533	1067.65	947.09	160.565	2.731
10	1071.5	3.995	0.029	1193.99	1068.61	170.266	2.44
11	1247.03	5.114	0.214	1278.86	1194.95	107.586	0.64
12	1391.7	4.744	0.357	1437.03	1279.82	204.15	2.01
13	1446.67	4.989	0.068	1513.22	1437.99	96.489	0.317
14	1609.67	4.694	1.412	1853.67	1514.19	416.526	13.661
15	1864.28	7.523	0.002	1885.5	1854.64	34.675	0.002
16	2076.46	7.38	0.022	2102.5	1886.46	243.635	0.088
17	2112.14	7.384	0	2117.93	2103.46	16.372	0
18	2135.29	7.383	0.007	2215.34	2118.9	109.076	0.019
19	2292.5	7.31	0.082	2320.47	2216.3	118.01	0.23
20	2352.29	7.253	0.076	2371.58	2321.43	57.002	0.115
21	2929.03	4.893	0.638	2998.47	2372.55	760.347	5.594
22	3372.68	3.581	2.59	3787.39	2999.44	1050.193	96.075
23	3872.26	6.952	0.155	3910.84	3788.36	141.228	0.619
24	3960.99	6.999	0.07	4002.46	3911.81	104.507	0.204
25	4008.25	7.044	0.004	4130.74	4003.43	146.303	0.024
26	4143.27	7.144	0.003	4166.42	4131.7	39.787	0.003
27	4359.31	7.063	0.003	4365.1	4167.39	227.051	0.032
28	4395	7.05	0.015	4430.68	4366.06	74.394	0.028
29	4451.9	7.065	0.001	4455.76	4431.64	27.748	0.001

Figure-7: FTIR spectra of Banana fruit powder system No. 15.



No.	Peak	Intensity	Corr. Inte	Base (H)	Base (L)	Area	Corr. Are
1	423.39	1.2132	0.0732	425.32	339.49	151.849	11.8596
2	468.72	1.0624	0.176	537.2	426.29	214.3611	3.1112
3	594.1	1.1646	0.0823	628.82	538.16	173.699	1.2618
4	715.62	0.8791	0.3916	807.24	629.79	349.3778	12.9469
5	867.04	1.1756	0.0241	877.65	808.21	132.5796	0.3941
6	1107.19	0.7721	0.021	1118.76	878.61	484.5027	0.4936
7	1169.88	0.7233	0.0546	1220.03	1119.73	213.0796	1.528
8	1232.57	0.7806	0.0149	1329.01	1220.99	224.4648	0.5068
9	1369.52	0.8682	0.0549	1409.06	1329.98	161.9725	1.0433
10	1451.5	0.8033	0.393	1543.12	1410.02	256.4818	6.4652
11	1655.96	1.2246	0.0668	1669.46	1544.08	229.8999	0.9383
12	1743.72	0.7317	0.8807	1916.36	1670.43	450.5604	21.5483
13	1932.76	2.4996	0.0117	1970.37	1917.33	84.8815	0.057
14	2034.99	2.3779	0.2045	2130.47	1971.33	254.9885	2.597
15	2163.26	2.6254	0.0452	2214.38	2131.43	130.7608	0.3046
16	2301.18	2.5033	0.1297	2370.62	2215.34	246.665	1.5348
17	2394.73	2.5738	0.0113	2417.87	2371.58	73.5376	0.0458
18	2684.06	1.6665	0.0547	2698.53	2418.84	466.0753	0.4705
19	2862.49	0.6979	0.1667	2889.49	2699.49	367.8374	3.0802
20	2945.43	0.6285	0.1454	2989.79	2890.45	214.6745	4.6267
21	3005.22	0.7877	0.1127	3127.71	2990.76	259.5424	1.0142
22	3462.37	1.1546	1.1118	3777.75	3128.67	1161.001	82.2397
23	3882.87	2.6387	0.0237	3896.38	3778.71	184.2287	0.3141
24	4205.96	2.0496	0.0354	4221.39	3897.34	532.1923	3.2742
25	4260.94	1.8982	0.1881	4295.66	4222.36	124.6386	1.422
26	4335.2	1.8022	0.532	4537.73	4296.62	381.8263	6.669
27	4595.6	3.4214	0.0341	4620.68	4538.7	119.8589	0.1781
28	4666.01	3.2726	0.1092	4700.73	4621.64	116.7722	0.5147

Figure-8: FTIR spectra of Banana Peel Powder system No.16.

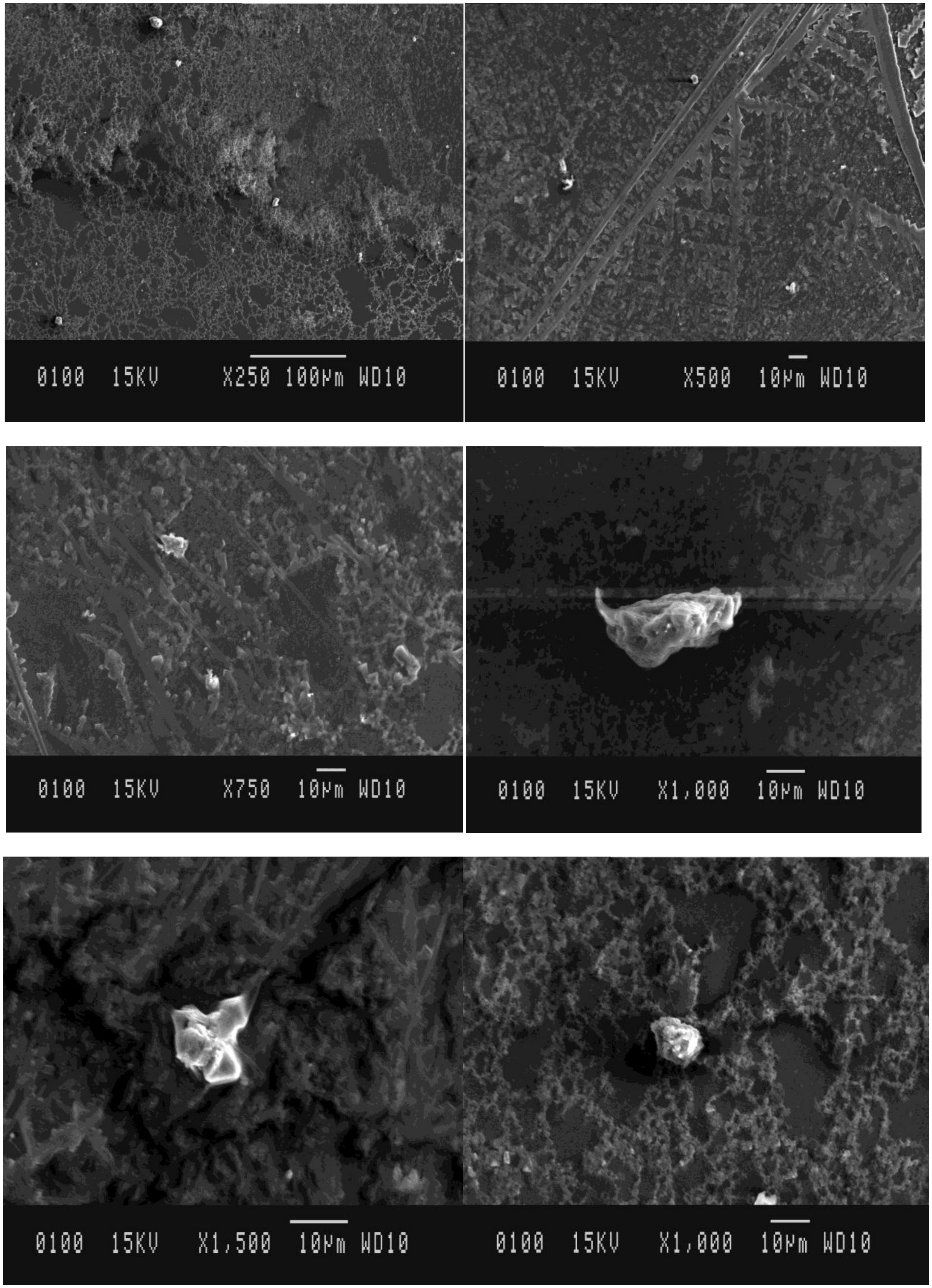


Figure-9: Scanning Electron Microscope images of Banana Leaf Ash system No. 1.

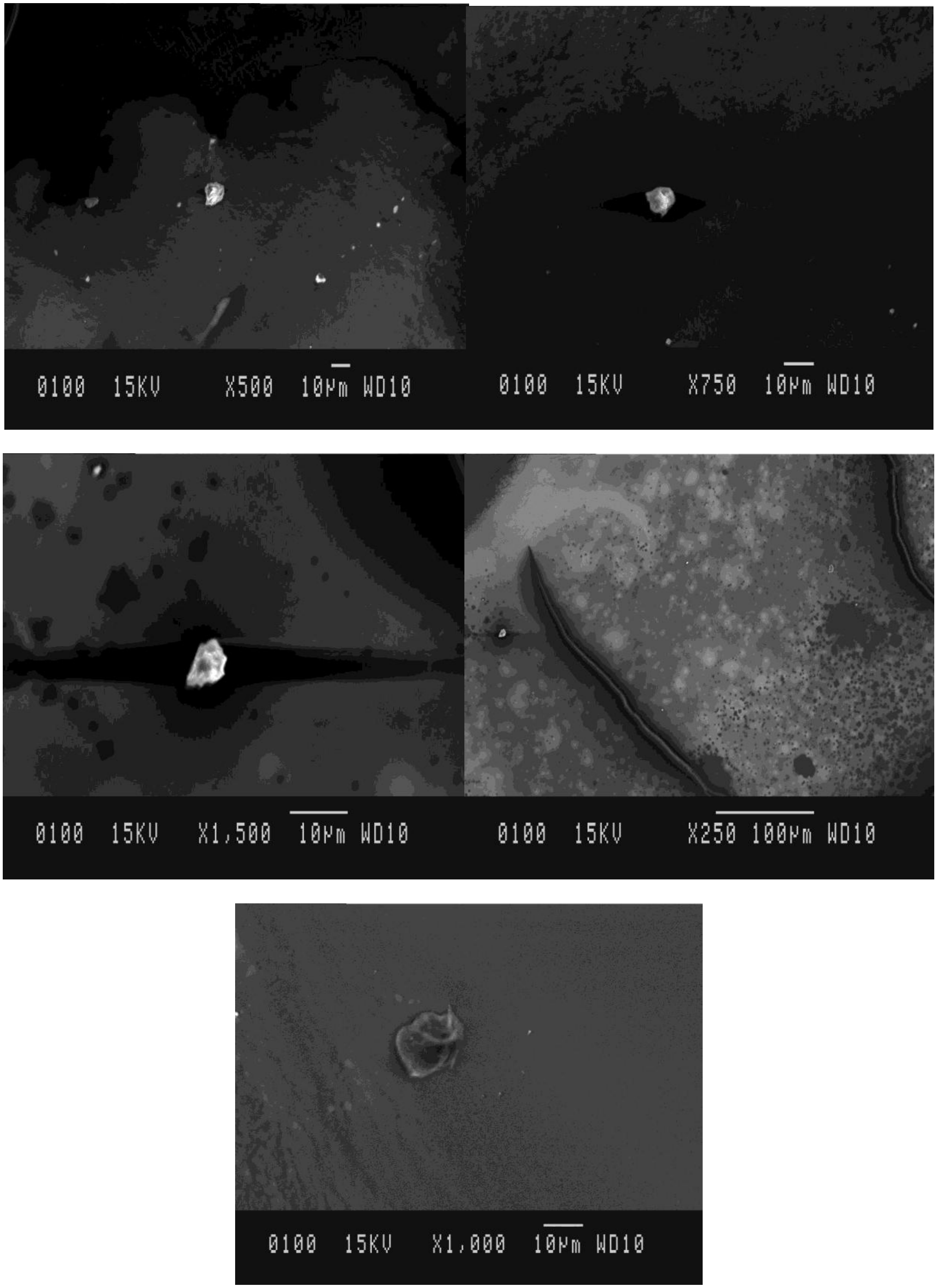


Figure-10: Scanning Electron Microscope images of Banana fruit powder system No. 15.

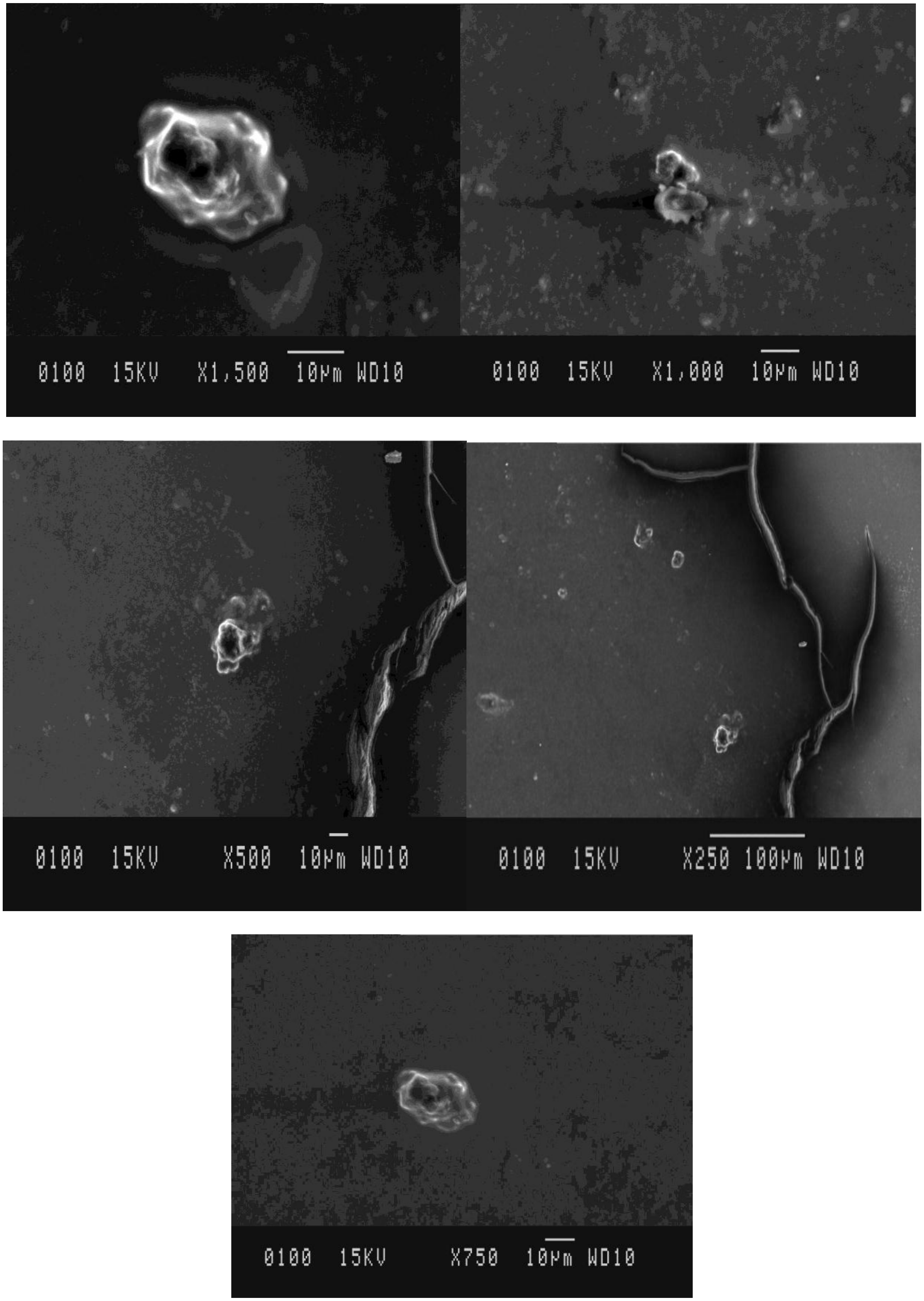


Figure-11: Scanning Electron Microscope images of Banana peel powder system No. 16.

Results and Discussion

Determination of pH: As quantity of Banana leaf ash sample increases from 1% to 20% pH also increases from 8.0 to 9.3. pH of 1% Banana fruit powder sample was found to be 6.1 and pH of 1% Banana Peel powder sample was found to be 14.0.

Determination of CaO content in a Banana Leaf Ash

For System No. 1

1 liter 1M EDTA ≡ 56.08 g CaO

Hence 7.5 ml 0.1 M EDTA ≡ (7.5 X 56.08 X 0.1) / 1000 = 0.04206 g CaO

Hence 10ml sample will contain 0.04206 g CaO

Hence 100ml sample will contain (100 X 0.04206) / 10 = 0.4206 g CaO

Hence 1g Banana Leaf ash sample contains 0.4206 g CaO

Similarly, Cao content for remaining systems can be calculated as follows:

Therefore, Average amount of CaO Present in 1g Banana Leaf ash sample is found to be 0.0869 g

Determination of Ascorbic acid from Banana fruit powder sample:

1 litre 2 N Sodium thiosulphate = 176 g Ascorbic acid

Hence (11.0-10.7) ml of 0.1 N Sodium thiosulphate = (11.0-10.7) x176 x 0.1 / 1000 x 2 = 0.00264.

Hence amount of Ascorbic acid in 10 ml system No. 15 is 0.00264 g

Hence amount of Ascorbic acid in 100 ml system No. 15 is 0.0264 g

Hence amount of Ascorbic acid in 1 g Banana fruit powder sample is 0.0264 g.

Determination of Ascorbic acid from Banana peel powder sample:

1 litre 2 N Sodium thiosulphate = 176 g Ascorbic acid

Hence (11.0-10.5) ml of 0.1 N Sodium thiosulphate = (11.0-10.5) x176 x 0.1 / 1000 x 2 = 0.0044.

Hence amount of Ascorbic acid in 10 ml system No. 16 is 0.0044 g

Hence amount of Ascorbic acid in 100 ml system No. 16 is 0.044 g

Hence amount of Ascorbic acid in 1 g Banana peel powder sample is 0.044 g

Table-5: Determination of CaO content in a Banana Leaf Ash.

System No.	Banana Leaf ash sample, g	Distilled Water	Banana Leaf ash sample Solution taken for titration	0.1 N EDTA required for titration	Amount of CaO Present in 10 ml Banana Leaf ash sample Solution	Amount of CaO Present in 100 ml Banana Leaf ash sample Solution	Amount of CaO Present in 1g Banana Leaf ash sample	Average amount of CaO Present in 1g Banana Leaf ash sample
1	1	100 ml	10	7.5	(7.5 x 56.08 x 0.1) / 1000 = 0.04206	(100 x 0.04206) / 10 = 0.4206	(1x 0.4206) / 1 = 0.4206	0.4206 + 0.2243 + 0.1682 + 0.0631 + 0.0505 + 0.0561 + 0.0441 + 0.0512 + 0.0324 + 0.0393 + 0.0240 + 0.0220 + 0.0185 + 0.0017 = 1.216 /14 = 0.0869
2	2	100 ml	10	8.0	(8.0 x 56.08 x 0.1) / 1000 = 0.04486	(100 x 0.04486) / 10 = 0.4486	(1x 0.4486) / 2 = 0.2243	
3	3	100 ml	10	9.0	(9.0 x 56.08 x 0.1) / 1000 = 0.05047	(100 x 0.05047) / 10 = 0.5047	(1x 0.5047) / 3 = 0.1682	
4	4	100 ml	10	4.5	(4.5 x 56.08 x 0.1) / 1000 = 0.02524	(100 x 0.02524) / 10 = 0.2524	(1x 0.2524) / 4 = 0.0631	
5	5	100 ml	10	9.0	(9.0 x 56.08 x 0.1) / 1000 = 0.02524	(100 x 0.02524) / 10 = 0.2524	(1x 0.2524) / 5 = 0.0505	
6	6	100 ml	10	6	(6.0 x 56.08 x 0.1) / 1000 = 0.03365	(100 x 0.03365) / 10 = 0.3365	(1x 0.3365) / 6 = 0.0561	
7	7	100 ml	10	5.5	(5.5 x 56.08 x 0.1) / 1000 = 0.03084	(100 x 0.03084) / 10 = 0.3084	(1x 0.3084) / 7 = 0.0441	
8	8	100 ml	10	7.3	(7.3 x 56.08 x 0.1) / 1000 = 0.04094	(100 x 0.04094) / 10 = 0.4094	(1x 0.4094) / 8 = 0.0512	
9	9	100 ml	10	5.2	(5.2 x 56.08 x 0.1) / 1000 = 0.02916	(100 x 0.02916) / 10 = 0.2916	(1x 0.2916) / 9 = 0.0324	
10	10	100 ml	10	7.0	(7.0 x 56.08 x 0.1) / 1000 = 0.03926	(100 x 0.03926) / 10 = 0.3926	(1x 0.3926) / 10 = 0.0393	
11	11	100 ml	10	4.7	(4.7 x 56.08 x 0.1) / 1000 = 0.02636	(100 x 0.02636) / 10 = 0.2636	(1x 0.2636) / 11 = 0.0240	
12	12	100 ml	10	4.7	(4.7 x 56.08 x 0.1) / 1000 = 0.02636	(100 x 0.02636) / 10 = 0.2636	(1x 0.2636) / 12 = 0.0220	
13	13	100 ml	10	4.3	(4.3 x 56.08 x 0.1) / 1000 = 0.02411	(100 x 0.02411) / 10 = 0.2411	(1x 0.2411) / 13 = 0.0185	
14	20	100 ml	10	6.3	(6.3 x 56.08 x 0.1) / 1000 = 0.03533	(100 x 0.03533) / 10 = 0.3533	(1x 0.3533) / 20 = 0.0017	

Table-6: Interpretation of IR spectra of Banana Leaf Ash.

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
4697.83	Weak and Broad	-	-
4026.58	Weak and Broad	-	-
3967.74	Weak and Broad	-	-
3870.34	Weak and Broad	-	-
3426.69	Strong and Broad	O-H stretching	Alcohol
3394.86	Strong and Broad	O-H stretching	Alcohol
2930.96	Weak and Broad	O-H stretching	Alcohol
2519.14	Weak and Broad	-	-
2351.33	Weak and Broad	-	-
2297.32	Weak and Broad	-	-
2210.52	Weak and Broad	C≡C stretching	Alkyne
2019.56	Weak and Broad	-	-
1963.62	Weak and Broad	C-H bending	Aromatic compound
1858.49	Weak and Broad	C-H bending	Aromatic compound
1600.99	Medium and Broad	C═C stretching	Conjugated alkene
1439.92	Medium and Broad	O-H bending	Carboxylic acid
1113.94	Strong and Broad	C-O stretching	Tertiary alcohol, aliphatic ether
876.68	Weak and Broad	-	-
785.06	Weak and Broad	-	-
471.62	Weak and Broad	-	-
423.39	Weak and Broad	-	-
403.14	Weak and Broad	-	-

Table-4: Interpretation of IR spectra of Banana fruit powder.

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
4372.81	Weak and Broad	-	-
4312.05	Weak and Broad	-	-
4011.14	Medium and Broad	-	-
3248.27	Strong and Broad	O-H stretching	Carboxylic acid
2930.96	Strong and Broad	O-H stretching	Carboxylic acid
2149.76	Weak and Broad	-	-
2089.96	Weak and Broad	-	-
1942.4	Weak and Broad	C-H bending	Aromatic compound
1865.25	Weak and Broad	C-H bending	Aromatic compound
1651.14	Strong and Broad	C=C stretching	Alkene
1613.52	Strong and Broad	C=C stretching	Alkene
1442.82	Weak and Broad	-	-
1383.02	Weak and Broad	-	-
1305.86	Weak and Broad	-	-
1240.28	Weak and Broad	-	-
1150.59	Weak and Broad	-	-
1076.33	Weak and Broad	-	-
924.91	Weak and Broad	-	-
859.32	Weak and Broad	-	-
764.81	Weak and Broad	-	-
688.62	Weak and Broad	-	-
574.81	Weak and Broad	-	-
528.52	Weak and Broad	-	-
471.62	Weak and Broad	-	-
434	Weak and Broad	-	-
411.82	Weak and Broad	-	-

Table-7: Interpretation of IR spectra of Banana peel powder.

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
4320.73	Medium and Broad	-	-
4005.36	Medium and Broad	-	-
3362.07	Strong and Broad	O-H stretching	Alcohol
2929.03	Strong and Broad	O-H stretching	Carboxylic acid
2144.94	Weak and Broad	-	-
1727.33	Strong and Broad	C═O stretching	α, β unsaturated ester
1605.81	Strong and Broad	C═C stretching	α, β unsaturated ketone
1386.88	Weak and Broad	-	-
1247.03	Weak and Broad	-	-
1058.97	Weak and Broad	-	-
927.8	Weak and Broad	-	-
854.5	Weak and Broad	-	-
765.77	Weak and Broad	-	-
521.77	Weak and Broad	-	-
462.94	Weak and Broad	-	-
379.99	Weak and Broad	-	-

Table-8: Interpretation of IR spectra of Banana Leaf Ash system No. 1.

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
4661.18	Weak and Broad	-	-
4602.35	Weak and Broad	-	-
4390.17	Weak and Broad	-	-
4273.48	Weak and Broad	-	-
4218.5	Weak and Broad	-	-
4163.53	Weak and Broad	-	-
4135.56	Weak and Broad	-	-
3958.1	Weak and Broad	-	-
3869.37	Weak and Broad	-	-
3392.93	Strong and Broad	O-H stretching	Alcohol
2929.03	Medum and sharp	C-H stretching	Alkane
2349.4	Weak and Broad	-	-

2289.6	Weak and Broad	-	-
2067.78	Weak and Broad	-	-
1874.89	Weak and Broad	-	-
1619.31	Strong and Broad	C=C stretching	α, β unsaturated ketone
1452.46	Weak and Broad	-	-
1393.63	Weak and Broad	-	-
1112.97	Strong and Broad	C-O stretching	Secondary alcohol
933.59	Weak and Broad	-	-
865.11	Weak and Broad	-	-
762.88	Weak and Broad	-	-
660.65	Weak and Broad	-	-
570.95	Weak and Broad	-	-
515.98	Weak and Broad	-	-
467.76	Weak and Broad	-	-
397.35	Weak and Broad	-	-
383.85	Weak and Broad	-	-

Table-9: Interpretation of IR spectra of Banana fruit powder system No. 15

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
4451.9	Weak and Broad	-	-
4395	Weak and Broad	-	-
4359.31	Weak and Broad	-	-
4143.27	Weak and Broad	-	-
4008.25	Weak and Broad	-	-
3960.99	Weak and Broad	-	-
3872.26	Weak and Broad	-	-
3372.68	Strong and Broad	O-H stretching	Alcohol
2929.03	Medum and sharp	C-H stretching	Alkane
2352.29	Weak and Broad	-	-
2292.5	Weak and Broad	-	-

2135.29	Weak and Broad	-	-
2112.14	Weak and Broad	C≡C stretching	Alkyne
2076.46	Weak and Broad	-	-
1864.28	Weak and Broad	C-H bending	Aromatic compound
1609.67	Strong and Broad	C═C stretching	α, β unsaturated ketone
1446.67	Medium and Broad	C-H bending	Alkane
1391.7	Medium and Broad	C-H bending	Aldehyde
1247.03	Weak and Broad	-	-
1071.5	Strong and Broad	S=O stretching	Sulfoxide
1037.75	Strong and Broad	S=O stretching	Sulfoxide
929.73	Weak and Broad	-	-
862.22	Weak and Broad	-	-
765.77	Weak and Broad	-	-
575.78	Weak and Broad	-	-
520.8	Weak and Broad	-	-
471.62	Weak and Broad	-	-
419.54	Weak and Broad	-	-
384.82	Weak and Broad	-	-

Table-10: Interpretation of IR spectra of Banana Peel Powder system No.16.

Spectra region wave number cm^{-1}	Intensity and Pattern of peak	Bond causing Absorption	Compound Class
4666.01	Weak and Broad	-	-
4595.6	Weak and Broad	-	-
4335.2	Medium and Sharp	-	-
4260.94	Medium and Sharp	-	-
4205.96	Medium and Broad	-	-
3882.87	Weak and Broad	-	-
3462.37	Strong and Broad	O-H stretching	Alcohol
3005.22	Medum and Broad	C-H stretching	Alkane
2945.43	Medium and Broad	C-H stretching	Alkane

2862.49	Medium and Broad	C-H stretching	Alkane
2684.06	Weak and Broad	-	-
2394.73	Weak and Broad	-	-
2301.18	Weak and Broad	-	-
2163.26	Weak and Broad	-	-
2034.99	Weak and Broad	-	-
1932.76	Weak and Broad	C-H bending	Aromatic compound
1743.72	Strong and Sharp	C═O stretching	ester
1655.96	Medium and Broad	C═C stretching	Alkene
1451.5	Medium and Broad	C-H bending	Alkane
1369.52	Weak and Broad	-	-
1232.57	Weak and Broad	-	-
1169.88	Weak and Broad	-	-
1107.19	Weak and Broad	-	-
867.04	Weak and Broad	-	-
715.62	Weak and Broad	-	-
594.1	Weak and Broad	-	-
468.72	Weak and Broad	-	-
423.39	Weak and Broad	-	-

SEM Analysis: Scanning Electron Microscope image of Banana Leaf Ash system No. 1, Banana fruit powder system No. 15 and Banana Peel Powder system No.16 shows that the material mainly consisted of spherical particles with 1-10 μm in diameter, and has a smaller aggregated particle size.

Conclusion

As quantity of Banana leaf ash sample increases from 1 to 20% pH also increases from 8.0 to 9.3. pH of 1% Banana fruit powder sample was found to be 6.1 and pH of 1% Banana Peel powder sample was found to be 14.0. Average amount of CaO Present in 1g Banana Leaf ash sample is found to be 0.0869g**.** Amount of Ascorbic acid in 1g Banana fruit powder sample is 0.0264g. Amount of Ascorbic acid in 1g Banana peel powder sample is 0.044g.

Interpretation of FTIR Spectra of Banana Leaf Ash shows presence of various functional groups such as C-H bending - Aromatic compound; C-O stretching-Tertiary alcohol, aliphatic ether; O-H bending –Carboxylic acid; O-H stretching - Alcohol; C═C stretching - Conjugated alkene; C≡C stretching–Alkyne. Interpretation of FTIR Spectra of Banana fruit powder shows presence of various functional groups such as O-H stretching - Carboxylic acid; C-H bending - Aromatic compound; C═C stretching – Alkene. Interpretation of FTIR Spectra of Banana Peel Powder shows presence of various functional groups such asO-H stretching - Alcohol, Carboxylic acid; C═O stretching - α, β unsaturated ester; C═C stretching - α, β unsaturated ketone. Interpretation of FTIR Spectra of 1% Banana Leaf Ash shows presence of various functional groups such asO-H stretching – Alcohol; C-H stretching- Alkane; C═C stretching - α, β unsaturated ketone; C-O stretching - Secondary alcohol. Interpretation of FTIR Spectra of 1% Banana fruit powder shows presence of various functional groups such asO-H stretching – Alcohol; C-H stretching – Alkane; C≡C stretching – Alkyne; C═C stretching - α, β unsaturated ketone; C-H bending-Alkane, Aldehyde, Aromatic compound; S=O stretching – Sulfoxide. Interpretation of FTIR Spectra of 1% Banana Peel Powder shows presence of various functional groups such as O-H stretching- Alcohol; C-H stretching – Alkane; C-H bending – Alkane, Aromatic compound; C═O stretching – ester; C═C stretching – Alkene.

Scanning Electron Microscope image of 1% Banana Leaf Ash, 1% Banana fruit powder and 1% Banana Peel Powder shows that the material mainly consisted of spherical particles with 1-10μm in diameter, and has a smaller aggregated particle size.

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