UTILIZATION OF FRUIT WASTE FOR TREATMENT OF WATER

DISSERTATION - II

MASTER OF SCIENCE (HONORS)

IN

CHEMISTRY

Submitted By

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DECLARATION

I certify that

- I Ramanpreet Kaur, hereby affirm that the dissertation entitled "**Utilization of fruit waste for treatment of water**" submitted to the School of Physical Science and Chemical Engineering.
- The work enclosed on this is innovative and has been carried out by me under the guidance of my supervisor, Dr. Richa Gupta.
- I have been following the guiding principle provided by the university in the preparation of the report.
- Whenever I have used resources (such as data, theoretical representations, any figure, and text) from other sources, I have given due recognition to them by citing them in the report and providing their details in the bibliography.

Ramanpreet kaur

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ACKNOWLEDGEMENT

I take the opportunity to present my votes of thanks to all those guidepost who really acted as lightening pillars to enlighten our way throughout this project that has led to successful and satisfactory completion of this study. It was very exciting for me to work on the project of **"Utilization of fruit waste for treatment of water".** During this work I gained both practical as well as theoretical knowledge of great significance. First of all, I would like to thank the Department of Physical Sciences and Chemical Engineering, **Lovely Professional University**.

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Ramanpreet kaur

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INTRODUCTION

Water is one of the necessary requirements of life. Today's world is facing considerable problems related to environmental pollution due to continuously increasing urbanization and industrialization, that has negative influence on water quality. Also the textile industries are creating a large amount of effluents involving acidic, toxic compounds and different type of dyes. Most of these dyes are stable, rapid and highly detectable and resistant to photochemical, chemical as well as biological degradation. Heavy metal pollution in aquatic system has become a consequential threat as these metals cannot be degraded and has lasting nature. Heavy metals such as; zinc, chromium, cobalt, nickel, copper, mercury and lead have been derived from various sources such a sandfill, agricultural activities like using pesticides and industrial wastewater [1-4]. Various methods are used for the removal of heavy metal species, these methods are Conventional adsorption, chemical precipitation, ion-exchange, membrane separation methods and biosorption are the commonly used methods to treat industrial wastewater [5-7]. By taking into account about the cost effectiveness and improved efficiency, the removal of dye from agricultural wastes should be done by adsorption method. Adsorption processes reduce the different pollutants that are available in water thus it has a vast applicability for the water pollution control. Activated carbon has been recognized as the most effective adsorbent for the ejection of various organic and inorganic pollutants from the aqueous media. As the research on activated carbon improvement is achieving a great attention due to the need to generate affinity of AC for certain impurities or pollutants to make easier their removal from water. Basically, there are two processes for preparing an activated carbon: chemical and physical activation [8]. Owing to the higher yield chemical activation is preferred over physical activation. Simply, shorter time and low temperature needed for activating the material. The main purpose of this study is to compare the efficacy of activated carbon obtained from fruit wastes by simple chemical activation method for the treatment of wastewater [9]. Conventional methods are highly efficient and use less space as comparable to Non-Conventional but these methods has some disadvantages also. The major disadvantage of conventional treatment is the production of high toxic chemical sludge and requires high electrical energy that will become expensive and is not environment-friendly. Therefore, removal of toxic heavy metals to an environmentally safe level in a cost-effective and environmentally friendly manner is of great

importance [10,11]. In recent years, considerable attention has been given to the study of the removal of heavy metal ions from solution by adsorption using agricultural waste materials.

Mango peels and mango kernels are plentiful residue of the kitchen waste and food industry was used as an alternative sources of an activated carbon. Mango (Mangifera indica L.) is a fruit that grows abundantly in 85 different countries across the world and is considered one of the most important tropical fruit in the world since its consumption corresponds to 50% of the entire consumption of all tropical fruits. Around 35 to 60% of the total mass of processed fruits is considered by-products, which are discarded in landfills without any commercial purpose [12-13]. From literature, it is known that the mango peel contains different phytochemicals like carotenoids, polyphenols, vitamin C, lactic acid, dietary fibres and vitamin E and it also exhibited good antioxidant properties [14-16]. The previous studies encourage me to find another useful utilization of mango peel as a new, low-priced and renewable precursor for preparing activated carbon as an adsorbent. The reprocessing of this large mass of natural waste product represents an important opportunity from both environmental and socioeconomic points of view. The Mango by-products are considered as a residue without a destination in the processing industries. These comfortably generated and eco-friendly by-products had been employed as an ideal alternative to the current high priced adsorbents for removing dyes from wastewater such as mango peels and mango kernels [17-19]. Recently, many researches have been performed with the aim of producing low cost ACs from mango by-products as a renewable source [20-21]. The adsorption property of activated carbon highly depends on the activation procedures, that are physical (thermal) activation, chemical activation, and the nature of source materials [22]. Therefore, the main focus of this study is to develop a low-cost AC adsorbent from mango peels and mango kernels with phosphoric acid activation.

DYES

Dyes are organic compounds that are regarded as an important group of pollutants. The disposing of industrial organic and inorganic wastes without the complete removal of the dyes give rise to the effluents that is leading to the contamination of nearby water bodies like rivers, lakes and streams with dyes [23-25]. Dyes are used in excess quantities in most of the industries including paper, textile, leather, cosmetics, printing, plastic, pharmaceuticals, food, etc. to color their products, which produces a large amount of waste water, that are characteristically high in color and high organic content. All the colors that we see around us are due to synthetic dyes as these dyes are used everywhere in everything. Two third of the total dye stuff production alone accounts by the textile industry and about 10 to 15 % of the used dyes come out through the liquid waste or sewage discharged into the river or the sea [26-27].

Malachite green ($C_{23}H_{25}N_2$) - It is a basic, cationic dye, tri-phenyl methane. This dye has been widely used for the dyeing of wool, leather, jute and silk. It also functions as an antiseptic and fungicide in an aquaculture industry [28]. Malachite green is harmful for major microorganisms like fungi and bacteria and also have some properties which are difficult for removal from the aqueous solution. As a result use of this dye was banned in certain countries and also it has been not approved by US Food and Drug Administration. But due to its low price and easily availability it still is used in many parts of world [29-32].

Methylene Blue ($C_{16}H_{18}N_3SCl.3H_2O$) : It is a basic aniline dye and is essential used dye in medicines and finds many applications in coloring of paper, clothes, cottons, and wools and it is also used in preparing hair colorants but it is dangerous to human life which is causing the rise in heartbeat, vomiting, shock, jaundice and even cancer [33-34].

ACTIVATED CARBON

In industries for the removal ,most popular adsorbent are used as the removal efficiency of AC is very high for harmful pollutants and is used to recover the organic as well as inorganic compounds from the continuous flow of liquid and gases. Due to its big internal surface area, it has high adsorption capability and during carbonization process porosity is formed. The presence of agents which are activating and carbonization conditions influenced the pore structures development [35]. However, there is a restriction for the usage of activated carbon by its high commercial cost which is an outcome of high production cost. There are two methods used for activated carbon synthesis that are physical activation and chemical activation. In physical activation, in an inert atmosphere the precursor is first carbonized and then activated in a stream of carbon dioxide or steam whereas on the other hand for chemical activation, the precursor is saturated with a dehydrating agent, usually zinc chloride or other inorganic acids, prior to carbonization in an inert environment. Moreover, the range of temperature which is used in chemical activation is lower in comparison to that used in physical activation [36]. Phosphoric acid is one of the acids that is selected as the activating agent instead of zinc chloride so as to avoid more serious environmental pollution by contamination with zinc compounds and also it is very easy to recover the carbon product during processing stage i.e. only rinsing with water is required [37].

Adsorption isotherm

Adsorption isotherm is defined that in equilibrium solution, there is relation between the amount of a substance which adsorbed in its constant concentration as well as at constant temperature. If a quantity, q is adsorbed by an adsorbent at the steady state equilibrium concentration c and then the function q(c) describes the adsorption isotherm. The most widely accepted surface adsorption models for single solute systems are the Langmuir and Freundlich models.

1. Langmuir adsorption isotherm

In 1916, a new model of isotherm for gases adsorbed to solids was published by Irving Langmuir published. It is derived from a proposed kinetic mechanism which is one of the simplest and semi-empirical isotherms. This model assumes uniform energies of adsorption on

the surface without transmigration of adsorbate in the plane of the surface [38]. This isotherm was based on different assumptions one of which is that dynamic equilibrium exists between adsorbed gaseous molecules and the free gaseous molecules.
It is based on four assumptions:

- The adsorbent surface is constant, i.e. all the sites for adsorption are identical.
- Adsorbed molecules do not act together.
- All adsorption happens through the same mechanism.
- At the maximum adsorption, only a monolayer is formed and the molecules of adsorbate do not deposit on other.

The Langmuir equation is written as (Langmuir, 1916):

$$\frac{1}{q_e} = \frac{1}{q_m} + \frac{1}{K_L Q_m C_e}$$

where K_L is Langmuir constant (L/mg) which is related to the affinity of binding sites and the free energy of sorption, Ce is the dye concentration at equilibrium in the solution, qe is dye concentration at equilibrium onto biosorbent (mg/g) and qm is dye concentration when monolayer forms on biosorbent (mg/g).

2. Freundlich adsorption isotherm

In 1909, an empirical equation was expressed by Herbert Freundlich for representing the isothermal variation of adsorption of a quantity of gas adsorbed by unit mass of solid adsorbent with pressure. This equation is useful description of adsorption phenomenon and is known as Freundlich Adsorption Isotherm which is entirely empirical. The intensity of adsorption is an indication of the bond energies between dye and adsorbent and the possibility of slight chemisorptions rather than physiosorption [39].
The Freundlich equation is written as

$$\ln q_e = \ln K_F + 1/n \ln C_e$$

Where n and K_F are Freundlich constants, that can be determined from the plot of ln q_e versus ln C_e. The parameters 1/n and K_F are interconnected to sorption capacity and the sorption intensity

of the system. The magnitude of the term (1/n) gives an indication of the approvability of the adsorbate systems.

Adsorption equation or simply Freundlich Isotherm.

$$\frac{x}{m} = kP^{\frac{1}{n}}$$

Where, x/m = adsorption per gram of adsorbent which is obtained be dividing the amount of adsorbate (x) by the weight of the adsorbent (m). P is Pressure, k and n are constants whose values depend upon adsorbent and gas at particular temperature.

Though Freundlich Isotherm correctly established the relationship of adsorption with pressure at lower values, it failed to predict value of adsorption at higher pressure. This relation is called as the freundlich adsorption isotherm.

3. Amount of adsorption at equilibrium, qe (mg/g), was calculated by

Amount adsorbed

q_e= Ci-Ce/m

Where, Ci and Ce were the initial and equilibrium concentrations (ppm) of dye, respectively and m are the weight of AC.

4. The dye removal percentage can be calculated as follows:

Percentage removal =100(Ci-Ce)/Ci

PARAMETERS

1. Effect of pH

2. Effect of Contact time.

3. Effect of Initial Metal Ion Concentration.

4. Effect of Particle Size.

5. Effect of adsorbent dose and initial dye concentration.

6. Ash Content.

7. Moisture Content.

8. Iodine Number.

9. Total Hardness.

OBJECTIVES:

1) Preparation of Activated carbon from mango peels and mango kernels.
2) Characterization of Activated carbon of mango peels and mango seeds by UV, FTIR, SEM and TG spectrometry.
3) Adsorption of various dyes and heavy metal determination from wastewater.

LITERATURE REVIEW

Various methods are convenient to eliminate the dyes from aqueous solution; amongst all, adsorption is simple and low-cost process which is well founded and worldwide accepted. In recent decades due to rise in the pollution all over there is a essential to develop the alternatives to commercial adsorbents and many researchers in this connection developed different types of adsorbents that have adsorption capacities as compared to commercial one. The adsorbents be like fly ash, biosorbent, food waste, silica, polymer, carbon nanotubes, clays, zeolites, chitosan, peat moss, food waste etc. are reported.

- **M.A.BARAKA et al., 2010** investigated the new trends in removing heavy metal from industrial wastewater. A vast range of treatment technologies such as adsorption, chemical precipitation, membrane filtration, photocatalysis and electrodialysis have been developed for removal of heavy metal from polluted wastewater. One of the most constructive conventional means has been found to be lime precipitation means to treat inorganic liquid waste with a metal concentration higher than 1000 mg/L; new adsorbents and membrane filtration are very often studied and widely applied for the treatment of the heavy metal-contaminated wastewater; photo catalysis is a promising unconventional technique for a clean and effective treatment. Ion exchange is another method used successfully in the industry for the removal of heavy metals from effluent.

- **KHAIRIA M. AL-QAHTANI, 2015 i**nvestigated the water purification by using different waste fruit cortexes (banana, tangerine and kiwi) were tested, and the phenomenon of adsorption was found to be depend upon different parameters like pH, time and amount of adsorbent used. As a result, it was found that pH of Cd^{+2} , Cr^{+3} and Zn^{+2} is 6 from the cortexes of fruits like banana and kiwi. The cadmium, chromium and zinc ions achieved equilibrium in 60 min. The experimental results for all of the metal ions were well fitted to the Langmuir mathematical equation, and the kinetics confirm to

the pseudo-second-order equation. Complexation is presented as the adsorption mechanism.

- **FAYZA S.HASHEM, KHAIRIA M.AL-QAHTANI et al., 2016** investigated the comparable study on activated carbon produced by different fruit peels by chemical treatment using phosphoric acid showed higher ejection efficiency compared to the dried fruits peels from which they are processed . The activated carbon obtained from kiwi and banana peels exhibited the higher efficiency for Cu (II) removal while that derived from pomegranate and mandarin peels showed adequate results. The characteristics of the activated carbon were studied via surface area, determination of percentage of age and moisture contents, SEM for microstructure and functional groups existing via FTIR.
- **DIMPLE C PAREKH et al., 2002** investigated that with the help of mango seed powder there is possibility to remove heavy metals present in aqueous solution like cadmium, copper and lead etc. This Study was carried out by using different parameters in batch technique as a function of metal ion concentration, contact time and pH of the solution. At acidic pH itself maximum sorption was observed. The study on synthetic solutions shows that for the removal of heavy metals from wastewater, mango seed powder can be used.

- **K. RAVINDHRANATH AND B. SREENIVASA, 2014** investigated the leaves and barks of some plants as bio-adsorbents for the control of methylene blue dye from waste water using different physicochemical parameters such as pH, sorbent concentration and time of equilibration for the maximum removal of Methylene Blue from waste waters have been optimized using simulated waste waters. The optimum concentration of sorbent and time of equilibration needed for the maximum removal of Methylene Blue is less for the leaves powders than the respective plants stems/barks powders as sorbents. Fivefold excess of common anions ions present in natural waters, have not interfered the extractability of Methylene Blue at optimum extraction conditions. Cation like Ca^{2+}, Mg^{2+} and Cu^{2+} have shown some interference but Fe^{2+} and Zn^{2+} have synergistically maintained the maximum extraction of the dye.

- **T. SANTHI, S. MANONMANI et al.,** Investigated the removal of Malachite green (MG) and Methylene blue (MB) by CAS from aqueous solutions. The removal efficiency was dependent of pH. From his results, it was obtained that the adsorption process depends upon pH value and also show that the efficiency to remove the different dyes like malachite green and methylene blue exceeded. When the amount of initial concentration of dye increases, there is an increase in the amount of dye adsorbed from aqueous solution. The equilibrium data well fitted to the Langmuir adsorption isotherm model and the adsorption kinetic followed the pseudo-second –order equation. These results suggest that a squmosa seed is a low-cost adsorbent for the removal of dye from industrial wastewater. The adsorption capacity of CAS on MG is greater than MB.
- **K. SHAHUL HAMEED et al., 2013** investigated the activated carbon prepared from the low cost materials such as jambul seed carbon(JSC), amla seed carbon(ASC), tamarind seed carbon(TSC) and soapnut carbon(SNC) for ejection of chromotrope (CH) dye from wastewater has suitable adsorption capacity with regard to the removal of chromotype dye from its aqueous solution . The obtained results were compared with that of Commercial Activated carbon (CAC). As a result, with increase in the amount of adsorbent than there is decrease in amount of adsorbent. He also conclude that adsorbents having low cost show adsorption capacities as following order: ASC>JSC>TSC>SNC. The activated carbons prepared were characterized by FT-IR and SEM analysis.
- **MUSTAFA T.YAGUB, TUSHAR KANTI SEN et al., 2014** investigated the development on the application of adsorption in removing the dyes from the aqueous solution. It tells information about the dye, its classification and toxicity level of these dye, different treatment methods and dye adsorption characteristics by different adsorbents. It has also presented the effectiveness of different adsorbents under different physico-chemical process parameters and their comparative adsorption capacity towards dye adsorption. The applicability of various adsorption kinetic models and adsorption isotherm models for the removal of dye by wide range of adsorbents has been reported.

MATERIALS AND METHODS

1. Raw material: For this project, the raw materials used are mango peels AC and mango kernels AC were obtained.

2. Chemicals: The chemicals used during this project were sodium thiosulphate, phosphoric acid, iodine solution, EDTA solution, hydrochloric acid, calcium carbonate, sodium bicarbonate.

3. Instrumentation: Muffle furnace, weighing machine, oven, TDS meter, UV spectro-photometer, heating mantle, IR Spectrometer.

4. Proximate analysis: Proximate analysis is the determination of moisture content, ash content and volatile matter by prescribed methods.

ASH CONTENT:

In this the crucible were preheated to about 500° C and cooled in dessicator and taken the weight. Then take 1g of activated carbon of peels in crucible and reweighed and placed in furnace and temperature raised to about 500° C for about 1.5hr. Allowed to cool in dessicator at room temperature and then measure the weight of the ash.

Total Ash% = [(D-B)/(C-B)]*100

D= weight of crucible + ash sample

B= weight of empty crucible

C= weight of crucible + original sample

MOISTURE CONTENT:

Thermal drying method was used in the determination of moisture content.1g of AC was weighed and taken in the Petri dish. It was then heated in an oven at 105-110° C of temperature for 1.5hr. After heating Petri dish was removed and cooled in a dessicator. After cooling the weight of dried sample was measured. The difference between the initial and final mass of the AC represents moisture content.

Moisture % = Loss in weight on drying (g)/ Initial weight (g) *100

pH:

1g of activated carbon of mango peels or mango kernels was taken in conical flask and 100ml of distilled water was added to it. The mixture was continuously stirred for 1hr. pH meter was used for taking down the readings.

IODINE NUMBER DETERMINATION:

Iodine number is defined as a measure of the micro-pore content of the activated carbon. A higher iodine number signifies higher micro-porosity of the sample. For determining the iodine number of activated carbon, 0.3 g of dried AC was mixed with 10ml of 5% by weight of HCl in a conical flask. It was swirled properly until the AC was wetted. After this 10ml of iodine solution and 1ml starch solution was added to it. The flask was shaken vigorously for 1min.The contents were filtered and the remaining filtrate was titrated against 0.1M solution of sodium thiosulphate solution until yellow color just disappeared. Concentration of the final solution was calculated. The procedure is repeated with a different amount of AC.

PREPARATION OF ACTIVATED CARBON BY MANGO PEELS

Mango peels are removed from the mango fruit employing a kitchen knife and washed it thoroughly with distilled water to remove any kind of impurities. Dried in sunlight for 2-3 days and then dried in oven at 55°C. Then these dried peels are crushed into a crusher machine and make a powdered form of size 335mm. Now take 20g of mango peels powder and add to it 60ml phosphoric acid in RBF and attach a condenser to it and boiling take place for 6 hours. Then remove the condenser, we get ash content which is highly acidic pH around 3. To make it basic we add a solution of sodium bicarbonate till ph reaches around 7. Then give a washing with distilled water 2 to 3 times. Collect the activated carbon by filtration through filter paper and dried in oven for 24 hours. We get a powdered activated carbon and collected it for further experiment.

Color- Light brown **Weight-** 28g (powdered mango peels)

Yield- 6.8g (AC of mango peels)

ACTIVATED CARBON OF MANGO PEELS

PREPARATION OF ACTIVATED CARBON BY MANGO KERNELS

Mango kernels are collected from the mango fruit and washed it properly with clean water 2-3 times to remove any kind of impurities from it. Then dried in sunlight for 1 week and again dried in oven at 55° C. These dried mango kernels are crushed in a crusher machine and make a powdered form of size 355mm. Now take 20g of powdered form of mango kernels in RBF and add to it 60ml phosphoric acid. Attach a condenser to it and boiling take place for 6 hours by maintaining a temperature at 40°C. Then take out the condenser, we get ash like which is highly acidic having pH around 3. To make it basic we add a solution of sodium bicarbonate till pH reaches around 7. Then give a washing with distilled water for 2-3 times. Collect the activated carbon by filtration through filter paper and dried in oven for 24 hours. We get a powdered activated carbon and collected it for further experiment.

Color- Light yellow **Weight**- 24.28g (powdered mango kernels)

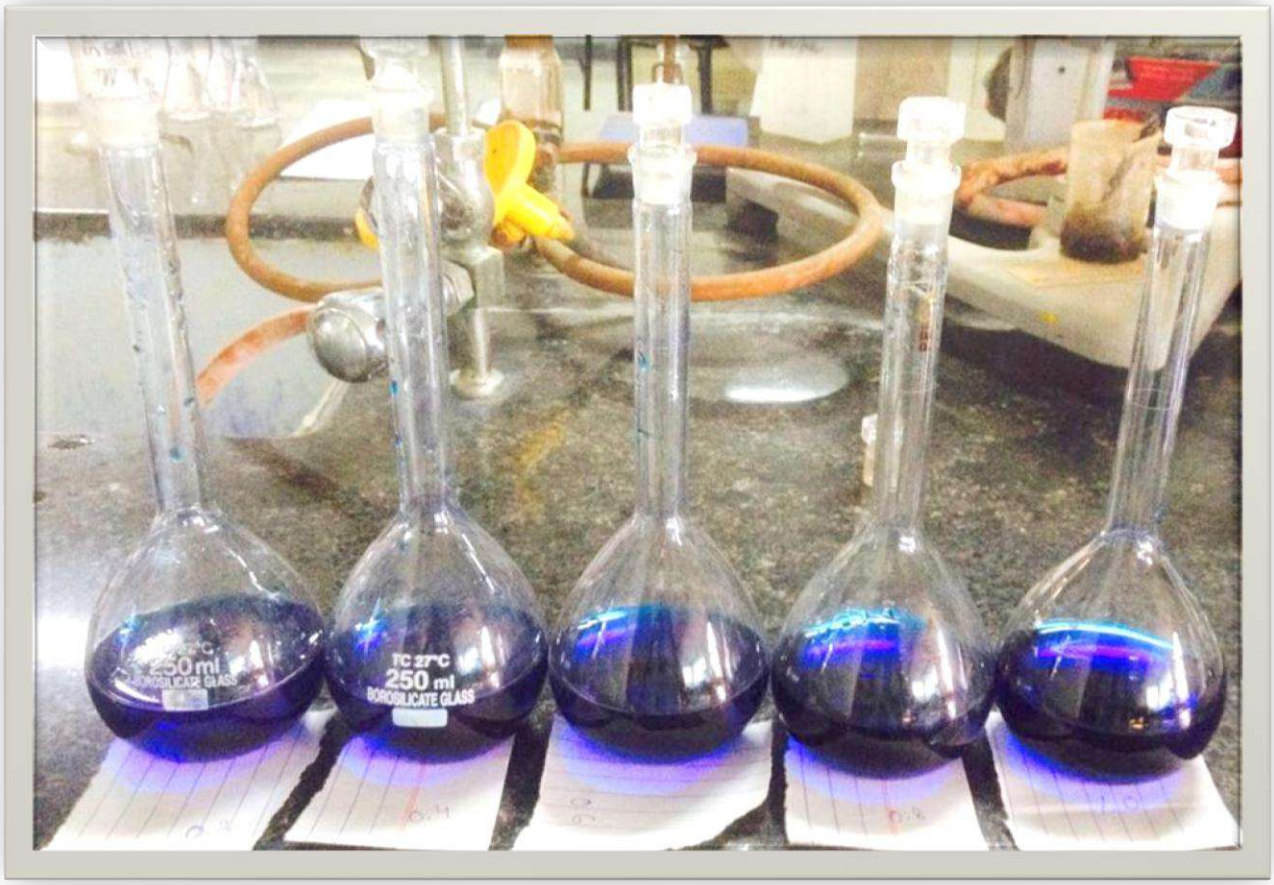
Yield- 6g (AC of mango kernels)

ACTIVATED CARBON OF MANGO KERNELS

Adsorbate

Methylene blue (basic blue 9; chemical formula, $C_{16}H_{18}ClN_3S$ and molecular weight 319.85 g/mole) was used as an adsorbate which is a synthetic basic dye. By dissolving the required amount of dye powder in double distilled water, A stock solution of MB dye was prepared.

Now prepared a methylene blue dye solution by taking 50 mg in 1000 ml distilled water to check the absorption phenomenon. Taken various amount of Activated carbon like 0.2g, 0.4g, 0.6g, 0.8g and 1g in different 100ml volumetric flasks. Make it to 100ml mark by adding methylene blue dye. We have noted the absorbance after 10min, 20min, 30min and so on. Absorption of dye was seen as time passes. We have taken absorbance after 1 day, 2 days and after 20 days. The color of the dye becomes light it changes from light blue to yellow then transparent as activated carbon shows its absorption process.



Total Hardness

Total hardness is defined as the amount of magnesium and calcium salts as carbonates, bicarbonates and sulfates that are dissolved in the water. As the calcium and magnesium content increases, the degree of hardness becomes greater. To check the hardness of water, prepare an EDTA solution, ammonia buffer, hard water of 500ppm and EBT indicator. The solution of EDTA was taken in burette. Firstly we take the blank reading by dissolving 2ml ammonia buffer, 2drops of EBT indicator in 5ml of hard water. Note down the reading when red color changes to blue or green. Now take the reading by taking hard water and 1g AC in 2ml ammonia buffer and 2 drops of EBT indicator. Note down the reading after 10 min, 20min, 30 min and so on. By the given formula of Total hardness we can check the hardness of water.

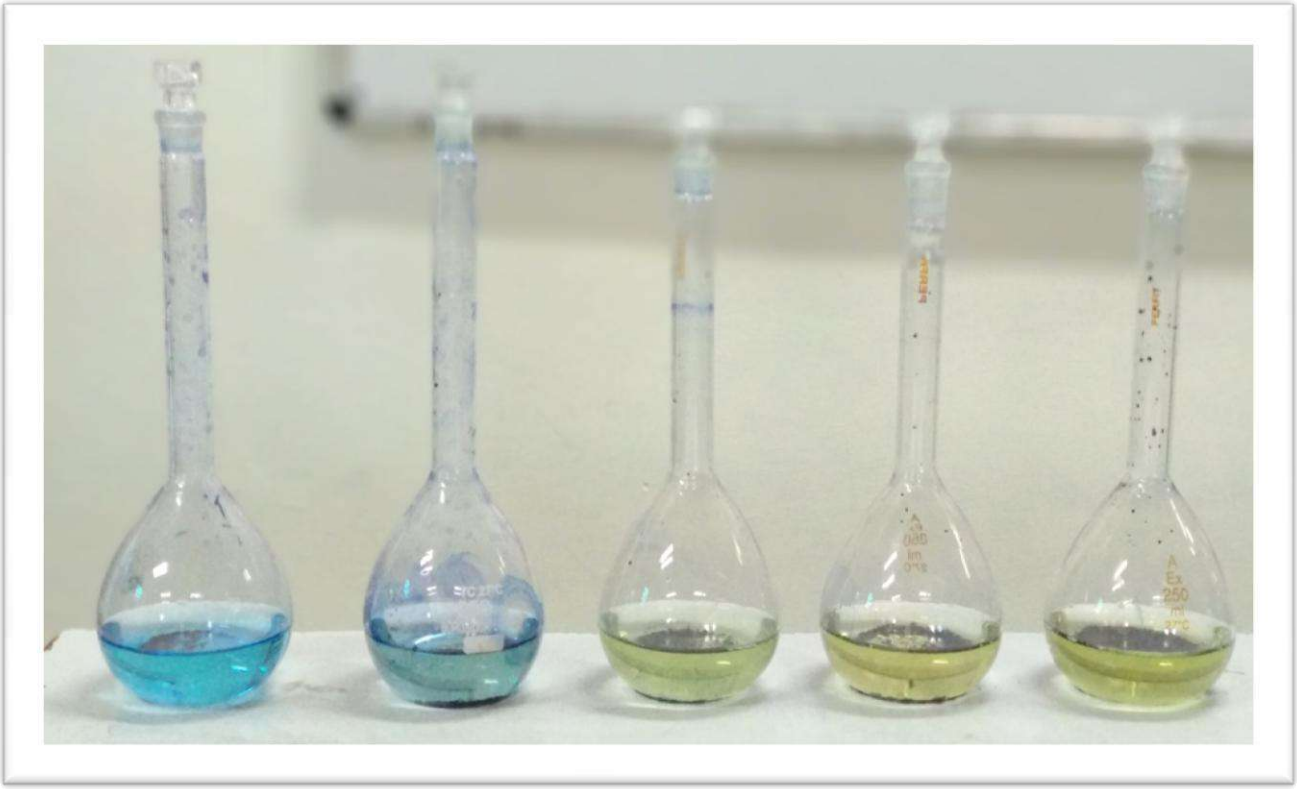
Total Hardness (in mg/l) = Volume of EDTA used*N*50*1000/Volume of Sample water

RESULTS AND DISCUSSION

Time	Wavelength	Absorbance of AC of mango peels				
		0.2g	**0.4g**	**0.6g**	**0.8g**	**1g**
10 min	650	3.447	3.445	3.427	3.400	3.401
	393	0.114	0.120	0.123	0.127	0.127
	288	3.622	3.940	3.941	3.907	3.938
20 min	706-653	-0.055	3.396	3.361	3.293	3.269
	288-393	-0.058	0.111	0.130	0.136	3.494
	290-245		3.80	3.966	3.749	1.807
30 min	650-660	3.314	3.314	3.247	3.147	1.473
	286-288	2.562	2.562	2.472	2.356	1.137
2 days	659-663	1.834	1.382	1.089	0.732	0.407
	285-288	1.146	1.195	1.237	1.161	
3 days	660-662	1.120	0.672	0.539	0.409	0.230
	288	0.710	0.768			
17 days	660-666		0.067	0.056	0.055	0.055
	611-616		0.072	0.055		0.058

Table 1: Absorbance of AC of mango peels in Methylene blue dye

ADSORPTION OF METHYLENE DYE AFTER 15 DAYS



UV SPECTRUMS OF AC OF MANGO PEELS AFTER DIFFERENT TIME INTERVALS

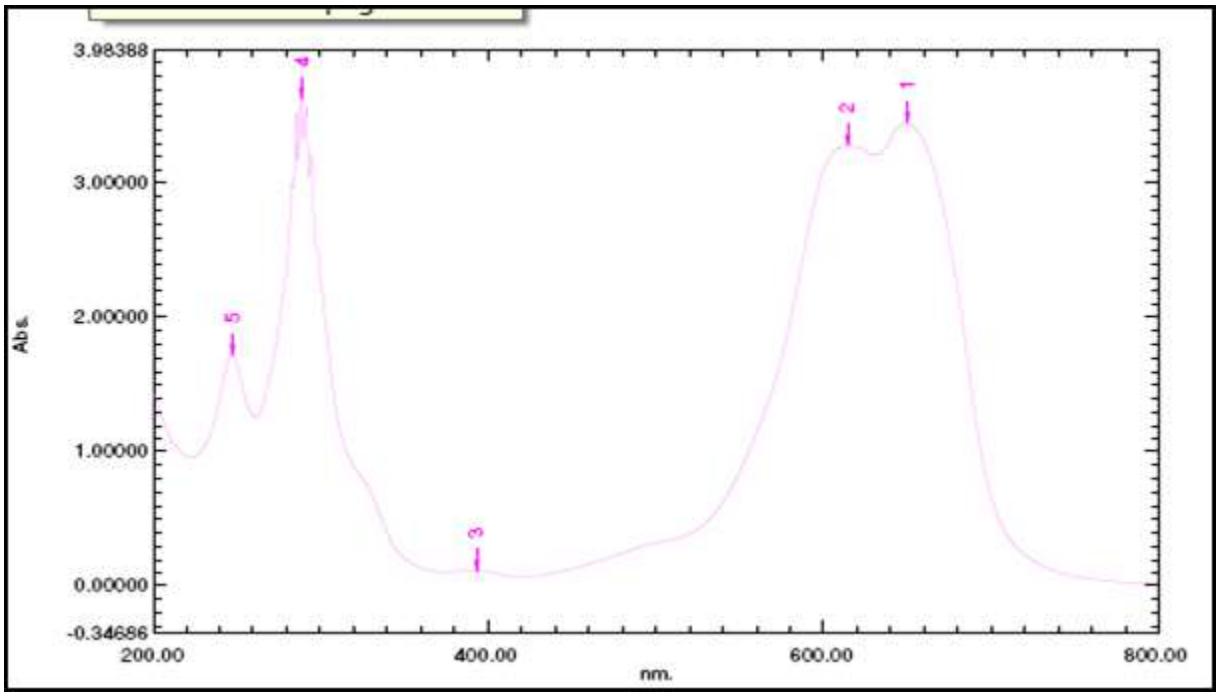


Figure 1: UV spectrum of 0.2g of AC of mango peels (after 10min)

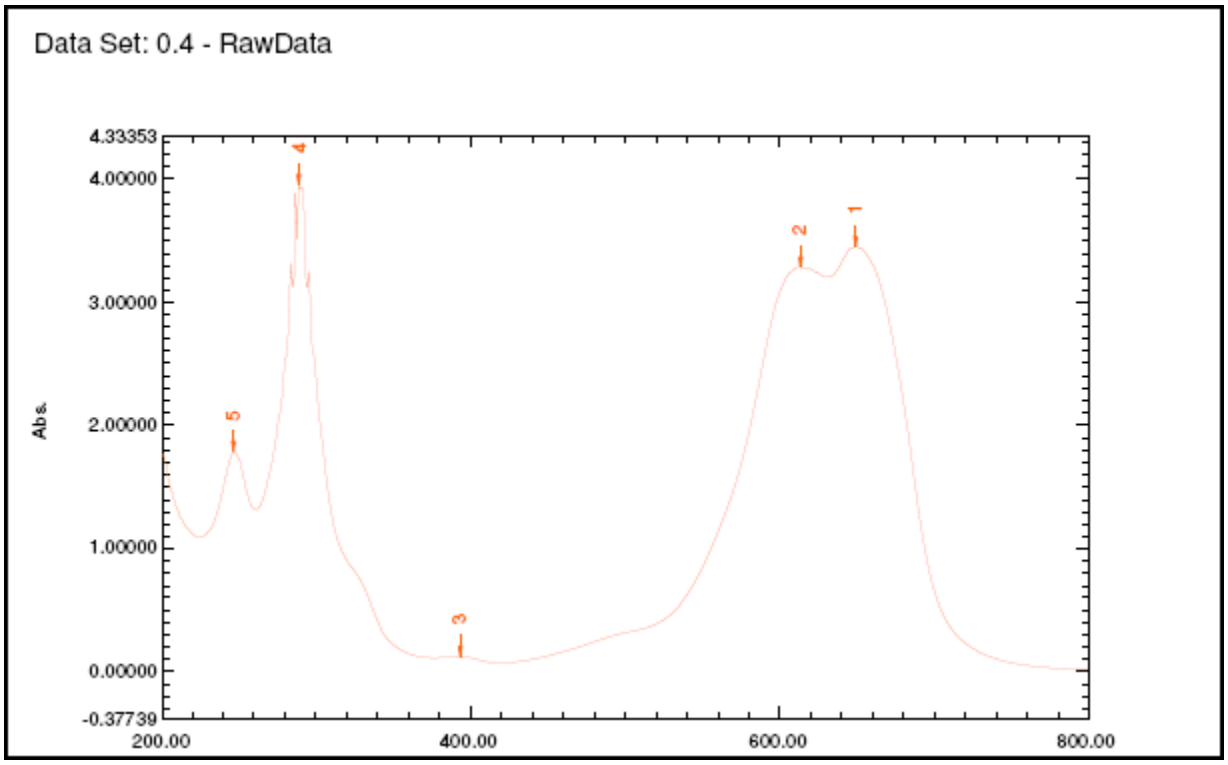


Figure 2: UV spectrum of 0.4g of AC of mango peels (after 10min)

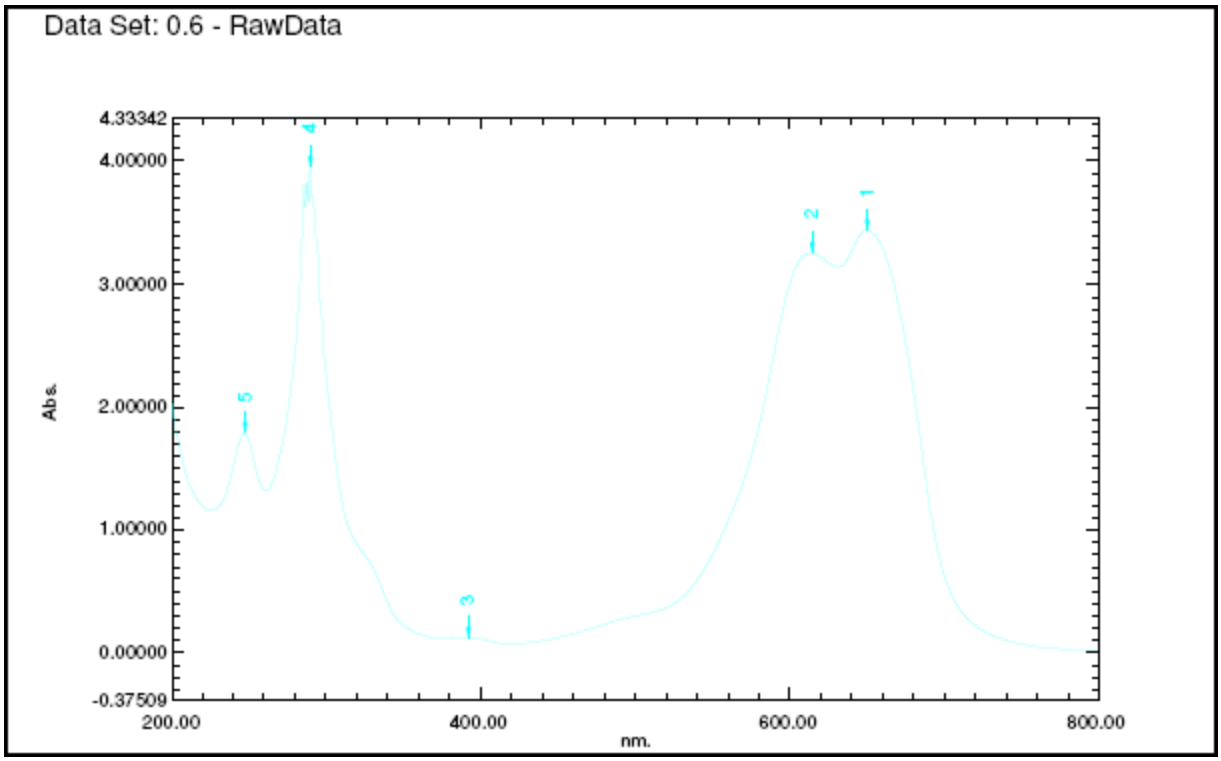


Figure 3: UV spectrum of 0.6g of AC of mango peels (after 10min)

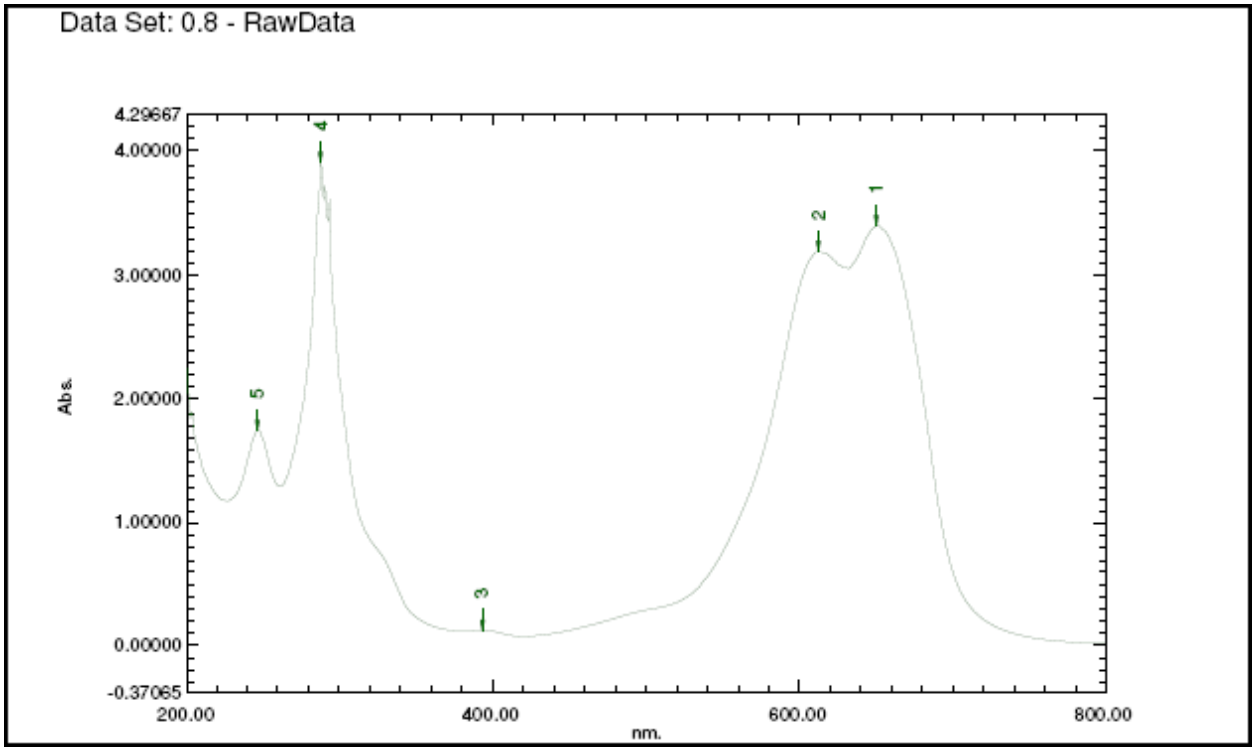


Figure 4: UV Spectrum of 0.8g AC of mango peels (after 10min)

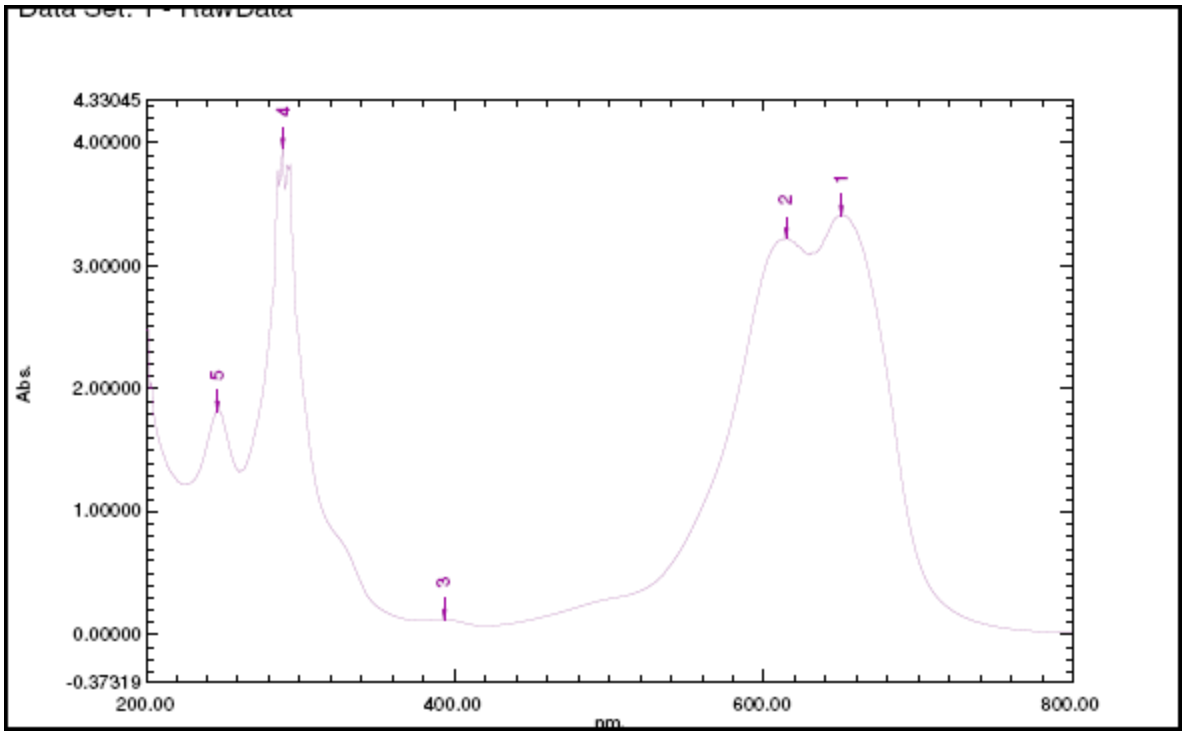


Figure 5: UV Spectrum of 1g AC of mango peels (after 10min)

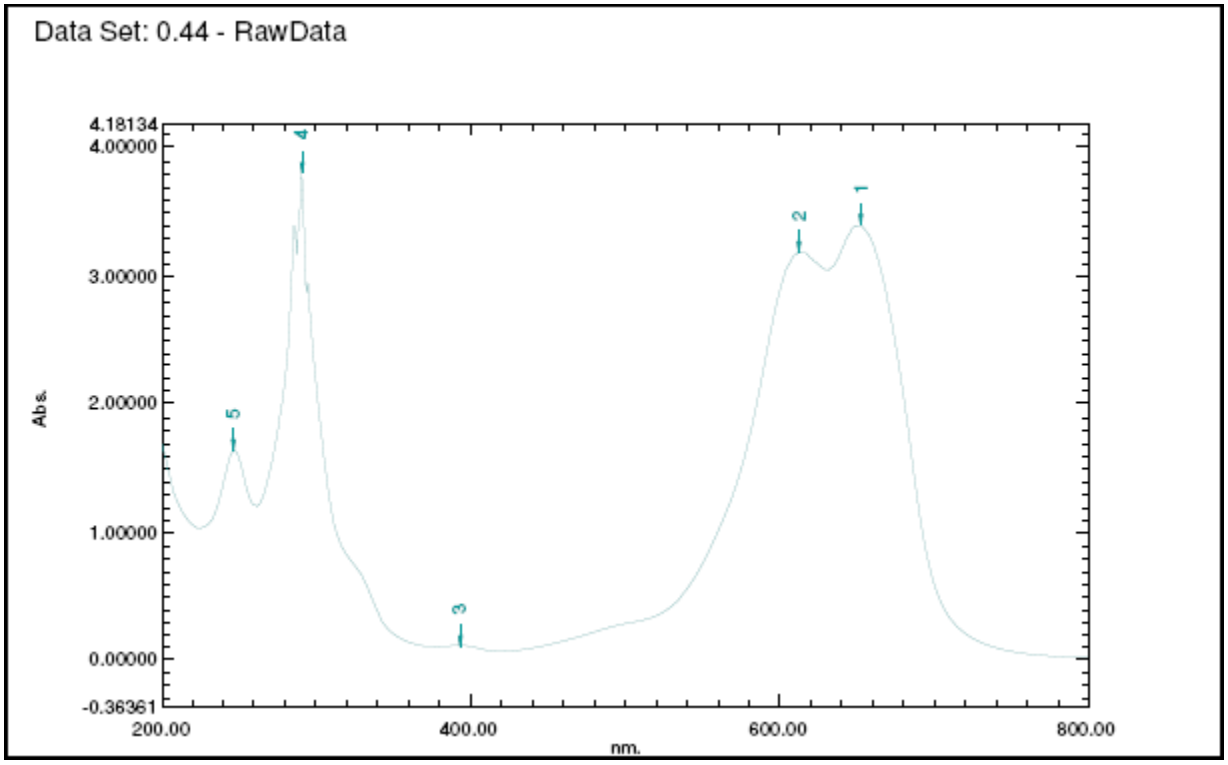


Figure 6: UV spectrum of 0.4g of mango peels (after 20 min)

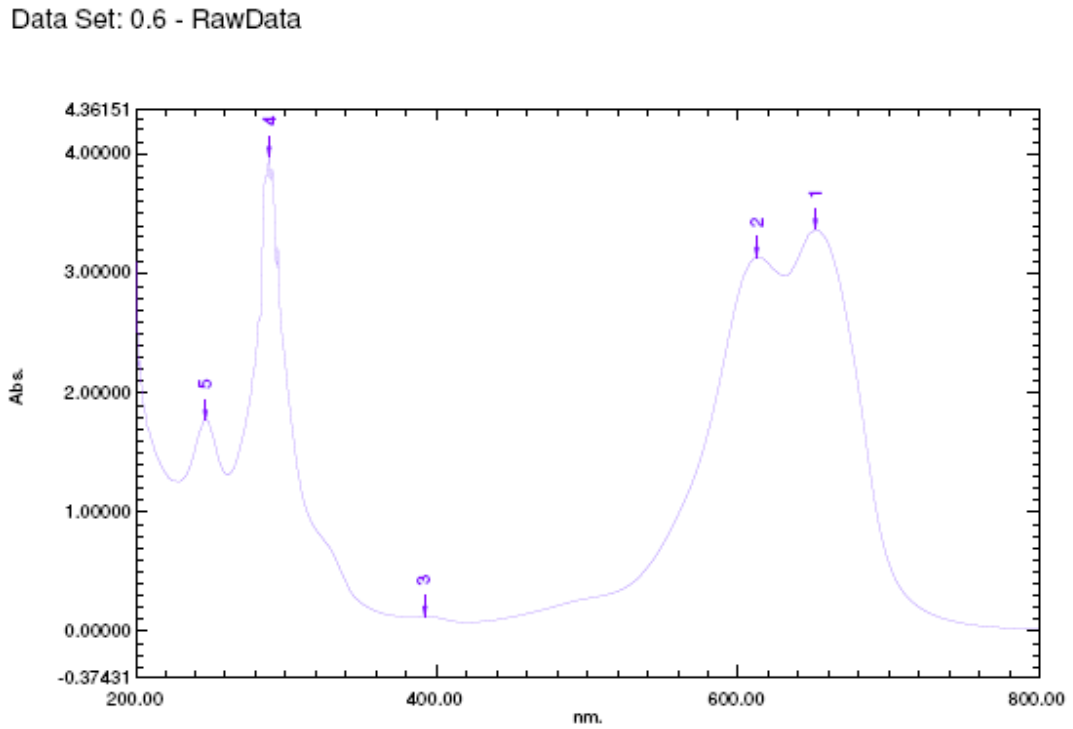


Figure 7: UV Spectrum of 0.6g of AC of mango peels (after 20 min)

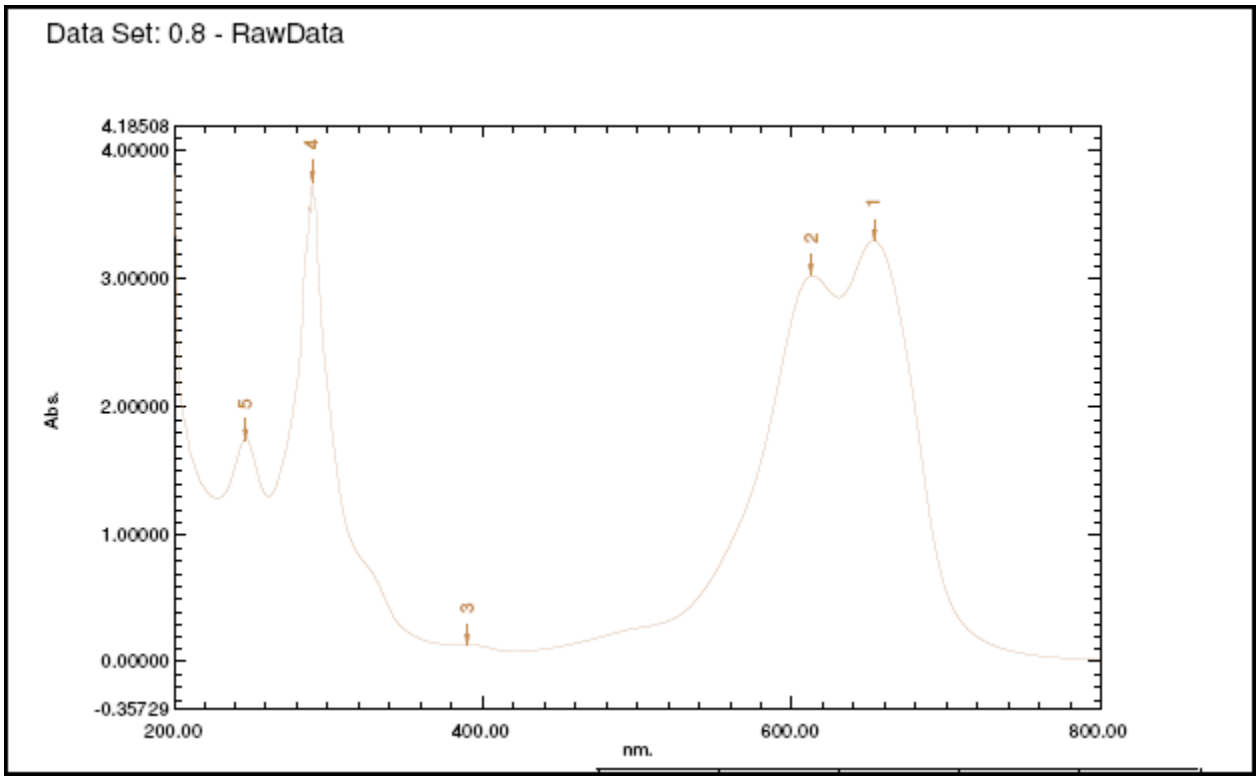


Figure 8: UV Spectrum of 0.8g of AC of mango peels (after 20 min)

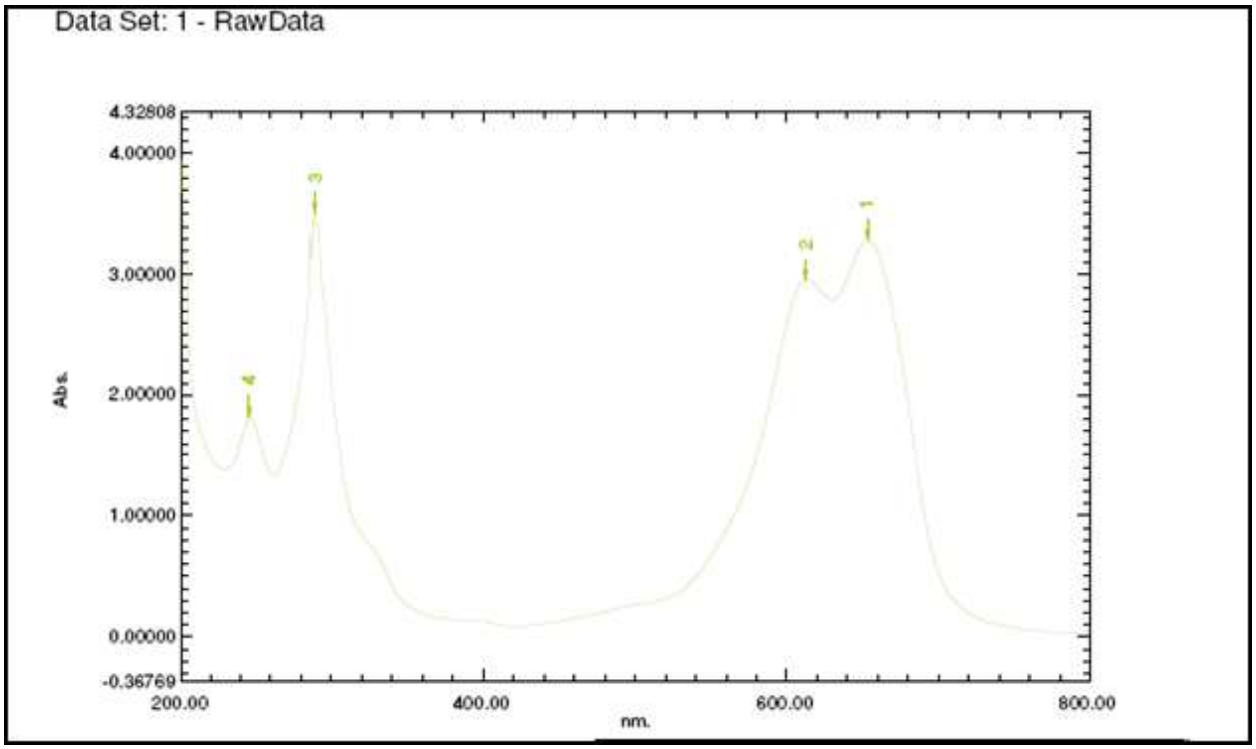


Figure 9: UV Spectrum of 1g of AC of mango peels (after 20min)

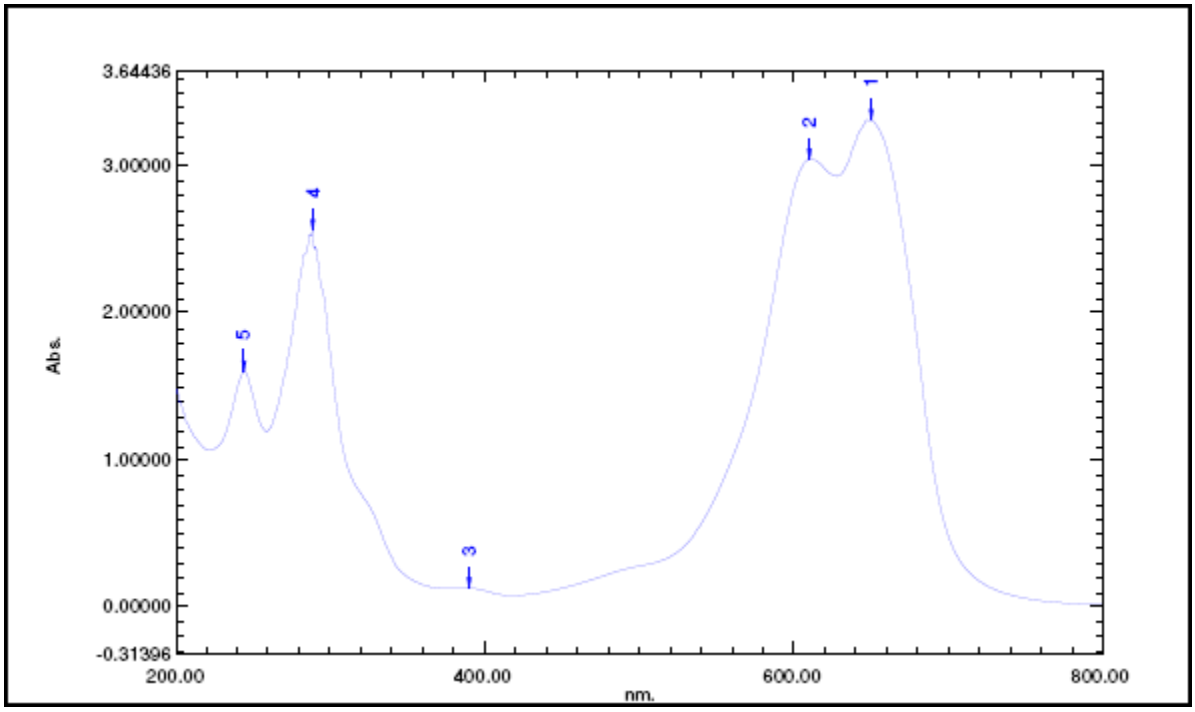


Figure 10: UV Spectrum of 0.2g of AC of mango peels (after 30min)

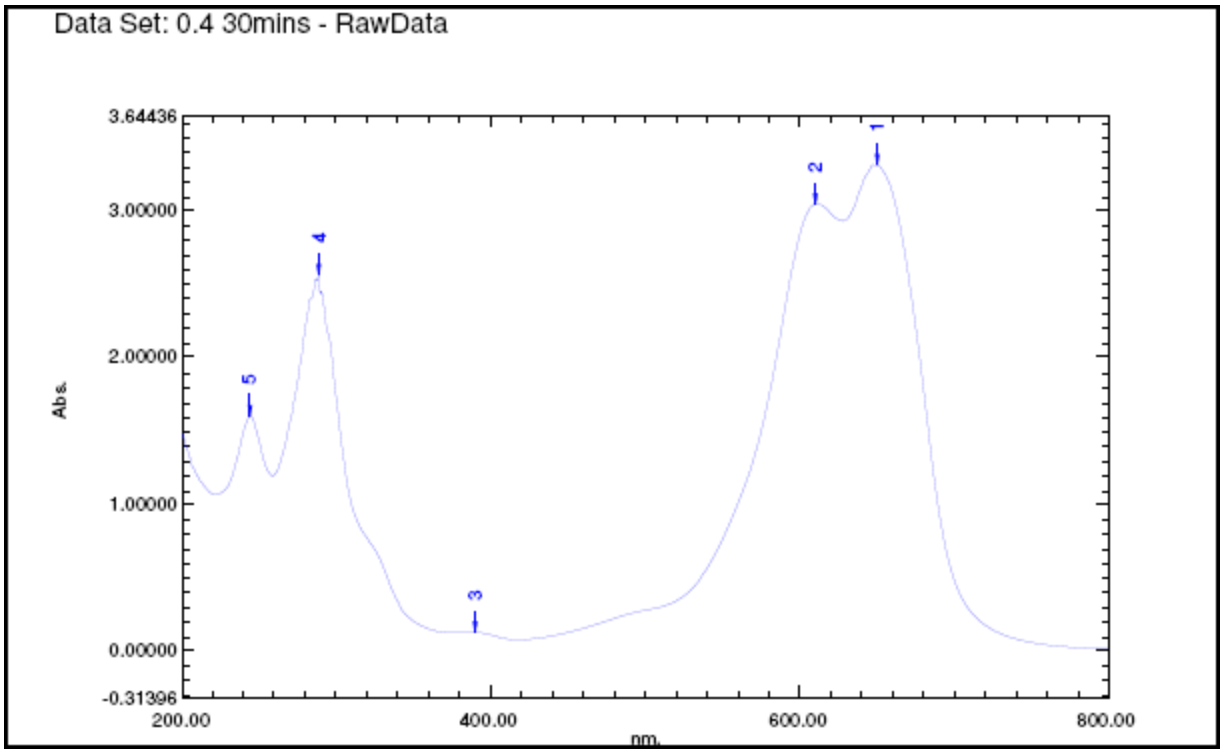


Figure 11: UV Spectrum of 0.4g of AC of mango peels(after 30min)

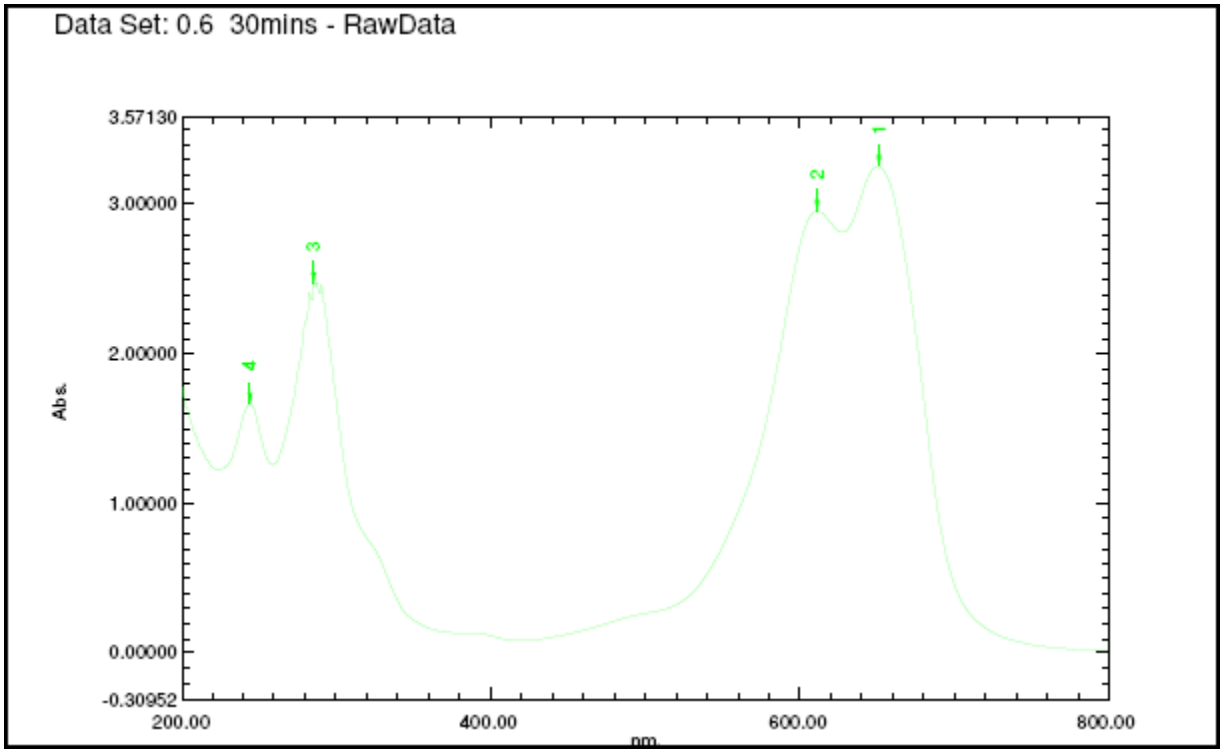


Figure 12: UV Spectrum of 0.6g AC of mango peels(after 30 min)

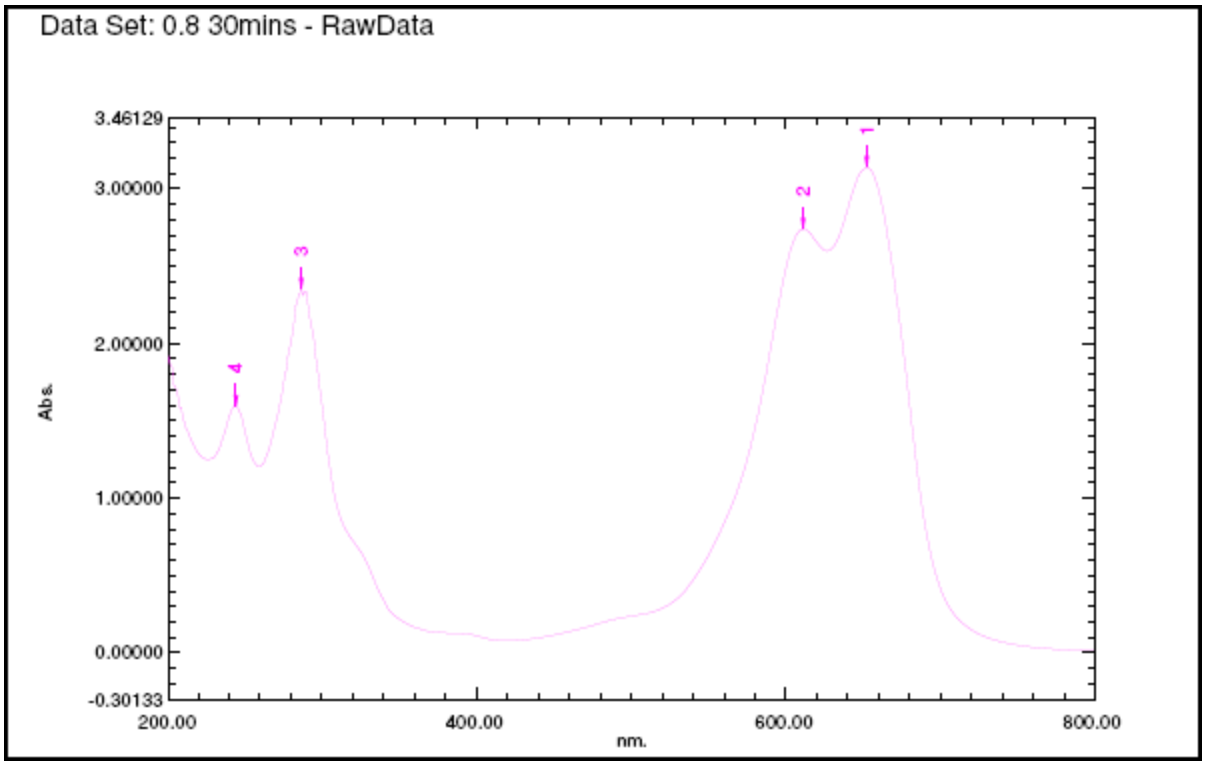


Figure 13: UV Spectrum of 0.8g AC of Mango peels (after 30min)

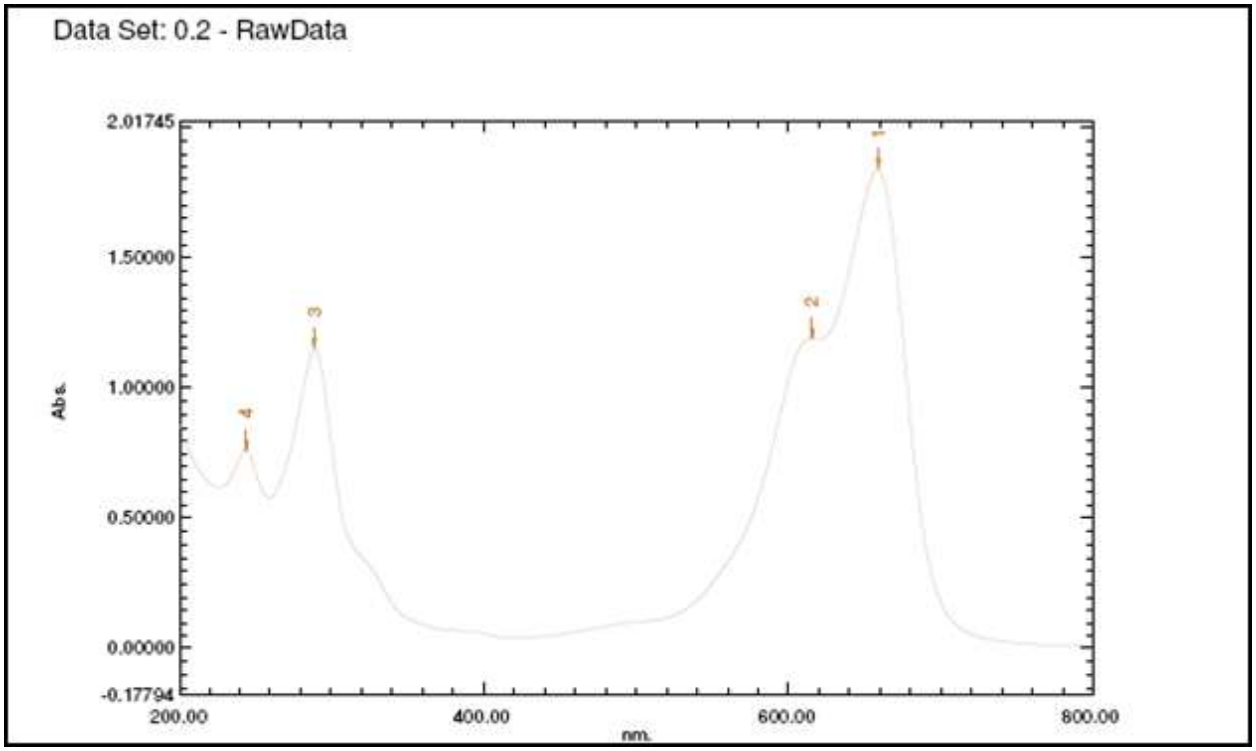


Figure 14: UV Spectrum of 0.2g AC of mango peels (after 2 days)

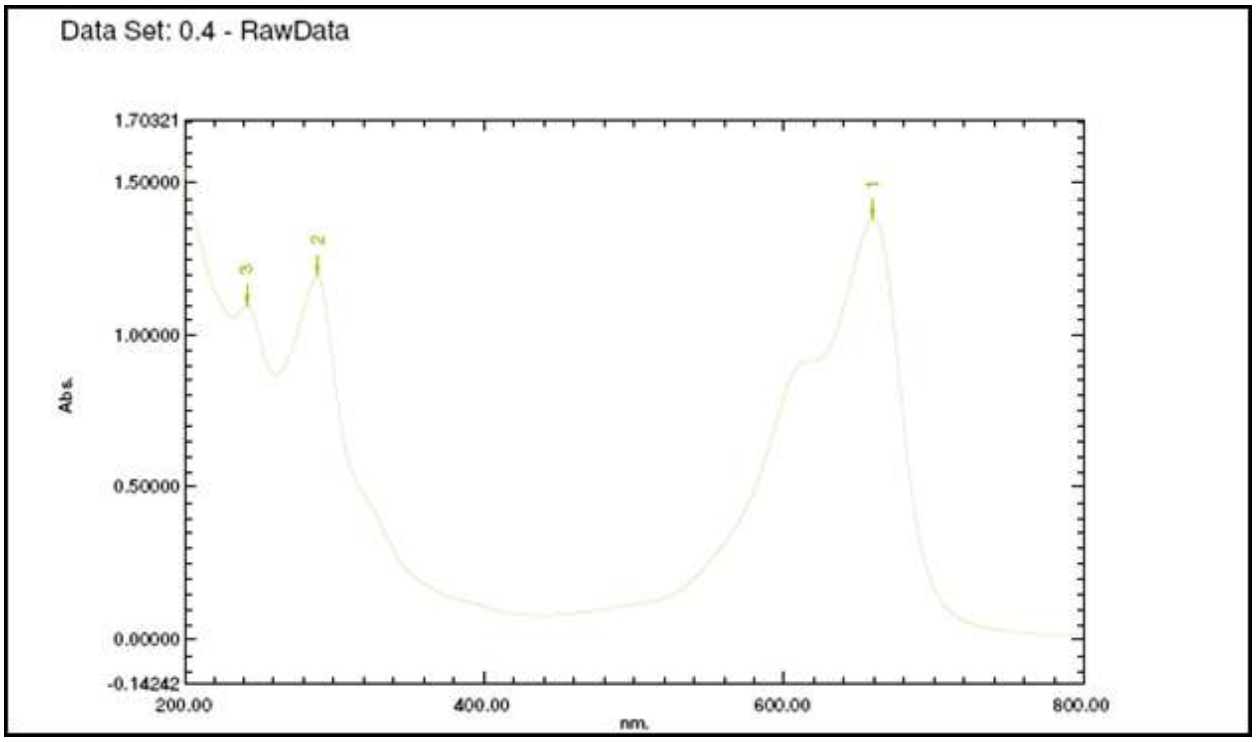


Figure 15: UV Spectrum of 0.4g AC of mango peels (after 2 days)

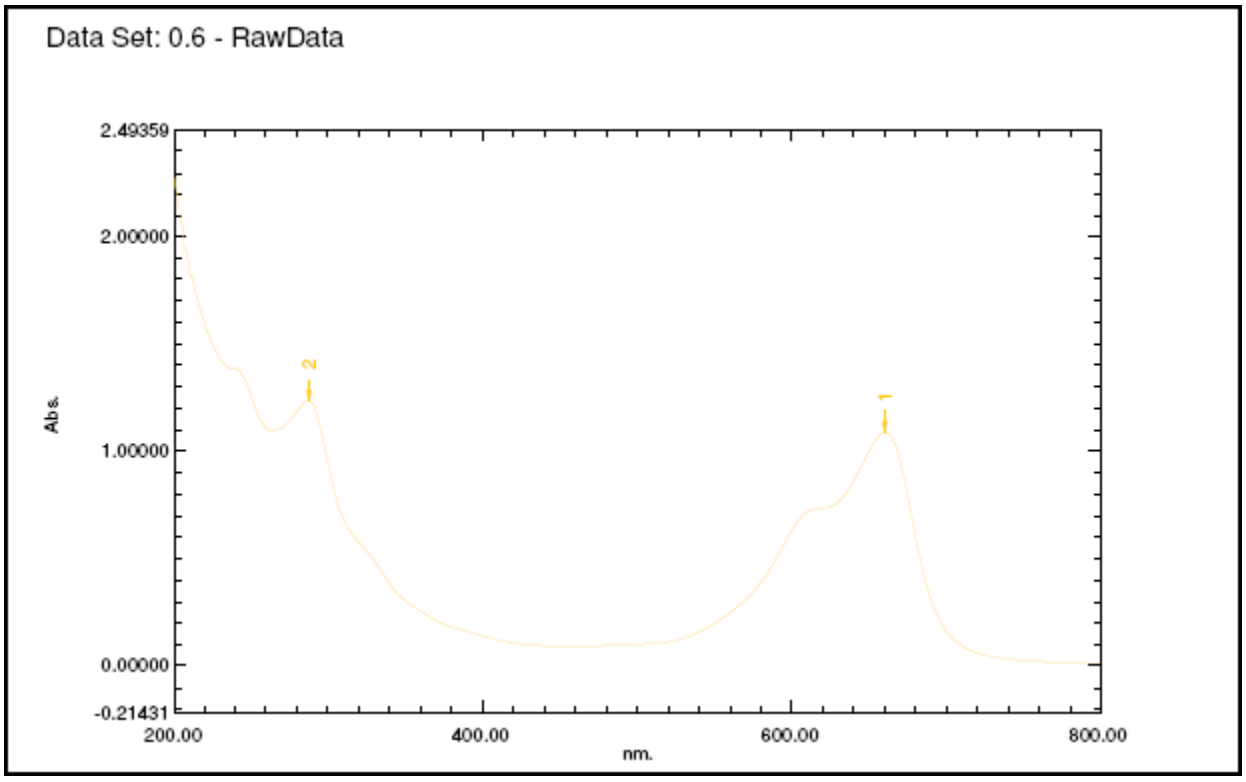


Figure 16: UV Spectrum of 0.6g AC of mango peels (after 2 days)

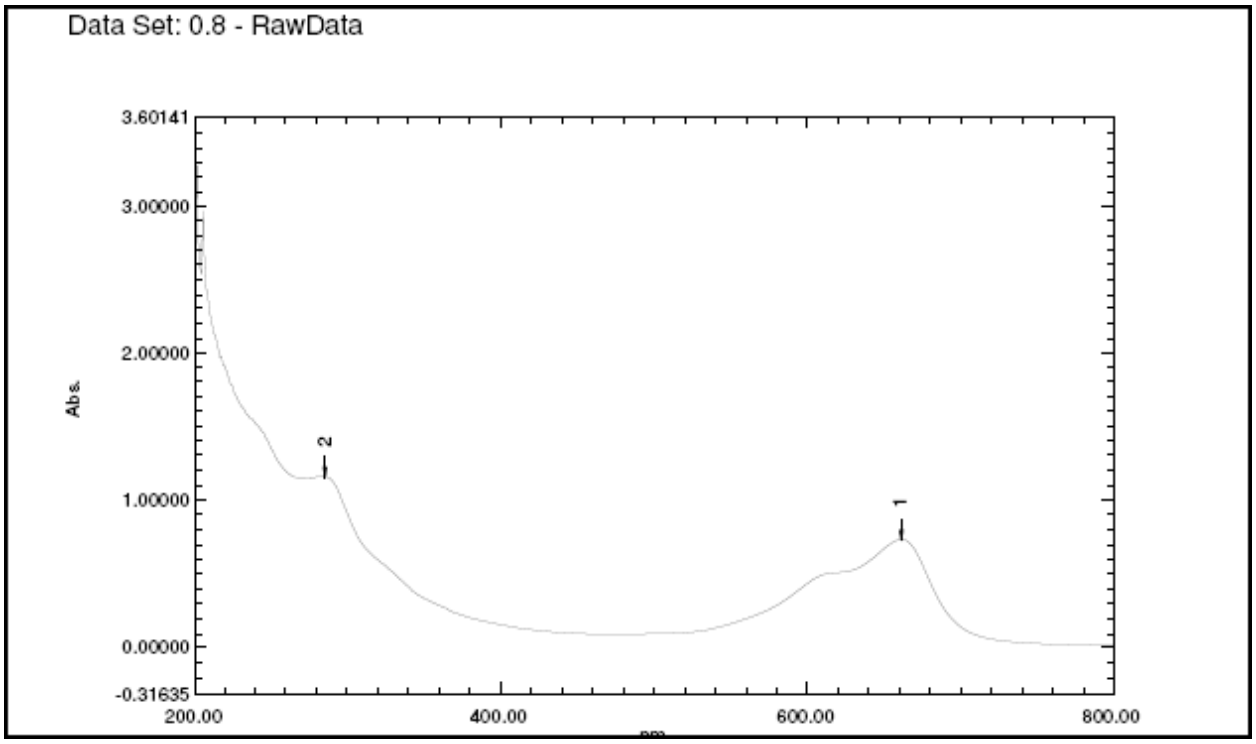


Figure 17: UV Spectrum of 0.8g AC of mango peels(after 2 days)

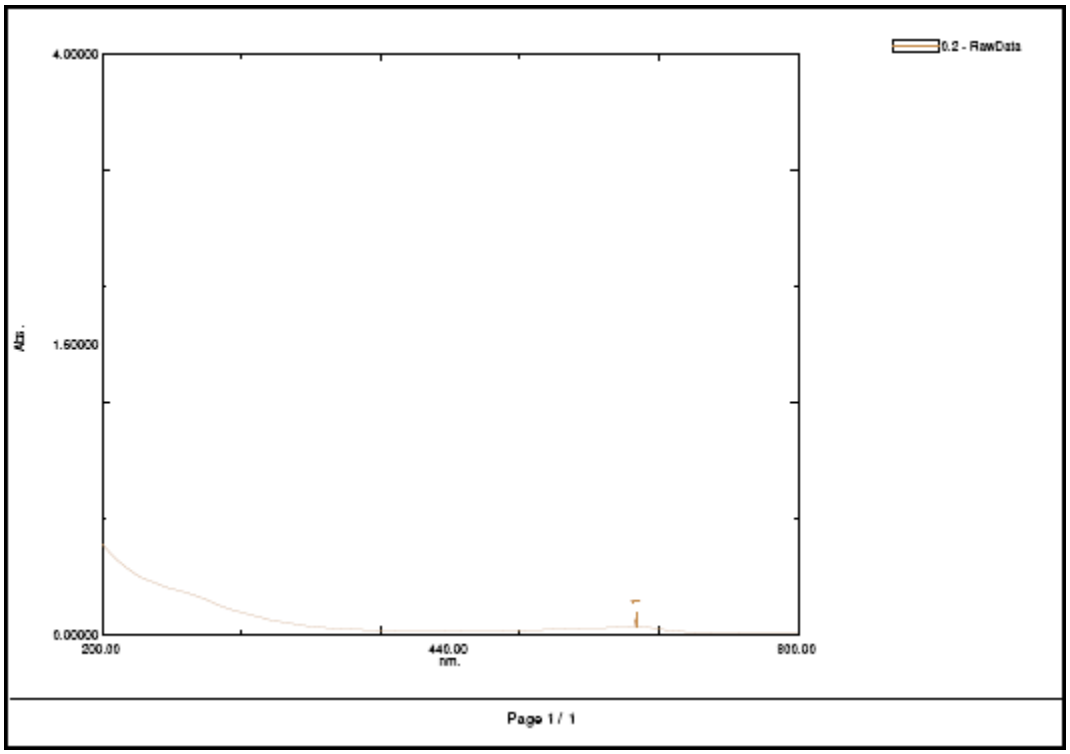


Figure 18: UV Spectrum of 0.2g AC of mango peels (after 17 days)

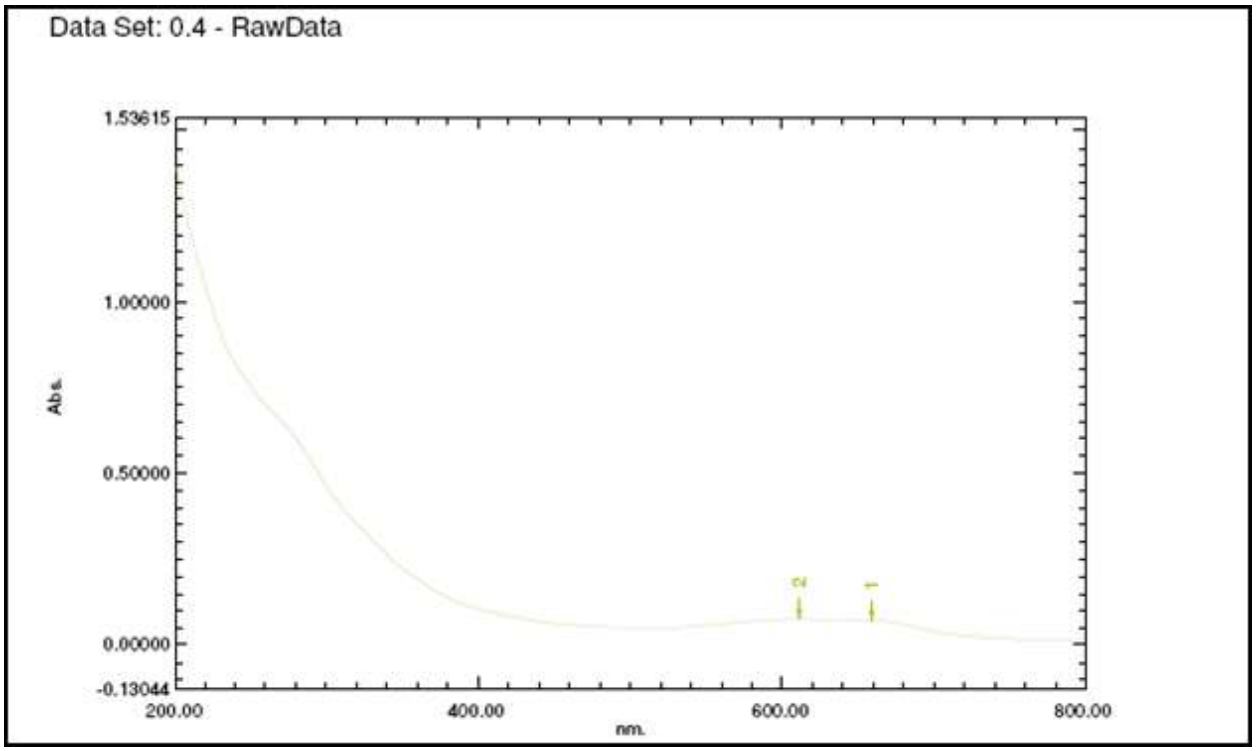


Figure 19: UV Spectrum of 0.4g AC of mango peels (after 17 days)

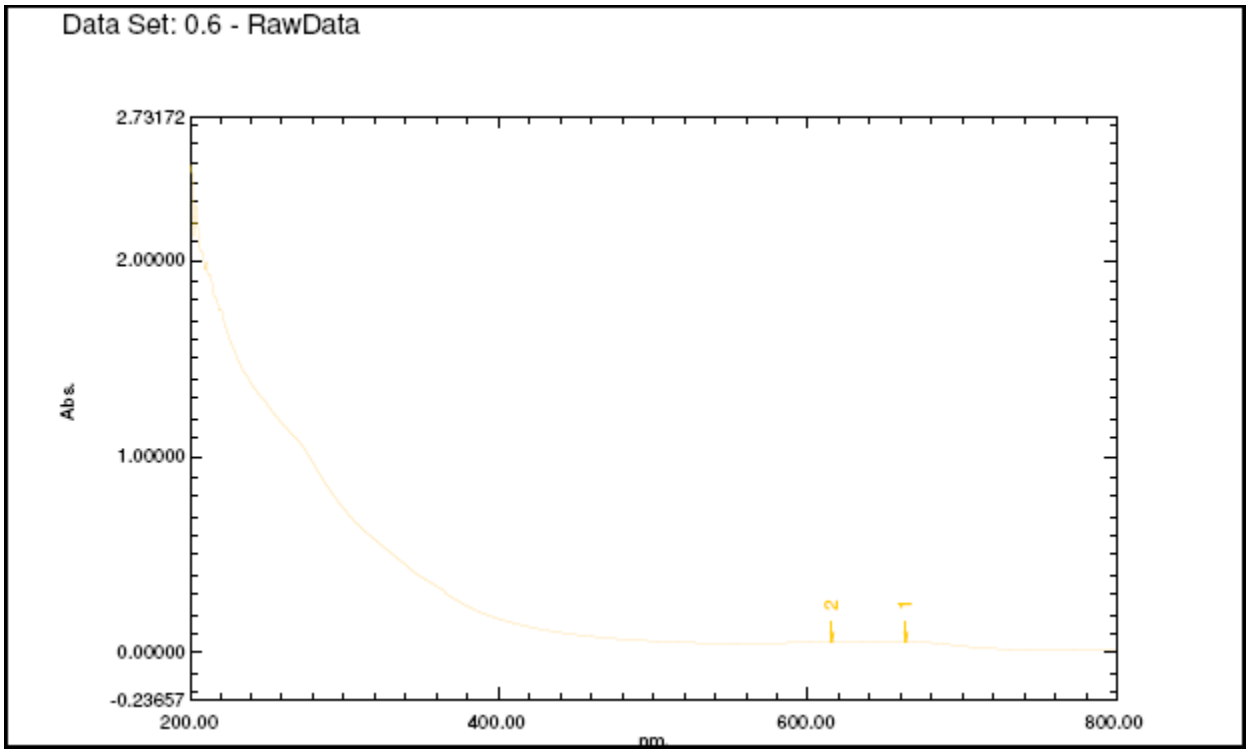


Figure 20: UV Spectrum of 0.6g AC of mango peels (after 17 days)

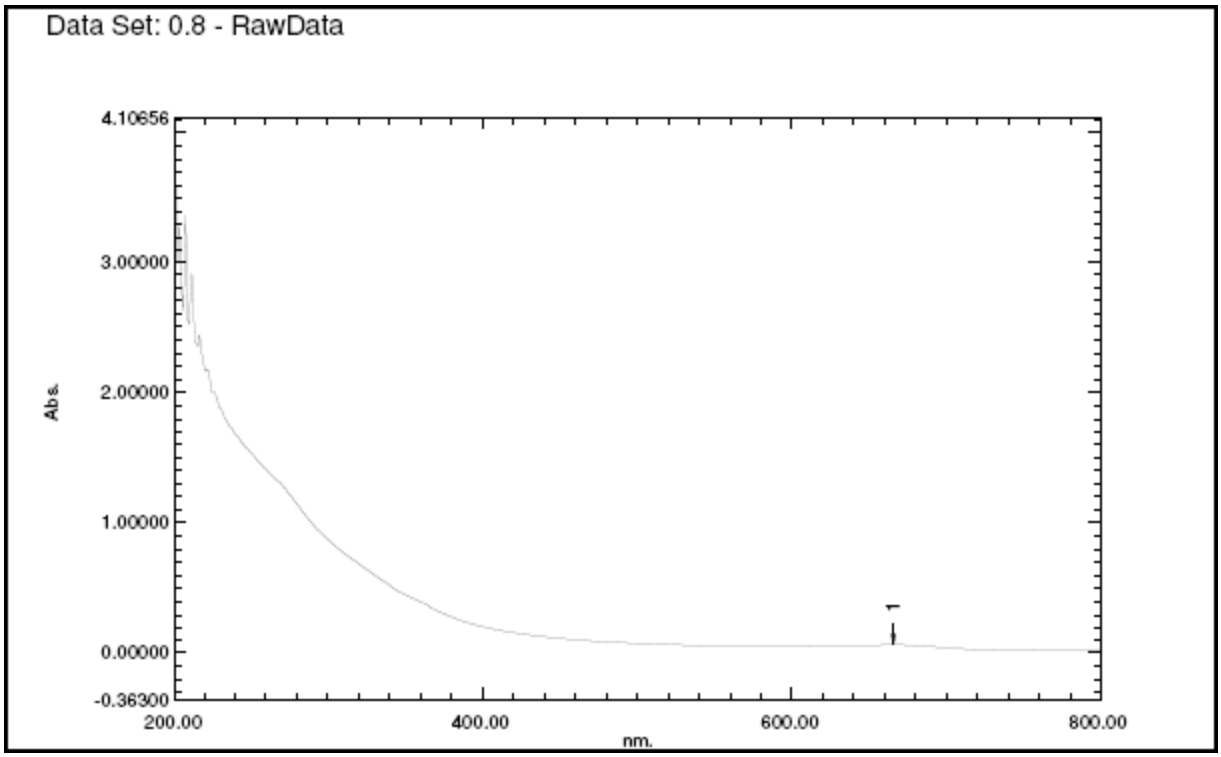


Figure 21: UV Spectrum of 0.8g AC of mango peels (after 17 days)

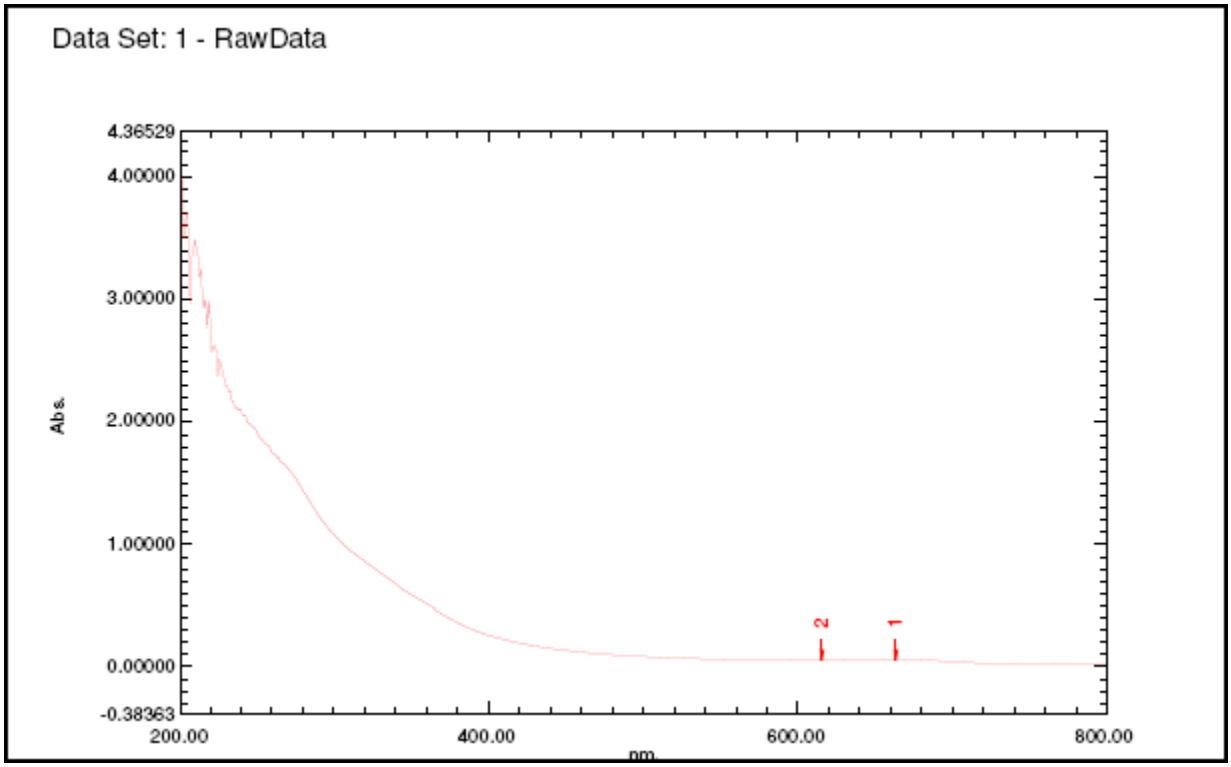


Figure 22: UV Spectrum of 1g AC of mango peels (after 17 days)

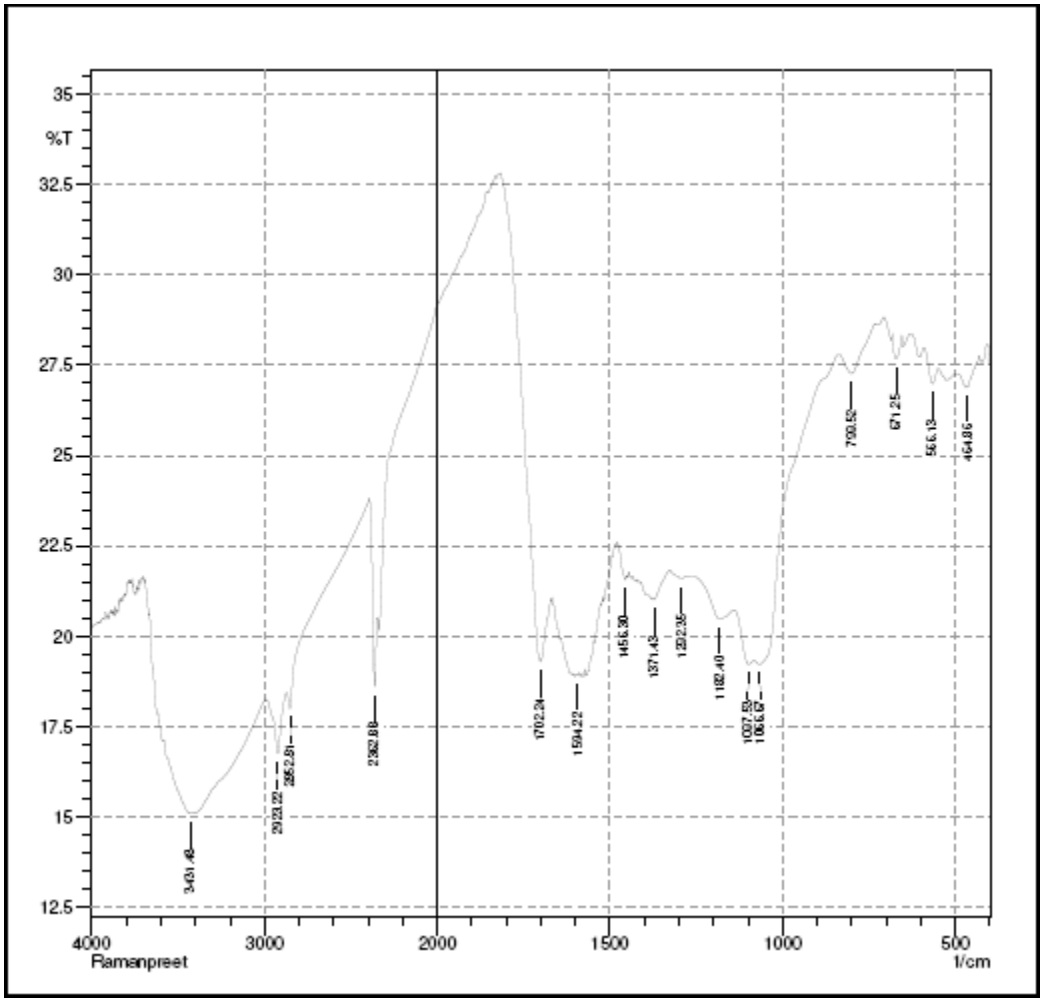


Figure 23: IR spectrum of AC of mango peels

IR PEAKS	ν (P-H2)=2332 cm^{-1}, ν (P-H)=2332cm^{-1}, ν (P-CH3) (asym)=1594cm^{-1}, ν (P-CH3)=1371cm^{-1}, ν(P=O)=1292cm^{-1}, ν(P-O-C)= 1007cm^{-1}

	Mango peels AC	Mango kernels AC
% moisture content	1.8	2.2
% ash content	3.82	1.64

IODINE NUMBER DETERMINATION OF MANGO PEELS AC

	Final value-initial value	**Volume (in ml)**
Blank solution	3.2ml – 1ml	2.2 ml
Sample solution	4.5ml -3.2ml	1.3 ml

IODINE NUMBER DETERMINATION OF MANGO KERNELS AC

	Final value- initial value	**Volume (in ml)**
Blank solution	6.6ml - 4.5ml	2.1 ml
Sample solution	8.1ml – 6.6ml	1.5ml

TOTAL HARDNESS OF MANGO PEELS AC

	Time	**Final - initial**	**Volume used(in ml)**	**Total Hardness**
Blank solution		5.4ml -1 ml	4.4 ml	**440**
With AC	10 min	9.3ml- 5.4ml	3.9ml	**390**
	20 min	13.3ml-9.3ml	4.0ml	**400**
	30 min	17ml-13.3ml	3.7ml	**370**
	40 min	20.9ml-17ml	3.9ml	**390**
	50 min	24.9ml-20.9ml	4.0ml	**400**
	1 hr	29ml- 24.9ml	4.1 ml	**410**

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