WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Comparative Study on Kumkum for Heavy Metal Detection

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DOI: https://doi.org/10.55248/gengpi.5.0124.0374

ABSTRACT –

Background -
Kumkum is referred to as a significant piece of jewellery for married women since they used to apply it to their foreheads as a sign of respect for their husbands a nd as a representation of their marital life. This Kumkum frequently contains metallic ions with harmful or toxic consequences. To determine the numerous toxico logical and hazardous consequences of kumkum, we must identify the metallic ions that are present in it.

Result - Metal ions can be analysed using a variety of chemical tests, chromatographic procedures, and spectroscopic analyses in order to identify the different metallic ions.

On the basis of a chemical test, qualitative analysis is carried out using a variety of chemical reagents to find the presence of a variety of Metallic ions.

We have employed paper chromatography in chromatographic techniques, and on the basis of Rf values, we have also attempted to identify the type of metallic ion in this case.

In colorimetry, we'll also be attempting to measure the rate at which light will be absorbed by the vibrant solution of kumkum powder in this project.

We have used UV visible spectroscopy to conduct spectroscopic analysis to determine the values of Kumkum's transmittance (light emission), absorbance (UV light), concentration of solute, absolute value, and fluorescence of metallic ions. In this area of our research, after dissolving kumkum in distilled water, we were able to measure the metallic ions present.

Conclusion - Only the toxicological and poisonous effects of kumkum can be investigated on the basis of this information.

KEYWORDS – Chemical Test, Chromatographic Analysis, Kumkum, Spectroscopic Analysis, Qualitative Analysis

MAIN TEXT –

Kumkum is referred to as a significant piece of jewellery for married women since they used to apply it to their foreheads as a sign of respect for their husbands and as a representation of their marital life. This Kumkum frequently contains metallic ions with harmful or toxic consequences. To determine the numerous toxicological and hazardous consequences of kumkum, we must identify the metallic ions that are present in it. [1]

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On the basis of a chemical test, qualitative analysis is carried out using a variety of chemical reagents to find the presence of a variety of Metallic ions. [3]

We have employed paper chromatography in chromatographic techniques, and on the basis of Rf values, we have also attempted to identify the type of metallic ion in this case. [4]

Since kumkum is a coloured product, we will use a colorimeter in colorimetry to measure the light absorption values of the various samples of kumkum. This will assist us in identifying the different kinds of metallic ions present in kumkum. [5]

We have employed UV visible spectroscopy to conduct spectroscopic examination to determine the values of Kumkum's transmittance (light emission), absorbance (UV light), concentration of solute, absolute value, and fluorescence of metallic ions. [6]

Science's field of toxicology aids in our understanding of the potentially hazardous consequences that substances, chemicals, or events can have on people, animals, and the environment.

The examination of biological samples for the presence of poisons, including drugs, is known as forensic toxicology. The type of drugs present in a person and whether their quantity is within the range of a therapeutic dosage or above the threshold for harm can both be determined by the toxicology report. [7]

Kumkum's qualitative analysis and metal ion detection

The heavy metals lead, mercury, arsenic, and cadmium are most frequently linked to human toxicity. Foods, pharmaceuticals, inadequately protected food containers, exposure to heavy metals at work, contamination of the air or water, and lead-based paint consumption can all result in heavy metal poisoning.

The determination of a sample's chemical composition is done by qualitative analysis. It includes a variety of analytical chemistry methods that offer non-numerical data about a sample. Qualitative analysis can reveal the presence or absence of an atom, ion, functional group, or molecule in a sample, but it can't tell you how much of it there is. Comparatively, a qualitative analysis is the quantification of a sample. By using this technique, metal ions in the Kumkum can be found. [8]

Chromatography –

Chromatography is a laboratory method used in chemical analysis to separate a mixture into its constituent parts. The combination is dissolved in a liquid solvent known as the mobile phase, which transports it through a system where a substance known as the stationary phase is fixed.

Paper Chromatography -

Paper chromatography is a method of chromatography that makes use of paper sheets or strips as the adsorbent, which serves as the stationary phase through which a solution is made to flow. By comparing the varied migration rates of dissolved chemical compounds across the paper sheets, it is a cheap means of doing so. It is a strong analytical tool that requires incredibly little material. Synge and Martin made the discovery of paper chromatography in 1943. Partition chromatography or adsorption chromatography may be the underlying principle. Because the chemicals are spread or partitioned between liquid phases, the process is known as partition chromatography. The two phases are water that is trapped in the filter paper's pores and a mobile phase that permeates the paper. The mixture is separated as a result of the movement of the mobile phase. Under the capillary action of paper pores, the chemicals in the mixture segregate according to differences in their affinities towards stationary and mobile phase solvents. Paper's solid surface serves as the stationary phase in an adsorption chromatography method where liquid serves as the mobile phase. [9]

Colorimetery –

A colorimeter is a device that measures how much light can pass through a sample of pure solvent vs how much can pass through a solution. A photocell used in a colorimeter may measure the amount of light flowing through the test substance. [10]

Spectroscopy –

The broad field of study known as spectroscopy monitors and analyses the electromagnetic spectra that emerge from the interaction of electromagnetic radiation with matter as a function of the radiation's wavelength or frequency.

UV – Visible Spectroscopy –

Absorption spectroscopy or reflectance spectroscopy in the ultraviolet-visible spectral range are both referred to as ultraviolet-visible spectroscopy or ultraviolet-visible spectrophotometry (UV-Vis or UV/Vis). Depending on how much light an analyte absorbs, UV-VIS spectroscopy is an analytical technique that can measure the analyte's quantity.

In the ultraviolet-visible spectral sector, absorption spectroscopy or reflectance spectroscopy are referred to as ultraviolet-visible spectroscopy or ultraviolet-visible spectrophotometry (UV-Vis or UV / Vis). This indicates that it utilises light in the visible and adjacent (near-UV and near-infrared (NIR)) bands.

The wavelength range for Ultraviolet / Visible Area (UV-VIS) measurements is roughly 200 nm to 800 nm. Transitions between a molecule's electrical energy levels occur when ultraviolet or visible light is absorbed by it. Characterization can be done on the optical and electrical characteristics of various materials, including films, powders, monolithic solids, and liquids.

The analytical method of UV-vis spectroscopy is affordable, straightforward, adaptable, non-destructive, and suited for a wide range of organic chemicals and some inorganic species. UV-vis spectrophotometers calculate the absorption or transmission of light through a medium as a function of wavelength.

High performance liquid chromatography and ultra-high performance liquid chromatography both utilise UV-vis detectors to classify and measure the concentration of compounds in liquid streams. By combining these methods with mass spectrometry, all animals can be detected. [11]

METHODS -

Requirements –

General Requirements –

1. Kumkum sample,
2. Distilled water.

Qualitative Metallic Ion Chemical Examination –

Nessler's reagent, Dilute Hydrochloric Acid, Concentrated Hydrochloric Acid, Potassium Iodide, Potassium Ferro cyanide, Sodium Hydroxide Solution, Potassium Chromate, Ammonium Phosphate Solution.

Paper Chromatography of Kumkum -

Whatmaan filter paper no. 2, Pencil, Scale, capillary tubes, chromatographic chamber, solvent system (Ethanol: Acetone; 1:1), Glass Rod, Chamber Covering.

Colorimetery of Kumkum –

Colorimeter, cuvettes, electricity source.

UV-Visible Spectroscopy of Kumkum –

UV spectrometer, vial, electricity, vial washer.

Methodology –

Sample Preparation –

1. Pour a specific amount of Kumkum powder in the test tube.
2. Now add distilled water into it to prepare the sample for various analysis for identifying Metallic ions.

Qualitative Metallic Ion Chemical Examination on Kumkum-

1. Take the prepared sample and start from analysis of zero group cation analysis and reach to sixth group cation analysis for Metallic ion detection.
2. Zero group – Add Nessler's reagent into the prepared sample.
3. First group – Add Dilute Hydrochloric Acid into the prepared sample and then add Concentrated Hydrochloric Acid into another test tube containing prepared sample.
4. Second group – Add Potassium iodide into the prepared sample.
5. Third group – Add Potassium Ferro cyanide into the prepared sample.
6. Fourth group – Add Sodium Hydroxide Solution into the prepared sample.
7. Fifth group – Add Potassium Chromate into the prepared sample.
8. Sixth group – Add Ammonium Phosphate Solution into the prepared sample.
9. Observe the changes after adding the chemical reagents and try to estimate the Metallic ion from the Kumkum sample.

Chromatographic Analysis of Kumkum (Paper Chromatography) –

1. Take a whatmann filter paper no. 2 and draw a line 1 cm away from one end of the paper using pencil.
2. Apply the Kumkum sample on the point of application using capillary tube.
3. Let it dry and place it in solvent system.
4. Let the solvent move 3/4 on to the paper and take it out.
5. Let it dry and calculate the Rf value.
6. Repeat same step with all the Kumkum samples.

Colorimeter Analysis on Kumkum –

1. Set the value of colorimeter wheel on to the value of red color as shown on reference.
2. Fill the cuvettes with the prepared sample of Kumkum.
3. Place or insert the cuvette one by one in the colorimeter chamber.

4. Now note the Absorbance value in the observation table as shown on the output screen.

Spectroscopic Analysis of Kumkum Sample (UV-Visible spectroscopy) –

1. Start the uv-visible spectrometer and wait for 15 – 20 minutes till the spectrometer takes time to setup and start.
2. Now wash the vials and pour distilled water into the vial and run the spectrometer to get the Spectroscopic values of solvent.
3. Now take the prepared samples of Kumkum in vials and analyze the samples under the spectrometer.
4. Wait for each sample to run wisely over the spectrometer for correct results.
5. Note the values of Absorbance, Transmittance, Fluorescence, Absolute Value and Concentration of Solute for the Kumkum samples.

RESULT –

Experiment	**Observations**	**Inference**
Compound + Nessler's reagent	There is no change in compound.	NH_4^+ Ammonium ion is absent.
Compound + Dilute Hydrochloric Acid	Formation of white precipitate.	Pb^{2+} Lead ion may be present.
Compound + Concentrated Hydrochloric Acid	Formation of frothy precipitate.	Hg_2^{2+} Mercury ion is present.
Compound + Potassium Iodide	Formation of yellow precipitate.	Pb^{2+} Lead ion presence is confirmed.
Compound + Potassium Ferro cyanide	There is no change in compound.	$Fe^{2+/3+}$ Iron ion is absent.
Compound + Sodium Hydroxide Solution	Formation of white precipitate.	Zn^{2+} Zinc ion is present.
Compound + Potassium Chromate	There is no change in compound.	Ca^{2+} Calcium ion is absent.
Compound + Ammonium Phosphate Solution	There is no change in compound.	Mg^{2+} Magnesium ion is absent.

Table 1 – Qualitative Metallic Ion Chemical Examination of Kumkum

Figure 1 – Chemical Examination of Kumkum for Ion Detection

Sample No.	**Color**	**Rf Value**	**Metal Assumption**
1	Yellow orange Pink red	0.046 0.338	Lead Mercury
2	Yellow orange Pink red	0.036 0.364	Lead Mercury
3	Pink red Yellow orange	0.327 0.636	Mercury Zinc

Table 2 – Chromatographic Analysis of Kumkum (paper chromatography)

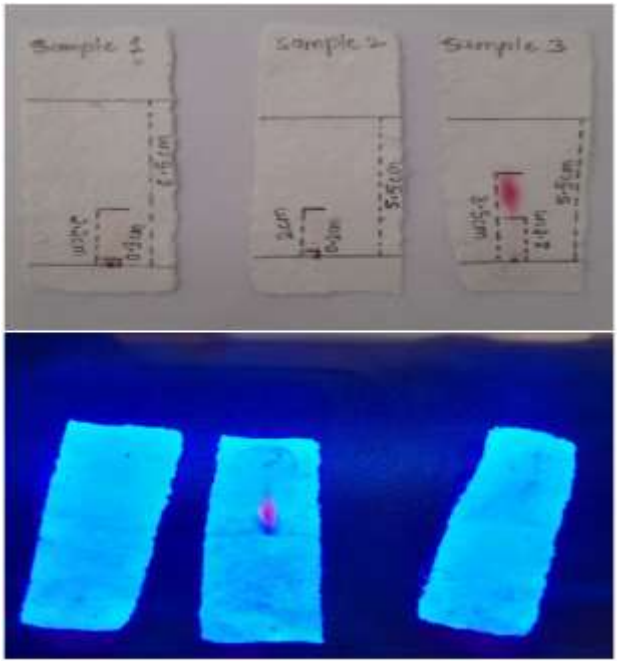

Figure 2 – Chromatographic Analysis of Kumkum with its examination under UV light.

Sample No.	Colorimeter Absorbance value
1	1.36
2	1.38
3	1.86

Table 3 – Absorbance value of Kumkum sample in Colorimeter.

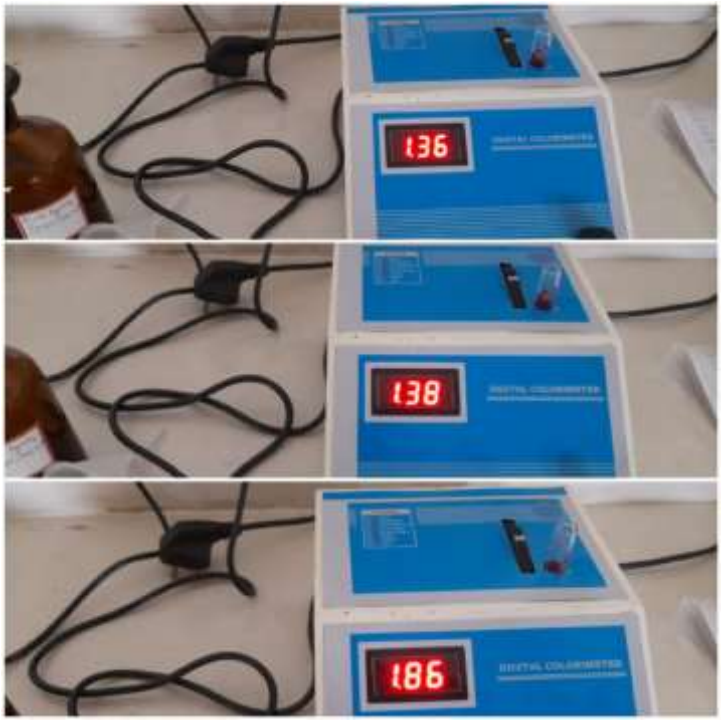

Figure 3 – Colorimeter Analysis of Kumkum Samples.

Sample No.	Transmittance	Absorbance	Absolute Value (Abs)	Concentration of Solute (mg/L)	Fluorescence
Water	25.7%	591.0	-0.018	0.018	152.5%
1	26.3%	580.6	-0.021	0.021	101.2%
2	52.5%	286.1	-0.011	0.011	102.8%
3	61.2%	216.4	-0.03	0.03	103.2%

Table 4 – Spectroscopic Analysis of Kumkum (UV-Visible Spectroscopy)

Figure 4 – UV Visible Spectroscopy Machine

DISCUSSION –

1. The three Kumkum samples all have concentrations of the metallic ions lead, mercury, and zinc, according to the qualitative metallic ion chemical examination of Kumkum.
2. Based on chromatographic analysis, it can be seen that zinc has the lowest concentration and mercury concentration is higher than lead concentration—Hg Pb Zn.
3. The colorimeter is used to measure the light absorbance values of various Kumkum samples.
4. Using uv-visible spectroscopy, the values of transmittance, absorbance, absolute value, solute concentration, and fluorescence for various Kumkum samples are analysed and determined.

CONCLUSION –

1. The presence of metals like Mercury, Lead, and Zinc in every Kumkum sample suggests that the samples are tainted.
2. Because Kumkum samples contain metallic poison ions, they are all poisonous and toxic by nature.
3. Since using such Kumkums may have negative effects on human health, their use must be outlawed.
4. If such Kumkums are used frequently, it may result in issues like skin infections, irritation of the skin, acne, skin dissolution, and skin problems.
5. Try to stay away from Kumkum with such a dark color, as all three samples have dark Kumkum.

PRECAUTIONS –

1. 1. Wash the equipment both before and after use.
2. 2. Treat every piece of machinery and equipment very carefully.
3. 3. Because the majority of chemical reagents are corrosive in nature, use them with extreme caution.

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