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للطالبة:

فاطمة فرحان مريم

بأشراف

د. سميرة عدنان مهدي

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The Republic of Iraq

Ministry of Higher Education

and Scientific Research

University of Babylon

College of Science

Department of Physics

SPECTROSCOPIC STUDY OF SOME MATERIALS

A Graduation Project in Partial Fulfillment of The Requirement for The Award of The Degree Of BA. Department of Physics College of Science

SUBMITTED BY:

Fatima Farhan Moreh

Supervised by:

Dr. Samira Adnan Mahdi

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بسم الله الرحمن الرحيم

﴿ وَالْأَرْضَ مَدَدْنَاهَا وَأَلْقَيْنَا فِيهَا رَوَاسِيَ وَأَنبَتْنَا فِيهَا مِن كُلِّ شَيْءٍ مَّوْزُونٍ ﴿١٩﴾ ﴾

صدق الله العظيم

سورة الحجر: الاية ١٩

الاهداء

الى نفسي الطموحة جدا لقد ظننت انني لا استطيع ولكن من قال انا لها نالها وإن أبت رغما عنها أتيت بها وها انا اليوم أكمل خطواتي برفق واليوم اكتب بحث تخرجي لمرحلة البكالوريوس بعد ان قضيت وقت طويل اركض خوفا أن يفوتني شيء فقد ادركت ان لا يفوتني شيء قد كتبه الله لي لقد كان حلما لا نظن دنوه لكن فضل الله كان عظيما رجوت كريما قد وثقت بصنعه وما كان من يرجو الكريم يخيب فسجادتي التي شهدت دموعي في الليالي العسيرة اليوم رجعت اليها ودموع تسابق تناهيد صدري المسرور

فالحمد لله....

من جعل الله الجنة تحت أقدامها، واحتضنني قلبها قبل يديها وسهلت لي الشدائد بدعائها، إلى القلب الحنون والشمعة التي كانت لي في الليالي المظلمات .. جنتي امي

من اخذ بيدي لاكمال طريقي من حصد الاشواك عن دربي

ضلعي الثابت و مصدر قوتي .. أبي

لى من مدت يديها في أوقات الضعف وراهنت على نجاتي ونجاحي و تذكرني بمدى قوتي واستطاعتي التي لا تحبطني وتؤمن بشجاعتي مهما ضعفت وارتخيت واقفة خلفي مثل ظللي مهما كثرة تخبطاتي

اختي ورفيقة قلبي .. رشا

Abstract

This study aims to investigate the spectroscopic properties of henna and pomegranate peel extracts under different dilutions and conditions. Two grams of henna powder were taken and diluted with water, then filtered using filter paper with water in three separate instances: 15 ml, 35 ml, and 45 ml . Similarly, a mixture of 1 gram of pomegranate peel and 1 gram of henna powder was prepared following the same method as the henna. The prepared samples were then subjected to spectroscopic analysis.

The spectroscopic analysis involved examining whether laser emission occurs when the samples are introduced into the spectrometer. The results of the analysis will provide insights into the optical properties and potential applications of henna and pomegranate peel extracts. By comparing the spectroscopic behavior of the samples at different dilutions and compositions, we aim to understand how these factors influence their spectroscopic characteristics.

The study design allows for the exploration of how variations in concentration and composition affect the spectroscopic response of the materials, providing valuable information for potential applications in fields such as medicine, cosmetics, and materials science.

The outcomes of this study will contribute to expanding our knowledge of the spectroscopic behavior of henna and pomegranate peel extracts, paving the way for further research and applications in various industries and scientific disciplines.

الخلاصة:

تهدف هذه الدراسة إلى استكشاف الخصائص الطيفية لمستخلصات الحناء وقشور الرمان تحت تراكيز وظروف مختلفة. تم أخذ غرامين من مسحوق الحناء وتخفيفهما بالماء، ثم تم تصفية المحلول باستخدام ورق ترشيح مبلل بالماء في ثلاث حالات منفصلة: ١٥ مل، ٣٥ مل، و ٤٥ مل. بالمثل، تم تحضير خليط من غرام واحد من قشور الرمان وغرام واحد من مسحوق الحناء باستخدام نفس الطريقة المستخدمة في تحضير الحناء. تم تخضير العينات المحضرة للتحليل الطيفي.

شمل التحليل الطيفي دراسة ما إذا كان يحدث انبعاث ليزر عند إدخال العينات إلى الطيفومتر. ستوفر نتائج التحليل تفاصيل حول الخصائص البصرية والتطبيقات المحتملة لمستخلصات الحناء وقشور الرمان. من خلال مقارنة السلوك الطيفي للعينات عند تراكيز وتراكيب مختلفة، نهدف إلى فهم كيفية تأثير هذه العوامل على الخصائص الطيفية لهذه المواد.

تتيح تصميم الدراسة استكشاف كيفية تأثير التباين في التركيز والتركيب على الاستجابة الطيفية للمواد، مما يوفر معلومات قيمة للتطبيقات المحتملة في مجالات مثل الطب ومستحضرات التجميل وعلم المواد.

ستسهم نتائج هذه الدراسة في توسيع معرفتنا حول السلوك الطيفي لمستخلصات الحناء وقشور الرمان، مما يمهد الطريق لإجراء المزيد من الأبحاث والتطبيقات في مختلف الصناعات والتخصصات العلمية.

إقرار السيد المشرف

اقرار المشرف

أشهد بان موضوع البحث الموسوم **"دراسة طيفية لبعض المواد"** والمنجز الطالبة من قبل **فاطمة فرحان مريح** قد اجري تحت اشرافنا في قسم الفيزياء كلية العلوم جامعة بابل كمتطلب جزئي لنيل شهادة البكلوريوس في علوم الفيزياء وذلك للفترة من ١/١٠/٢٠٢٣ ولغاية ١/٤/٢٠٢٤

التوقيع:

الاسم الثلاثي للسيد المشرف: *د. سميرة عدنان مهدي*

اللقب العلمي:

التاريخ: / ٤ / ٢٠٢٤

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CHAPTER ONE

Introduction

1.1 Introduction

Spectroscopic studies in the realm of science and technology constitute a vital and pivotal component in understanding the molecular and atomic properties and behaviors of materials. This understanding relies on the precise analysis of how materials interact with energy across different wavelengths. Spectroscopic analysis of materials serves as a powerful tool for acquiring knowledge about their composition and reactions, thus playing a crucial role in the development of various applications in diverse scientific and industrial domains [1].

The aim of this research is to conduct a spectroscopic study of some materials, focusing on the utilization of advanced techniques such as spectrometry, X-ray, and fluorescence, to examine and comprehend the characteristics of these materials comprehensively. The spectroscopic study will be conducted in an active medium, enabling a deeper understanding of their behavior under various conditions, whether in natural or laboratory-simulated settings [2].

Through the application of these techniques, we seek to identify the molecular and structural architectures of the studied materials, as well as analyze their reactions and dynamics at the atomic and molecular levels. Additionally, we will investigate the optical and chemical properties of these materials, contributing to expanding our understanding of their potential uses in various industries and scientific fields [3].

This study requires a comprehensive and systematic effort, as we will meticulously analyze the obtained data to extract precise and reliable results. We anticipate that the findings of this research will enrich scientific and technological knowledge, opening new avenues for harnessing the potential of these materials in multiple domains.

1.2 Henna (Lawsonia inermis)

1.2.1 The History

Henna has a rich history and holds significant cultural importance in various parts of the world. It has been used for centuries in regions such as South Asia, North Africa, and the Middle East for decorative and ceremonial purposes. Henna application, known as mehndi, is an integral part of traditional weddings, festivals, and celebrations in many cultures. It is often applied to the hands and feet in intricate designs as a form of temporary body art [4].

Apart from its decorative use, henna has been employed for its medicinal properties in traditional medicine systems. It has been used to treat various skin conditions such as rashes, burns, and inflammation due to its cooling and soothing effects. Additionally, henna has been used as a natural hair dye and conditioner, providing a reddish-brown tint to the hair while also nourishing and strengthening it.

In modern times, henna continues to be widely used for its cosmetic and therapeutic benefits. It is a popular natural alternative to synthetic hair dyes and hair care products due to its gentle and nourishing properties. Many people prefer henna for temporary body art over chemical-based tattoos due to its non-toxic nature and temporary staining effect. Moreover, henna extracts are increasingly being studied for their potential pharmaceutical applications, including antimicrobial, anti-inflammatory, and antioxidant properties [5] [6].

Henna products are readily available in various forms, including powder, paste, and pre-mixed cones, in markets worldwide. These products may contain additional ingredients such as essential oils, sugar, or lemon juice to enhance color intensity and paste consistency. While natural henna is generally safe for external use, consumers should be cautious of black henna products that may contain harmful additives such as para-phenylenediamine (PPD), which can cause allergic reactions and skin sensitivities [7].

In summary, henna is not only a versatile cosmetic and therapeutic agent but also a cultural symbol with deep-rooted significance in many societies. Its continued use and exploration in various fields highlight its enduring appeal and potential benefits for human health and well-being.

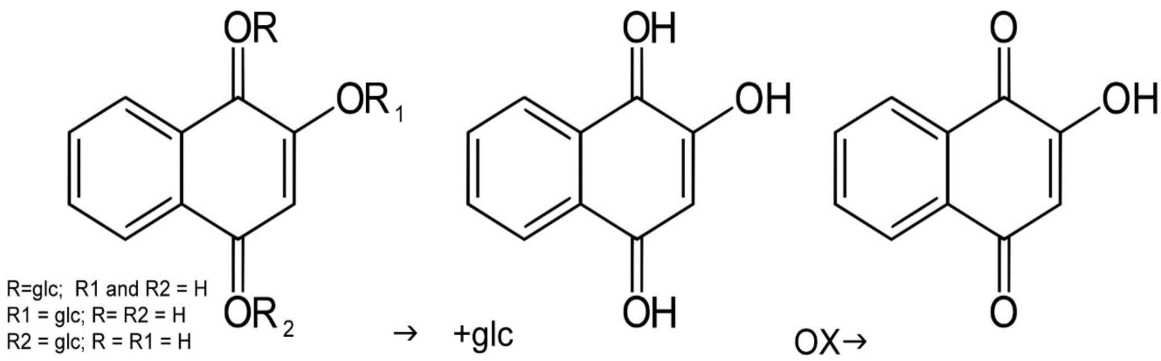
1.2.2. Chemical Properties:

- Henna is a plant native to South Asia, North Africa, and parts of South and Central Asia.
- The main component of henna is a dye molecule called lawsone, which gives henna its distinctive reddish color.
- Henna also contains other compounds such as sugars, proteins, and volatile oils.

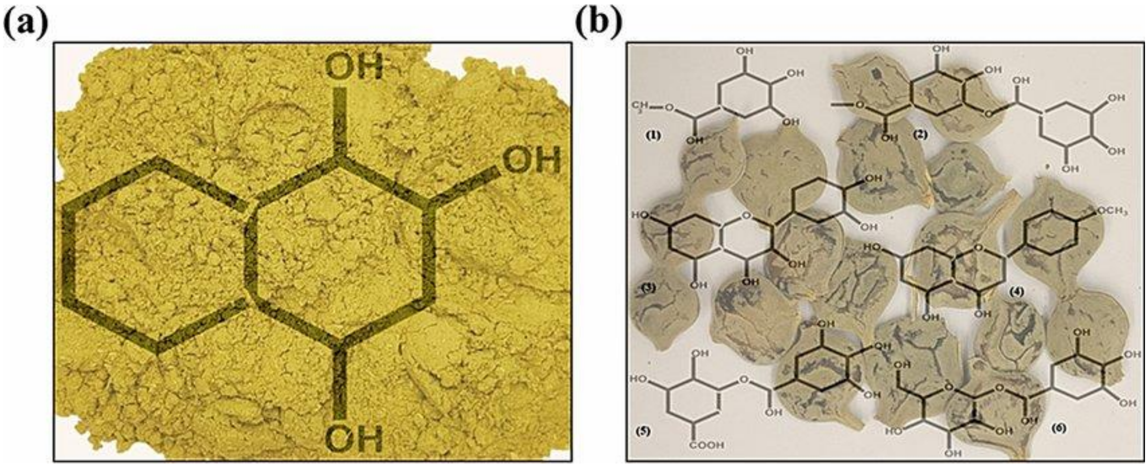
1.2.3 Physical Properties:

- Henna is a fine powder ranging in color from dark green to brown, which turns into a reddish-brown color when mixed with water or other liquids [8].
- It has a characteristic earthy odor.
- Henna powder is insoluble in water but soluble in alcohol and other organic solvents.
- When applied to the skin or hair, henna forms a temporary stain due to the binding of lawsone with proteins.

1.2.4. Chemical Structure: The chemical structure of lawsone, the main dye molecule in henna [9], can be represented as follows:



This structure consists of a benzene ring with adjacent hydroxyl and ketone groups, which are responsible for its dyeing properties.



(a) Chemical structure of Henna dye; (b) Structures of the main components of Acacia nilotica pods, Polygalloytannin (1), Tannin (2), Quercetin (3), Acacetin (4), Ethyl gallate (5), Digallic acid [10].

1.3 Pomegranate Peels

1.3.1 The History

Pomegranate (Punica granatum) is one of the oldest known fruits, with a history dating back thousands of years. Its use can be traced to ancient civilizations such as those of Mesopotamia, Egypt, and Persia, where it held significant cultural and religious symbolism. The fruit, with its juicy arils nestled within a tough, leathery skin, was revered for its beauty, flavor, and medicinal properties [11].

In many ancient cultures, every part of the pomegranate was utilized, including its peel. Pomegranate peels were valued for their medicinal properties and were used in traditional herbal medicine to treat various ailments. The rich content of bioactive compounds in the peels, such as tannins, flavonoids, and phenolics, contributed to their therapeutic effects.

Throughout history, pomegranate peels were utilized in diverse ways. In traditional Ayurvedic medicine, the peels were used to treat digestive disorders, diarrhea, and dysentery. In Chinese medicine, pomegranate peels were prescribed for their astringent and anti-inflammatory properties, often used to treat sore throats and mouth ulcers [12].

The use of pomegranate peels extended beyond medicine. In ancient dyeing techniques, the peels were employed as a natural source of dye, imparting shades of yellow and brown to textiles. Additionally, pomegranate peels were utilized in culinary practices, adding flavor and color to various dishes and beverages [13].

Today, the historical significance of pomegranate peels continues to be recognized, albeit with a modern twist. Scientific research has corroborated many of the traditional uses of pomegranate peels, revealing their potent antioxidant, antimicrobial, and anti-inflammatory properties. As a result, pomegranate peels are increasingly incorporated into dietary supplements, skincare products, and herbal remedies.

In conclusion, the history of pomegranate peels is one of ancient reverence and enduring utility. From ancient civilizations to modern science, the value of pomegranate peels has remained steadfast, offering a testament to the enduring legacy of this remarkable fruit [14].

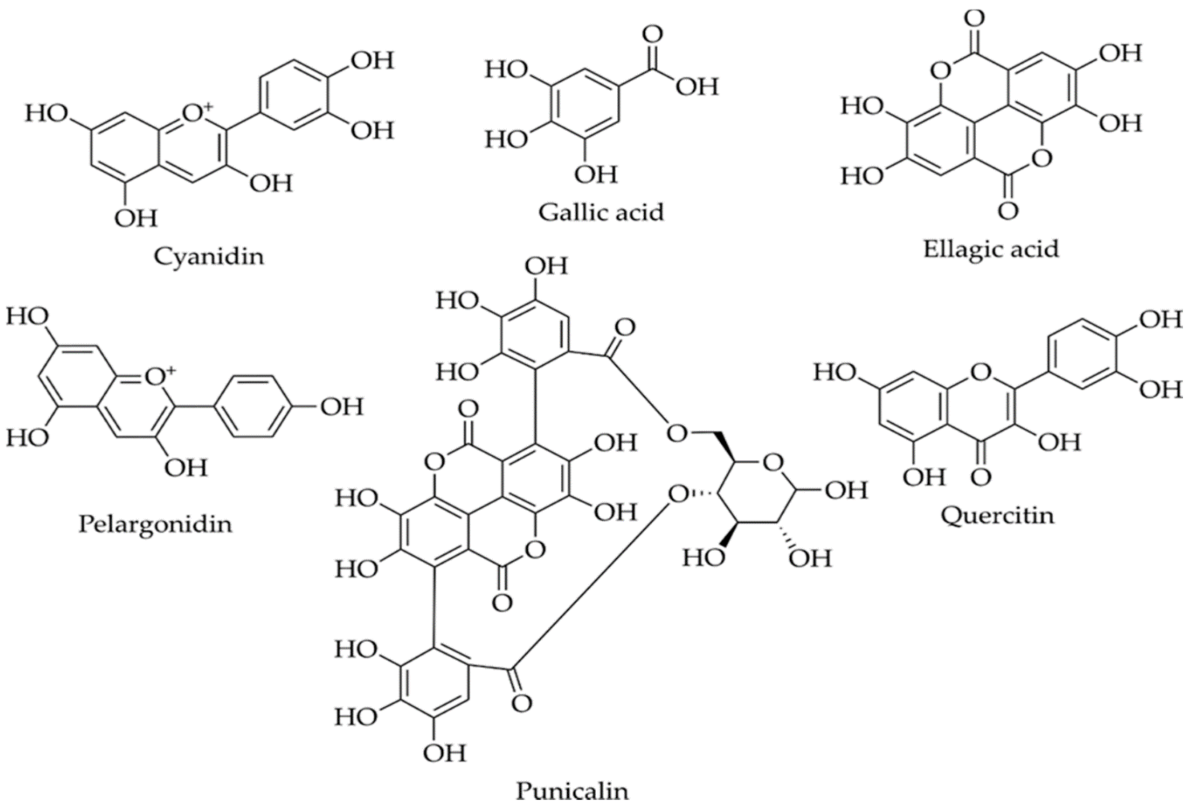
1.3.2. Chemical Properties:

- Pomegranate peels contain a wide range of chemical compounds that give them their unique properties.
- One of the main compounds in pomegranate peels is tannins, which represent a diverse group of phenolic compounds that possess antioxidant and antimicrobial properties.
- In addition to tannins, pomegranate peels contain other compounds such as flavonoids and phenolics, which contribute to their anti-inflammatory and anti-cancer properties.

1.3.3.Physical Properties:

- Pomegranate peels are typically solid and sturdy due to their content of tannins, which give them a firm texture.
- The color of pomegranate peels can vary from brownish to dark red, depending on the variety and ripeness.
- Pomegranate peels can be ground and utilized to extract active compounds for use in traditional medicine or industrial purposes.

1.3.4. Chemical Structure: Pomegranate peels primarily consist of a variety of chemical compounds, with tannins being one of the most significant. The simplified diagram of the chemical structure of pomegranate peel illustrates one common type of tannin [15], as follows:



This tannin consists of galloyl units and gallic acid, possessing antioxidant and antimicrobial properties [16].

1.4 Aim of stude

1. Investigate the spectroscopic properties of henna and pomegranate peel extracts under different dilutions and conditions.

2. Assess the influence of dilution levels (15 ml, 30ml, and 35ml) on the spectroscopic behavior of henna extracts.

3. Analyze the spectroscopic response of henna and pomegranate peel extracts when mixed together in varying compositions.

CHAPTER TWO

Literature Review

2.1 Related work:

1. Abed, Lina, and Noureddine Belattar conducted a study on the polyphenols content, chelating properties, and adsorption kinetics of red and yellow pomegranate peels towards lead (II). The study aimed to address the global concern of metal pollutants in industrial wastewaters by assessing the effectiveness of pomegranate peels as biosorbents for lead removal. Results showed that red peels had higher polyphenols content compared to yellow peels, and both varieties demonstrated significant lead adsorption capacity. The study concluded that pomegranate peels can serve as efficient and reusable biosorbents for lead removal from aqueous solutions [17].

2. Atef, Riham, N. M. Aboeleneen, and Nabil M. AbdelMonem investigated the preparation and characterization of low-cost nano-particle material using pomegranate peels for the removal of brilliant green dye from aqueous solutions. The study demonstrated the successful preparation of pomegranate peels nano-particles (PPNP) with promising adsorption properties. SEM and TEM images revealed the morphology and size of the PPNP, while adsorption experiments showed efficient removal of the dye under optimized conditions. The study highlighted the potential of PPNP as a cost-effective adsorbent for wastewater treatment [18].

3. Vargas-Torrico, Maria Fernanda, et al. developed active films incorporating pomegranate peel extract (PPE) for the preservation of raspberries. The study focused on characterizing the physicochemical properties of the films and evaluating their ability to extend the shelf life of raspberries under refrigerated conditions. Results indicated that the incorporation of PPE improved mechanical properties, antioxidant activity, and UV-light barrier of the films, leading to enhanced

preservation of raspberries. The study suggested the potential of PPE-incorporated films for food packaging applications [19].

4. Diaf, R., et al. (2023). A chemometric strategy based on a Box–Behnken design to optimize the removal of hexavalent chromium from water using Pomegranate peels as an eco-friendly adsorbent. This study investigated the use of dry pomegranate peel powders (PGPs) as eco-friendly adsorbents for hexavalent chromium removal from water. PGPs were characterized, and a Box–Behnken design was employed to optimize the adsorption process. Results indicated high removal efficiency under specific conditions, with adsorption following pseudo-second order kinetics. Thermodynamic analysis revealed the process to be exothermic and spontaneous. PGPs show potential for chromium removal in water treatment applications [20].

2.4. Summary:

The related studies investigated various aspects of utilizing pomegranate peels for environmental, industrial, and biomedical applications. Abed and Belattar (2022) assessed the potential of pomegranate peels as biosorbents for lead removal, highlighting their polyphenol content and iron-chelating activity. Atef et al. (2023) focused on the preparation of low-cost nano-particle materials from pomegranate peels for the removal of brilliant green dye, demonstrating promising adsorption properties. Vargas-Torrico et al. (2024) developed active films incorporated with pomegranate peel extract for the preservation of raspberry fruit, showcasing improved mechanical and antioxidant properties. Diaf et al. (2023) investigated the use of pomegranate peels as eco-friendly adsorbents for hexavalent chromium removal from water, employing a chemometric approach to optimize the adsorption process. These studies collectively highlight the versatility and potential of pomegranate peels in various fields, ranging from environmental remediation to food preservation and biomedical applications.

CHAPTER THREE

Patients

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Methods

3.1 Patients and Methods

In step one The practical aspect involves taking the specified concentrations of henna and pomegranate peel powder, as shown in Figure (3.1), according to the given weights. The powders were measured using a precise electronic balance in the laboratory.

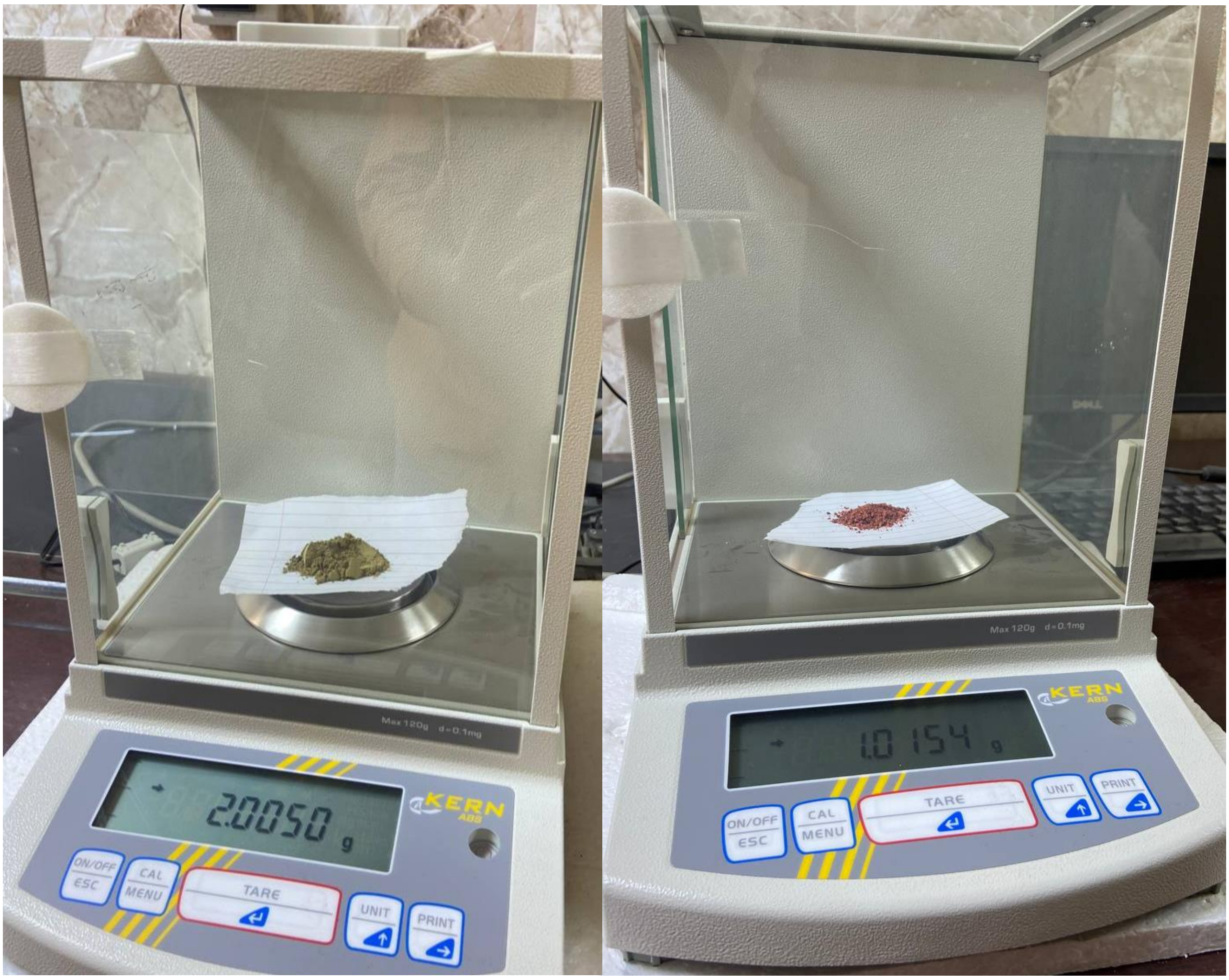


Figure (3.1): It represents the measurement of weights in the laboratory.

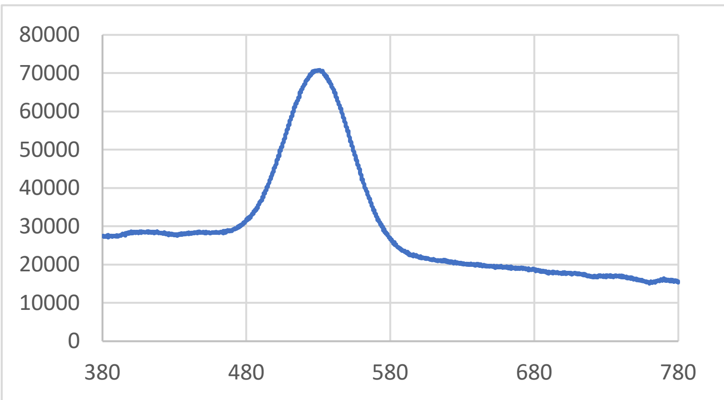
The next step involves diluting the measured powders from the first step by adding a specific amount of water to each, turning them into solutions. As we can show in Figure (3.2), This process ensures that the concentration of the active ingredients in the henna and pomegranate peel powders is appropriately adjusted for the intended application.

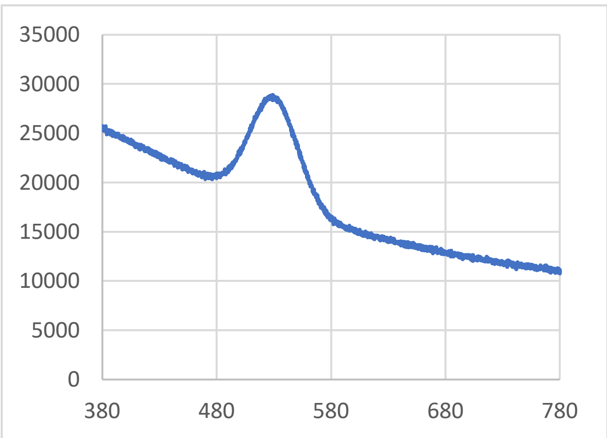
Figure (3.2): Represents the addition of water to powders.

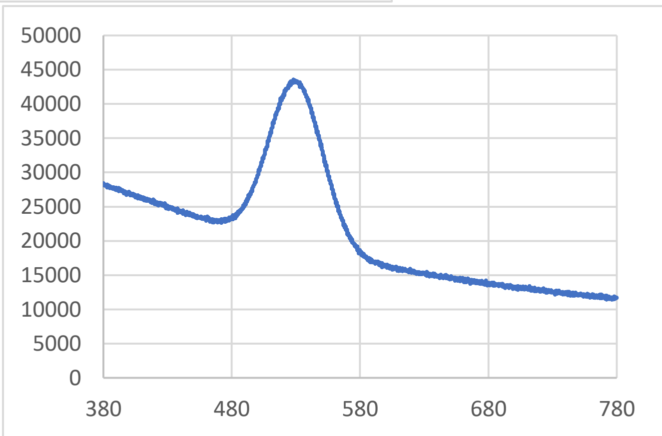
After that in step 3, In the conducted experiment, 2 grams of henna were mixed with varying amounts of water and filtered through filter paper to obtain filtered solutions. Three different concentrations of henna solution were prepared by repeating this process 15, 35, and 45 ml of water, respectively.

The final step: Transfer the filtered solution obtained from the filter paper to the spectrometer for spectral analysis of the substances. The spectrometer used in this experiment is a scientific instrument that measures the intensity of light at different wavelengths. By passing light through the sample, it measures how much light is absorbed at each wavelength, providing information about the chemical composition of the solution. This spectral analysis helps in identifying the presence of specific compounds in the henna and pomegranate peel solutions and determining their concentrations.

The following chart illustrates the spectral analysis of each element. The solution was diluted three times with 15, 35, and 45 units of water,







respectively.

Figure (3.3): The graph represents the spectroscopy at different concentrations.

3.2 Statistical Analysis

The Figher (3.4) graph that represents the spectral response curves of different sensors or filters:

X-axis (Wavelength): The x-axis shows the wavelength range from 380 nm to 780 nm, which covers the visible light spectrum.

Y-axis (Response Intensity): The y-axis measures the response intensity, which indicates how sensitive a sensor or filter is to light at different wavelengths. The values range from 0 to 80,000 units.

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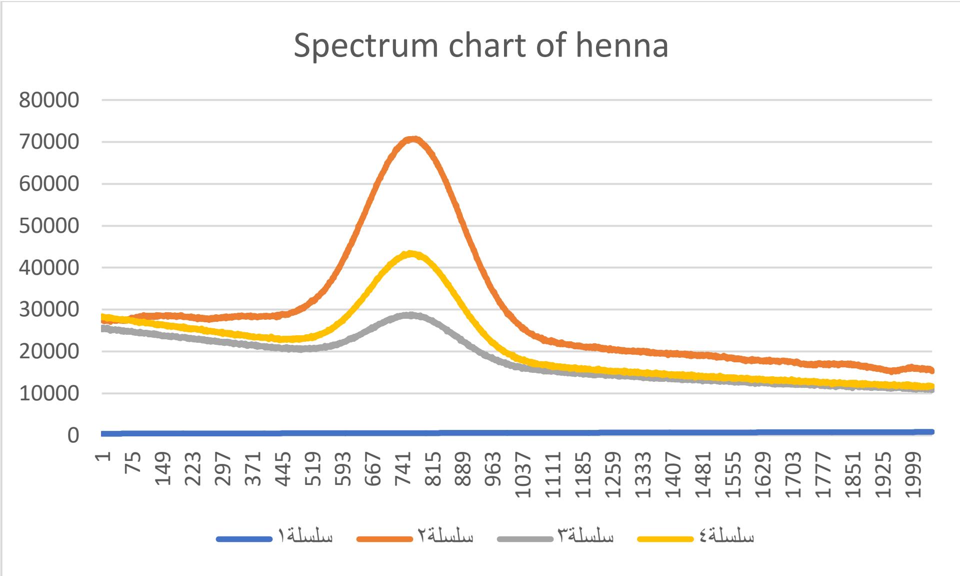
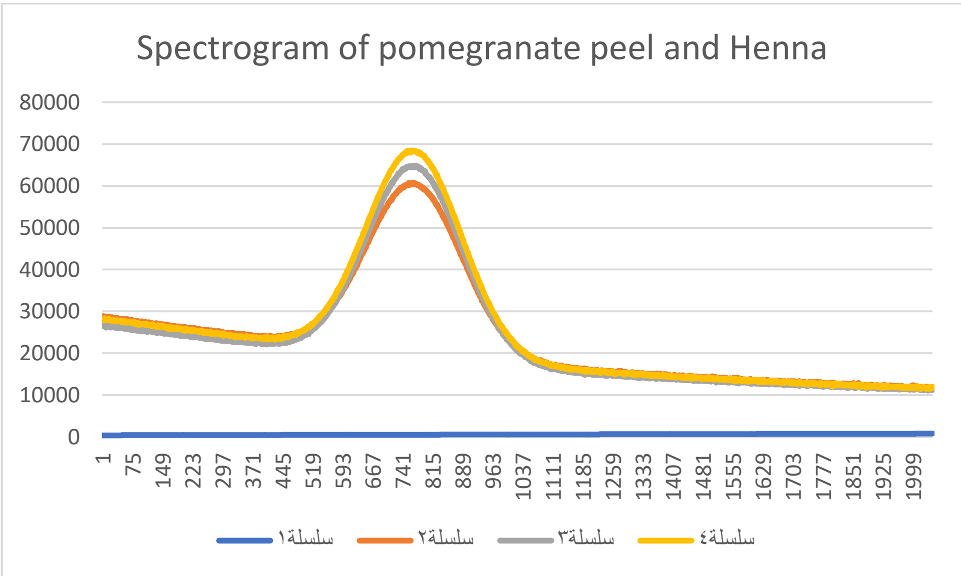


Figher (3.4. a)



Figher (3.4. b)

Figher (3.4): represents the graph that represents spectral response, a- for Henna. b- for pomegranate peel and Henna.

Also we have Figure (3.5) The graph in represents the relationship between concentration and absorbency:

X-axis (Concentration): This axis represents the concentration of a substance. It ranges from 0 to 7. Concentration refers to the amount of a solute (e.g., a chemical) dissolved in a given volume of solvent (e.g., water).

Y-axis (Absorbency): The y-axis represents the absorbency, which is a measure of how much light a substance absorbs. It ranges from 0 to 100. Higher absorbency values indicate that the substance absorbs more light.

Data Points and Curve:

There are five data points plotted on the graph (represented by black squares). The red curve connects these data points, indicating a trend.

The equation displayed on the graph is: $y = 40.238\ln(x) + 18.211$. This equation describes the relationship between concentration (x) and absorbency (y).

The logarithmic function (ln) suggests that as concentration increases, absorbency also increases, but at a decreasing rate. In other words, the curve starts steep and then levels off.

The equation helps describe how absorbency changes with varying concentrations.

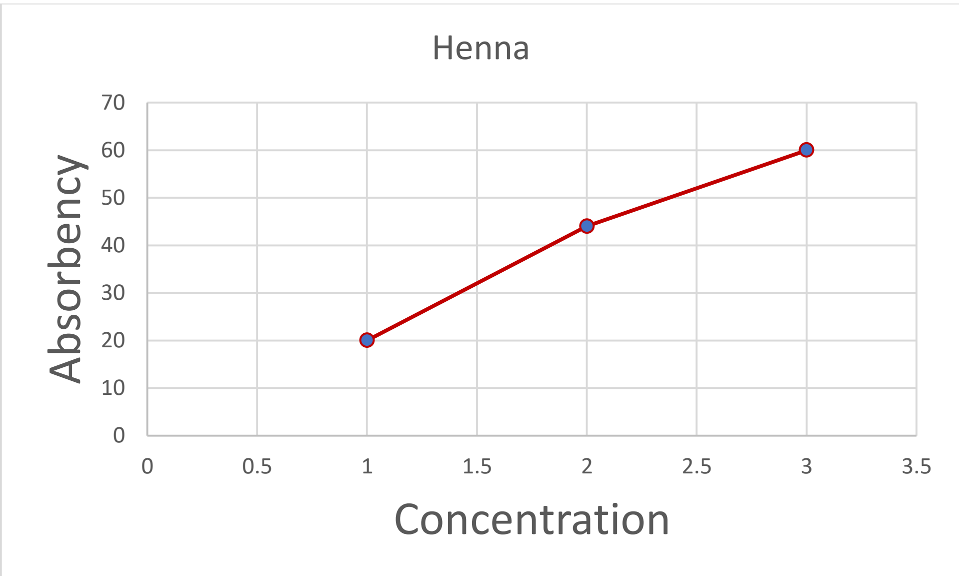


Figure (3.5. a)

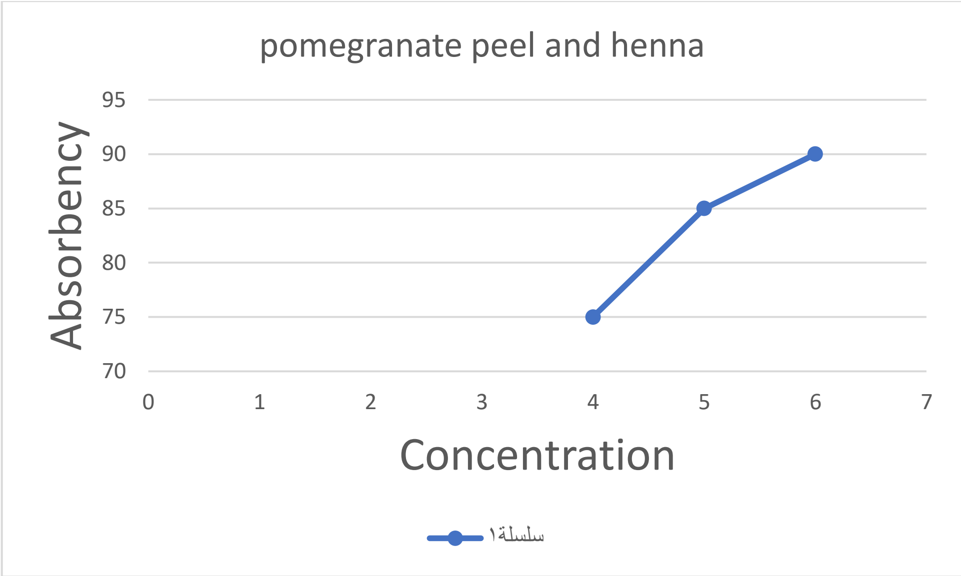


Figure (3.5. b)

Figure (3.5): Represents the relationship between concentration and absorbency. a- for Henna. b- for pomegranate peel and henna.

4.1 Results

Figure (4.1), a graph showing the normalized absorption spectra of various substances or conditions across different wavelengths of light, measured in nanometers (nm).

X-axis: Represents the wavelength range from 400 nm to 700 nm, which covers part of the visible spectrum.

Y-axis: Indicates the normalized absorption levels, which is a way to compare the absorption properties of different substances regardless of their concentration.

Lines: The multiple lines in different colors represent the absorption spectra under different conditions or for different substances. Each line peaks around the 500 nm mark, which suggests that the substances or conditions have a higher absorption in that region of the spectrum.

This type of graph is commonly used in chemistry and physics to study the interaction between light and matter, such as in the analysis of dyes, pigments, or the concentration of substances in a solution.

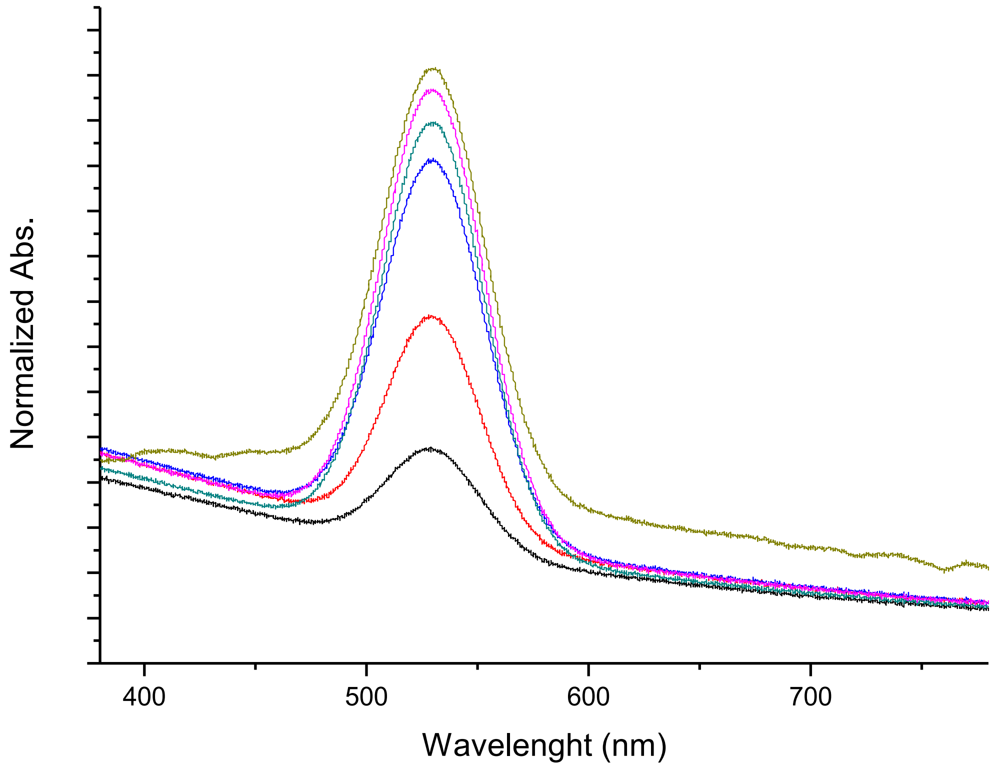


Figure (4.1) the graph showing the normalized absorption spectra.

4.2 Discussion

The spectral analysis of the henna and pomegranate peel solutions revealed interesting insights into their chemical composition. The variations in the intensity of light absorption at different wavelengths provide valuable information about the presence and concentration of specific compounds.

Overall, the results indicate that the concentration of both henna and pomegranate peel solutions varied depending on the amount of water used for dilution. As the concentration of the solution decreased, there was a corresponding decrease in the intensity of light absorption at certain wavelengths.

These findings suggest that the dilution of the solutions affects the chemical composition and concentration of the active ingredients present in henna and pomegranate peel. Further analysis, including identification of specific compounds and their concentrations, would provide a more detailed understanding of the chemical properties of these natural dyes.

Moreover, the spectral analysis data can be further analyzed using statistical methods to determine any significant differences between the different concentrations of henna and pomegranate peel solutions. This would help in optimizing the formulation of these natural dyes for various applications in industries such as cosmetics, textiles, and food coloring.

CHAPTER FIVE

Conclusions

&

Recommendations

5.1. Conclusions

In general, according to the results obtained from this study:

1. **Effect of Dilution on Spectral Analysis**: The spectral analysis of henna and pomegranate peel solutions showed that the intensity of light absorption varied with the concentration of the solution. As the solutions were diluted with water, there was a corresponding decrease in the intensity of light absorption at certain wavelengths.
2. **Optimization of Formulation**: The results suggest that the concentration of the solutions can be adjusted by diluting them with specific amounts of water. This information is valuable for optimizing the formulation of henna and pomegranate peel solutions for various applications.
3. **Potential Applications**: The ability to adjust the concentration of henna and pomegranate peel solutions makes them suitable for use in industries such as cosmetics, textiles, and food coloring. By understanding how different concentrations affect the chemical composition of these natural dyes, it is possible to tailor them for specific applications.
4. **Further Research**: Further research is needed to identify the specific compounds present in henna and pomegranate peel solutions and to determine their concentrations at different dilutions. Additionally, exploring the potential applications of these natural dyes in different industries would be beneficial.

Overall, the results of this study provide valuable insights into the spectral analysis of henna and pomegranate peel solutions and their potential applications in various industries.

5.2 Recommendations

1. **Optimization of Dilution Process**: Further experimentation can be conducted to determine the optimal dilution ratios for henna and pomegranate peel solutions. This will help in achieving desired concentrations for specific applications.
2. **Identification of Specific Compounds**: Additional analysis, such as chromatography or mass spectrometry, can be performed to identify the specific compounds present in henna and pomegranate peel solutions at different dilutions. This will provide a better understanding of their chemical composition.
3. **Application-Specific Formulation**: Tailoring the formulation of henna and pomegranate peel solutions based on their intended application is recommended. For example, different concentrations may be required for cosmetics, textiles, and food coloring applications.
4. **Quality Control Measures**: Establishing quality control measures to ensure the consistency and purity of henna and pomegranate peel solutions is important. Regular testing and analysis should be conducted to maintain product quality.
5. **Exploration of New Applications**: Investigating potential new applications for henna and pomegranate peel solutions in industries such as pharmaceuticals, agriculture, and environmental science is recommended. Their natural properties make them potentially valuable in a wide range of fields.

Implementing these recommendations will contribute to a better understanding of henna and pomegranate peel solutions and their potential applications in various industries. Additionally, it will help in optimizing their formulation for improved performance and effectiveness.

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