Characterization of coriander seeds "coriandrum sativum"

L. KADIRI, A. LEBKIRI, E. H. RIFI, Y. ESSAADAOUI, A. OUASS,
I. LEBKIRI, H. HAMAD
Laboratory of Organic Synthesis and Extraction Processes - Department of Chemistry
University Ibn Tofail, Kenitra - Faculty of Sciences, PO Box. 133 – 14000- Morocco
E-mail: kadiri.lamya@gmail.com

Abstract--- Coriander seeds have, over their culinary and medicinal benefits, a significant adsorbent power of heavy metals due to their high adsorption capacity and their adaptation in aqueous medium. Our present work relates, on one hand, to the characterization of the material in order to determine its morphology by using techniques based on spectroscopy such as Fourier Transform Infrared (FTIR) and the X-ray Diffraction (XRD), on the other hand, to the study of acid-base behaviour of seeds of coriander in contact with some aqueous solutions in the presence and absence of metal ions. Also, a test of this material in the removal of copper ions Cu^{2+} from aqueous solutions by coriander seeds has been realized using Atomic Absorption spectroscopy (AAS) in order to highlight the importance of coriander seeds as a potential tool in the treatment of wastewaters containing heavy metals.

Index Terms -- Coriander seeds, Characterization, X-Ray Diffraction (XRD), Fourier Transform Infrared (FTIR), pH zero charge, Atomic Absorption Spectroscopy (AAS).

1 INTRODUCTION

Coriander (*Coriandrum Sativum.L*) is a popular spice [1] and a major ingredient of curry powder, an effective anti-oxidant [2], [3] and a drug for indigestion [4], against worms [5], rheumatism [6], [7]. Coriander seeds have also several properties such as antimicrobial activity [8], insecticidal effect, Hypolipidemic activity, hypoglycemic action [9], [10].

A range of aldehyde compounds are largely responsible for the aroma of Coriander leaves. The largest proportion of coriander leaves are those aldehydes with 6-10 carbon atoms, particularly decyl (10) and nonyl (9) aldehydes.

Other major constituents of the leaves are 2-decenoic acid, decanoic acid (also known as capric acid) and tetradcenoic acid.The chemical composition of coriander seeds is slightly different, with the alcohol linalool being the major constituent.

This study will demonstrate that Coriander seeds can be used also to treat wastewaters in the treatment plants like an effective natural biosorbent of heavy metals [11], [12], [13]. For that all, the characterization of the material has been studied so as to determine its morphology by using FTIR and XRD techniques. Acid-basic equilibrium has been followed by using distilled water and mineral salts, also, the point pH zero charge was determined. Finally, the extraction kinetic of copper ions Cu^{2+} by coriander seeds was studied following the evolution of pH and ion concentration in order to determine the material capacity to fix heavy metals.

I- MATERIELS AND METHODS

1. Materials

Coriander seeds were washed to eliminate the impurities, and were dried to 40 °C in order to prevent a possible deterioration of the physical and chemical properties of material. Then, they were grinded, the particles between 112 and 250 µm were collected and used for analysis and treatments. According to the literature, chemical composition of coriander in general is illustrated on the table.

Table 3: Chemical composition of coriander seeds [14]

Component	%
oils	17.6±0.1
Protein	13.0±1.2
Minerals	4.3±0.0
Cellulose	34.4±0.2
carbohydrates	30.7±1.2

2. Methods

Fourier Transform Infrared (FTIR)

The Fourier Transform Infrared (FTIR) was carried out using a device of type VERTEX 70 in the range of wavelengths of 400 to 4000 cm^{-1}. The spectral resolution is 4.0 cm^{-1}. The pellets were conducted from an intimate mixture of sifted sample (1 mg) and potassium bromide (100 mg) under a pressure of 4.5 108 Pa.

X-Ray diffraction (XRD)

The analysis of the material prepared in the laboratory by X-ray diffraction was carried out at the University Center for Analysis, Expertise of Technology Transfer and Incubators at the Kenitra Faculty of Science to determine the type of its structure.

Results and Discussions

1. Fourier Transform Infrared Spectroscopy (FTIR)

• *Lamya KADIRI, Ibn Tofail University, morocco*
E-mail : kadiri.lamya@gmail.com
A. LEBKIRI, E. H. RIFI, Y. ESSAADAOUI, A. OUASS, I. LEBKIRI, H. HAMAD, Laboratory of Organic Synthesis and Extraction Processes - Department of Chemistry University Ibn Tofail, Kenitra - Faculty of Sciences, PO Box. 133 – 14000- Morocco

The curve represented in the **figure 1** which were a plot of measured infrared intensity versus wavenumbers of infrared light is a Fourier Transform Infrared (FTIR) spectrum of coriander seeds treated by distilled water and filtrated by a Buchner funnel.

The bond observed under 3302.5 cm^{-1} corresponding to O-H bond was observed due to the presence of carbolic acid (phenol). Under a wavenumber 2923.05 cm^{-1}, the C-H asymmetric stretches were appeared. However, from a wavenumber 2853.58 cm^{-1} the C-H symmetric stretches were appeared.

Around a wavenumber 1744.81 cm^{-1}, C=O stretches associated with the carboxylic acids and / or esters were appeared.

From a wavenumber 1458.8 cm^{-1}, a light deformation due to the presence of C-H was observed.

Around a wavenumber 1144.5 cm^{-1}, C-C stretches were appeared.

Under a wavenumber 1028.75 cm^{-1}, C-O stretches may be observed due to the presence of cellulose [15], [16].

The results observed have shown that the seeds of coriander contain chemical functions comprising oxygen due to the presence of carboxylic acid, esters and ethers. Moreover phenols and cellulose were dominated.

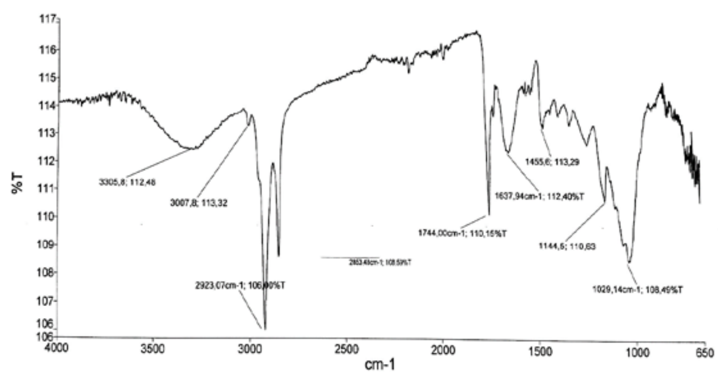

Figure 1: Infrared spectrum of coriander seeds

2. X-ray Diffraction (XRD)

The curves of the X-ray Diffraction (XRD) of coriander seeds (rough and washed by distilled water) were repre-

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sented in the **figure 4**. The results have shown a clear domination of the amorphous form which makes the extraction possible due to the presence of cellulose [17], lignin as major constituents. Therefore the XRD pattern is expected to exhibit crystallinity.

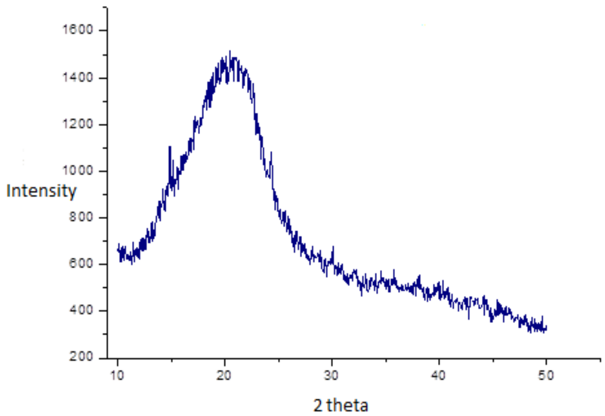

Figure 2: X-ray spectrum of coriander seeds

3. Acid-base equilibrium:

When 0.5 g of the solid support was immersed in 100 ml of the distilled water which the pH= 5.8, an acid-base rearrangement of the solution was observed due to a rapid increase of the pH of the aqueous solution which results by using H^+ protons, after 3 hours the pH was stabilized on 6.9 (**figure 5**).

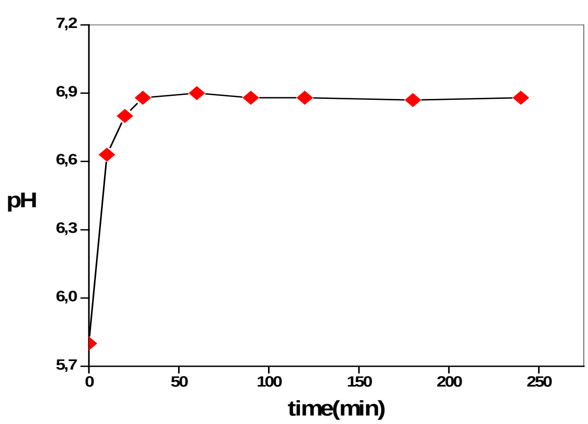

Figure 3: Acid-base behaviour of coriander seeds in the double distilled water

4. pH zero charge

The physico-chemical parameters were determined using methods reported in other work [18]. The point of zero charge, pH_{pzc} of adsorbent was determined by the method described elsewhere [19]. In brief, 100 ml of 0.01M NaCl solutions were placed in various Erlenmeyer flasks. Their pH was adjusted to different values between 2 to 12 by the addition of 0.1 M HCl or NaOH solutions. Now 0.5 g of adsorbent powder was added into each solution and the final pH of these solutions was recorded after 48 hours of agitation. The pH_{pzc} is the point where the curve pH_{final} verses $pH_{initial}$ intersects the straight line corresponding to:

$$pH_{initial} = pH_{final}.$$

The point of zero-charge, as shown in Figure 4, was evaluated to be 6.35. This indicates that the adsorbent acquires a positive charge below pH 6.35 may be due to the protonation of –OH groups to $–OH_2^+$ groups while the –COOH groups impart a negative charge above pH 6.35 could be due to ionization into $–COO^-$ groups [20].

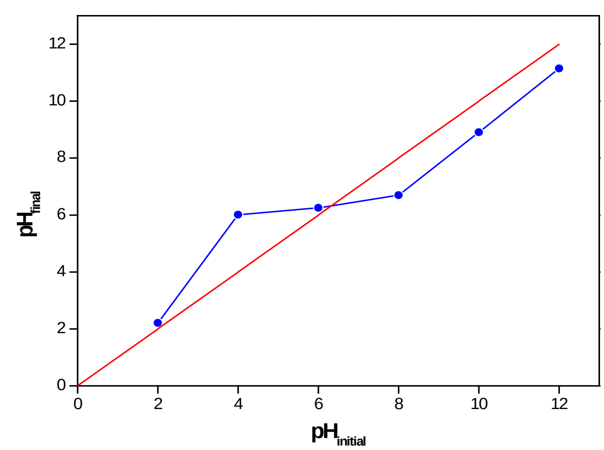

Figure 4: Determination of point zero charge

5. Behaviour of material in contact with mineral salts

Four aqueous solutions containing various inorganic salts: Na_2SO_4, NaCl, $NaNO_3$ and CH_3CO_2Na have been pre-

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pared with a concentration of 0.1 mol / l and an initial pH= 5. In 100 ml of each of these solutions we immersed a quantity of the seeds of coriander of mass equal to 0.5 g. The system is stirred at room temperature. The acid-base rearrangement of the solid support with the aqueous solution containing mineral salt was followed by noting the pH values.

The study of the effect of mineral salts on the behaviour acid-base of coriander seeds: NaCl, $NaNO_3$, Na_2SO_4 curves are characterized by an increase in pH values after a short time from the start of the experiment until equilibrium is achieved. The pH remains constant in the presence of CH_3CO_2Na due to the buffering of the acetate medium. The pH values are stabilized at:

- 45 min for NaNO3 where pH max = 5.80
- 85 min for Na2SO4 where pH max = 6.20
- 95 min for NaCl where pH max = 6.34

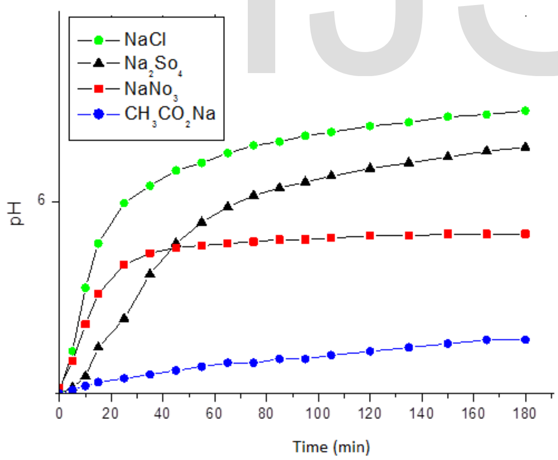

Figure 5: Effect of mineral salts on acid-base behaviour

6. Behaviour of material in contact with copper ions

Copper is chosen as an ion representative heavy metal due to their high toxicity and their use in plating factories and industry. We made synthetic solutions containing Cu by dissolution of copper sulfate salt in distilled water.

Extraction of Cu^{2+} ions has been achieved in a beaker of 250 ml un-der the effect of agitation with a mass of 0.5 g of coriander seeds in contact with a solution of Cu^{2+} concentration of 10 ppm and a volume of 100 ml for 3 hours. After each test mining, the solution has been filtered using the filter under vacuum, then the filtrate was analyzed by type nov AA350 Analytik jena spectrometer atomic absorption spectroscopy [21].

The study of the remove of copper ions Cu^{2+} (V = 100 ml, [Cu^{2+}] = 10 ppm) by coriander seeds (m= 0.5 g) through following the evolution of the concentration and the pH versus time has shown on (**figure 7)** that the fixation of Cu^{2+} on the area of our material has been detected on a short time (chemical balanced solution around 60 minutes). The result has been manifested by the decrease of the Cu^{2+} concentration. The pH measurements have increased with time; this is the acid – base balance of the material with the aqueous solution of the metal Cu^{2+}.

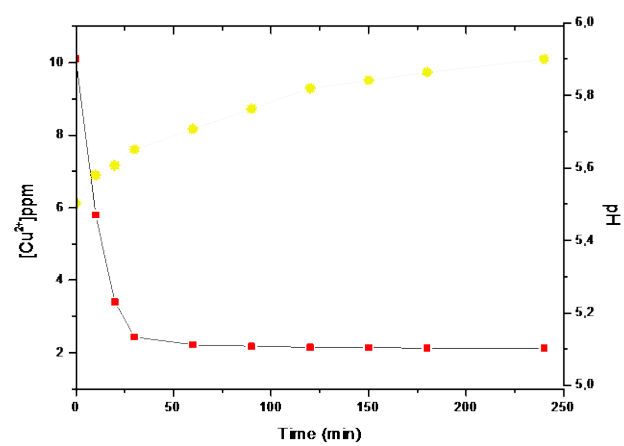

Figure 6: Evolution of pH and concentration of Cu^{2+}

CONCLUSION

This study has shown that coriander seeds contain cellulose which makes the adsorption of protons very easy.

This result was obtained by the Fourier Transform Infrared (FTIR) analysis of the material.

Moreover, the X-ray Diffraction (XRD) analysis results have demonstrated that it is possible to extract heavy metals by coriander seeds due to the presence of cellulose.

Also the results obtained by the acid-base rearrangement of coriander seeds of heavy metal in the double distilled water have shown an acid-base rebalancing of material with the double distilled water.

The results obtained by the acid-base rearrangement of coriander seeds of heavy metal in the presence of mineral salts have shown an acid-base rebalancing of material with mineral salts.

The study of point of pH zero charge indicated that the adsorbent acquires a positive charge below pH 6.35 may be due to the protonation of –OH groups to –OH_2^+ groups while the –COOH groups impart a negative charge above pH 6.35 could be due to ionization into –COO^- groups

The study of the copper ions Cu^{2+} extraction by coriander seeds through following the evolution of the concentration and the pH versus time has shown that the fixation of Cu^{2+} on the area of our material has been detected on a short time (chemical balanced solution about 60 minutes). The pH measurements have increased with time; this is the rebalancing of the acid - base of the support with the solution of the metal Cu^{2+}.

To sum up, coriander seeds can be an effective adsorbent potential of heavy metals contaminating wastewaters.

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