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Moringa oleifera seeds powder as an alternative coagulant for beet sugar juice samples instead of lead acetate

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ABSTRACT

Lead acetate is the most common coagulant used in quality control laboratories in the sugar industry to clarify juice samples. Due to its known poisonous effects, health hazards, and extremely harmful impact on the environment, this study focused on finding an alternative coagulant that was efficient, safe, cost-effective, and eco-friendly. A powder made from *Moringa oleifera* (*M.o*) seeds, which is rich in phytochemicals with antimicrobials, was tested to produce a natural coagulant capable of clarifying the juice samples. The produced coagulant proved efficient and was potentially characterized by a better environmental performance than the extremely harmful lead acetate. An amount of three grams of *M.o* seed powder proved to be an effective coagulant, achieving a 64.14 % removal of non-sugar compounds and led to the correct sugar polarimetric measurements. There is no way to compare the exorbitant price of lead acetate to the cost of naturally and available occurring *Moringa* seeds. The adsorption process was described by three adsorption isotherms, which were applied to evaluate the adsorption equilibrium.

1. Introduction

Sugar beet made up ≈ 20% of the global sugar production in 2019 [1]. The main objective in any sugar treatment process is to eliminate the color and turbidity that are coexisting with sucrose solutions to obtain high-quality sugar. Thus, the exclusion of non-sugars from sugar is the goal of almost every step of sugar production. The removal of the majority of these non-sugars is always the main purpose of juice purification. Clarification processes are considered as the bottleneck of sugar manufacture. Therefore, any improvement in these processes reflects itself on the grade of purity of the sugar and its yield. There are many industrial stages in sugar factories to produce sugar from both sugar beet and sugar cane. These stages comprise slicing, extraction, juice treatment, evaporation (beet end stage), crystallization, separation by centrifugation, sugar dryer and sugar packing (sugar end stage). The juice of sugar cane and beets darken a few minutes after their extraction due to the oxidation of some of their chlorophyll and polyphenolic compound components, harming their commercialization and necessitating quick consumption. And it can negatively affect their polarimetric readings [2]. Impure sucrose solutions like juices, syrups, and liquors affect their polarimetric readings since they are also optically active and may change the direction of polarized light. To reduce the effects of these interfering substances, sugar quality control laboratories use clarifying reagents on the samples to precipitate non-sugars. A frequently used clarifying reagent is lead acetate. Neuropsychological development, cognitive functioning, and chronic kidney diseases have been linked to exposure to lead in various settings. It also affects other cardiovascular functions, causing 9% of hypertensive heart disease, 2% of rheumatic heart diseases, and 3% of other cardiovascular diseases worldwide [3]. The color of sugar depends on the color of the juices from which sugar is produced. Colorants (coloring substances) are not present in beet juice but are formed

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during processing; sugar beet is an off-white color, but processed beet juice is colored [4]. The mechanisms of color formation in beet processing are complicated due to many involved parameters. The formation of non-sugars is considered an important factor that affects the quality and quantity of beet sugar. The chemical composition of sugar beet is as follows: water (73-76.5%), dry substances (23.5-27%){sucrose 14-20%,nonsucrose substances 2.5% (1- 1.1% nitrogenous (0.2% amino acids, 0.1% betaine, etc. 2-0.9 % non-nitrogenous (0.3% invert sugar, 0.2% raffinose, etc.)-3-0.3% minerals (K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, PO_4^{3-}) 4- 0.2% others) } and 5% beet marc {(2.4% Pectin-1.2% Cellulose-1.1% Hemicellulose-0.1% Protein-0.1% Saponin-0.1% Minerals)}. All of these compounds are considered as impurities except sucrose. This non-sugar content must be removed because of its effect on the polarimetric reading through the use of coagulants. The most common coagulant used in quality control laboratories in the global sugar industry is lead acetate. Consecutive trials for rendering alternative coagulants have been carried out. The effect of calcium hydroxide and acetic acid on the rate of deterioration and dextran formation during sugar beet storage has been studied [5]. Modified sugar beet pulp has been applied to remove cations and color from thin sugar juice [6]. Activated carbon (charcoal) was heated up with diluted molasses to 75º C for 1 hr., where the coagulated protein and plant pigment floated to the surface and formed froth on the top of the flask; this layer was skimmed off by hand [7]. Waste management of powdered activated carbon from cyclone of some sugar factories was used to decolorize sugar mud juice [8]. Calcium phosphate flocs that are formed during the clarification of cane juice have proved their ability to remove impurities [9]. Calcium sulphate, as the coagulant in phase, has been used for sugar beet juice clarification; it has been recommended as a good substitute for the traditional coagulant CaO used in Serbia [10]. Gel-permeation chromatography (GPC) with UV and RI detection was used to separate and determine some color components in raw, thin, and thick sugar beet juices [4]. Ion-exchange technology is another technique used to decolorize sugar syrups and remove colors from both beet and cane sugar syrups [11]. Near-infrared transmittance spectroscopy combined with multivariate concentration and pH value has been applied to determine the contents of raw, thin, and thick sugar beet juices [12,13]. Strides in the direction towards using natural coagulants for clarifying fruit juices have been established through the use of rice puree as a naturally sourced clarifying agent for cashew (*Anacardiumoccidentale*) apple juice; it can better replace industrial clarifying agents for a safer drink production [14]. The use of natural biodegradable materials of plant sources to clarify turbid water has proven successful, beneficial, and sets a precedent. The present work aimed to compare the environmental-economic viability of using a naturally available biodegradable material of plant origin to purify the turbid sugar beet juice with that of the traditionally used lead acetate coagulant. The coagulation activity of the natural coagulant extracted from common bean at different pH values of wastewater from sugar production and in the primary treatment of distillery wastewater in the bioethanol production from sugar beet juice has been studied [15,16]. *Moringa oleifera* has proven to be the best natural coagulant discovered so far which can replace aluminum sulphate (alum) [17,18]. But this is the first time a natural coagulant namely the powder processed from *Moringa oleifera* seeds, is used for clarifying the sugar beet juice itself. Among all the plant materials that have been tested over the years, this powder has proven to be sustainable and environmentally friendly [19,20].

2. Material and methods

The study was carried out in the quality control laboratory of the Fayoum sugar works, Fayoum, Egypt (Figure 1). The beet sugar molasses studied in this investigation were obtained from the Fayoum factory. All the chemicals were of AR grade. The dry and good quality *Moringa oleifera* seeds were selected from the pods collected from Qualamshah, Fayoum, middle Egypt (Figure 1). These pods were allowed to completely dry on the tree (the brown color pods) because the green ones were reported as not possessing any coagulation activity [21].

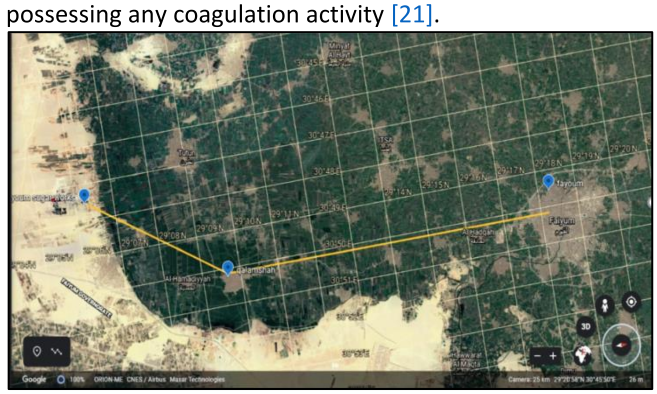

Fig. 1. Locations of Fayoum sugar works, Qalamshah town, and Fayoum city along with their longitudes and latitudes.

The extracts prepared from the powdered unshelled seeds were less effective in coagulation and removal of turbidity. The seeds are opened and then dried in an oven for 24 hr. at 50°C. The husk, hull and wings were removed from the kernels, and then they were milled to powder in the blender which was sieved through a 0.4 mm sieve in order to obtain a particle size of less than 0.4 mm. Figure 2 illustrates these steps.

Fig. 2. The order of extraction and preparation of *Moringa olivera* seeds

2.1. Instruments

A refractometer (ATAGO RX 500) was used to measure the dry substance in the sample solution. It depends on measuring the angle of refraction of a beam of light when it collides with a different medium. The beam of light passes from the air through the solution, and the direction change on an angle called the refractive angle or refractive index is formed. Because of the relationship between the refractive index and the dry soluble substance, the refractometer displays this relationship in the form of a refractometric dry substance (RDS) or traditionally called Brix. The refractometer is designed to measure the sample in order to express its Brix content as a mass percentage (% m/m). A polarimeter (Anton par MCP500 Sucromat) determined the optically active substances (sucrose) in the solution sample. The technique is based on the rotation of plane polarized light as it passes through the sucrose solution. The degree of rotation is proportional to the concentration of the optically active substances. A spectrophotometer (Shimadzu UV 1800) determined the color of the sample solution based on the intensity of the absorbed light by the colored compounds.

2.2. Use of Moringa oleifera (M.o) seeds as an alternative coagulant to lead acetate:

2.2.1. Procedure

A reference sample was run using the traditional coagulant, e.g., lead acetate, to assess the removal percentage of the tried coagulants in the following manner. The molasses sample was diluted to 1:1 by water. The dry substance of the sample (D.S) or (Brix˚) was measured to =78. Twenty-six grams of the sample and 5 mL of lead acetate solution (35%) were put in 200 mL in a measuring flask and completed to the mark by distilled water to measure the sucrose percentage; the purity and color were determined (Color = 65000 IU and Purity = 61.65). Due to the complexity of the sugar beet juice composition and the numerous factors that can influence its coagulation activity, it is necessary to determine the optimal conditions for achieving satisfying results using the proposed coagulant for clarification and color removal.

a)<u>The use of *Moringa oleifera* aqueous solution as a coagulant:</u>

1- Put 20 g of the powdered *M.o* seeds in 200 mL deionized water and pour in a high speed mixer for 1 hour. Then leave it to settle for another hour.

2- Filter the solution on Whatman glass microfiber filters; take aliquots of 5, 10, 15, 25, and30 mL of the filtrate (20 x 1000/200 mL ≡ 100 mg/mL).

In each of five 200 mL volumetric flasks, 6.5 g of the molasses sample was added; the specified aliquot of the aqueous *M.o* seed powder was added to test its dose effect on both the color and purity. The obtained results are illustrated in Table 1 and graphically represented in Figure 3.

Table 1. Optimization of the dose of aqueous *Moringa oleifera* seed powder solution used as coagulant.

Dose (Ml)	**Purity (brix %)**	**Color(IU)**	**Removal (%)**	**Standard deviation (%)**	**Standard error (%)**
5	57	500	15.3	0.360	0.208
10	59	450	30.7	0.5507	0.317
15	60.25	400	38.4	0.360	0.208
20	61.506	335	48.4	0.435	0.251
25	61.5	328	49.46	0.4503	0.26
30	61.5	325	50.01	0.443	0.255

b)<u>Extraction of the bioactive coagulant from *Moringa*</u>

The previous steps were repeated using only 10 grams of *Moringa oleifera* seeds fine powder suspended in a 1M NaCl solution. The solution was filtered, and the purity was measured (61.62, color=31384); the removal percent was determined to be 51.7%. The obtained results are illustrated in Table 2 and graphically represented in Figure 3 (b).

c) <u>Extraction of the bioactive component in *Moringa oleifera* in 1M sodium chloride heated on a water bath for 1 hour.</u>

The same steps were repeated using the prescribed extract. The measured sugar Brix %, purity (61.62), and removal % (59.76) are displayed in Table 3 and Figure 3 (c)

d) <u>Use of *Moringa oleifera* seeds powder directly as coagulant for lab. samples</u>

The reference molasses sample was measured as illustrated previously using the traditional coagulant lead acetate. As shown in Table 4 and Figure 3 (d), 6.5 g of the molasses sample and the *Moringa oleifera* seed dose were added to each of the five 200 mL measuring flasks.

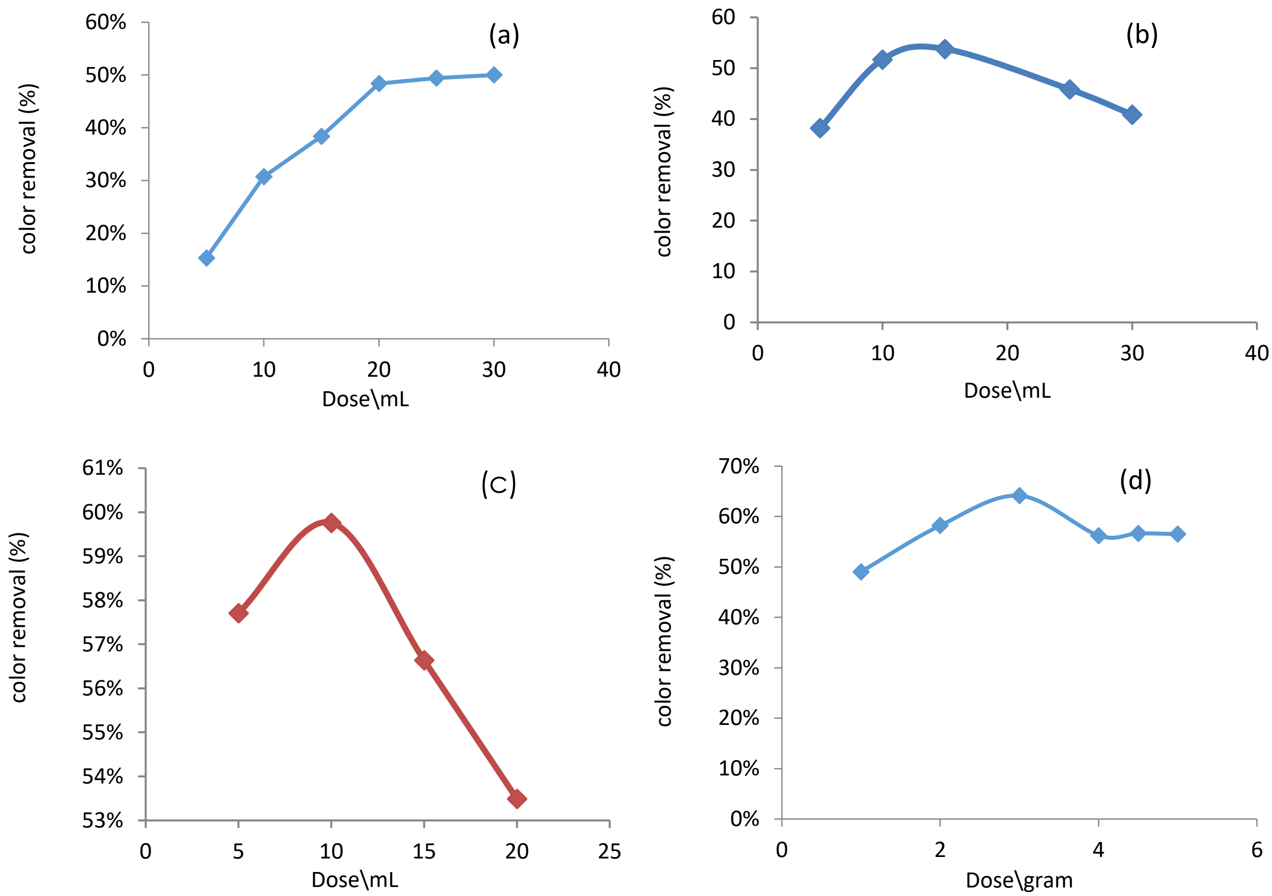

Fig. 3. (a) Relation between the dose of aq. *M.o.* solotion and removal % of non-sugar material; (b) *M.o* extracted in NaCl; (c) *M.o* powder extracted in heated 1M NaCl solution; and (d) *M.o* powder.

Table 2. Optimization of the dose of *Moringa oleifera* seeds powder in 1M sodium chloride solution.

Dose (mL)	Purity (%brix)	Color (IU)	Removal (%)	Standard deviation (%)	Standard error(%)
5	60	40155	38.22	0.6	0.346
10	61.6	31384	51.7	0.624	0.36
15	61.59	30172	53.8	0.556	0.32
25	61.48	35200	45.84	0.393	0.227
30	61.6	38425	40.88	0.594	0.343

Table 3. Optimization of the dose of *Moringa oleifera* seeds powder in 1M sodium chloride solution heated on a water bath.

Dose (mL)	Color(IU)	Purity (%brix)	Removal (%)	Standard deviation (%)	Standard error (%
5	2748	61.59	57.71	0.4932	0.284
10	2615	61.64	59.76	0.3785	0.218
15	2844	61.63	56.42	0.4529	0.26153
20	3023	61.55	53.49	0.4293	0.2478

Table 4. Optimization of the dose of *Moringa oleifera* seeds powder.

Dose (g)	Purity (%brix)	Color (I U)	Removal (%)	Standard deviation (%)	Standard error (%)
0.5	61.26	35560	45.29	0.429	0.247
1	61.29	33104	49.07	0.251	0.145
2	61.61	27153	58.22	0.655	0.378
3	61.58	23307	64.14	0.588	0.339
4	61.33	28440	56.24	0.26	0.207
4.5	61.22	28150	56.66	0.4875	0.281
5	61.18	28220	56.58	0.473	0.273

3. Results and discussion

From the adsorption results, it was clear that the adsorption of non-sugar components is concordant with the following order: *Moringa oleifera* fine powder >*M.o* soln. extracted in boiling 1M NaCl >*M.o* soln. extracted in 1M NaCl > aqueous *M.o* soln. This is logical due to the increase of the concentration of *M.o* content, which is the effective factor in the adsorption process. The use of saline solution in the preparation of the *Moringa oleifera* coagulant is advised due to its proven contribution to the coagulant extract efficiency [22]. This was concordant with our findings where the aqueous *Moringa* solution achieved 50.01% removal, 51.7 % with the 1M NaCl solution at ambient temperature and 59.67% for the boiling 1M NaCl *M.o* one. This means that the extraction step in the boiled NaCl soln. has enabled the gain of more *M.o* in the solution leading to higher removal efficiency (Table 3). It is important to evaluate the chemical and technological characteristics of beet juice in order to estimate the quality of the beetroots for sugar production. [23] studied the quality of sugar beet, which ranged from 75.20% at the start of the season to 82.80% at its end; its purity ranged from 85.54 to 87.75%, which after the evaporation process increased by 2.8%. Another environmental problem is caused by the discharge of ≈ 500 filter papers/day from the factory's quality control laboratory during the work season; each filter paper is filled with the sludge produced by the coagulation products containing 175 mg lead acetate. These filter papers are thrown or collected in a hole located at the back of the factory. The collected precipitate taken from the filter papers was dried in an oven and then dissolved in water, subjected to consecutive dilutions to fit the measurement range of lead concentration in the solid waste using ICP.A sample of this soil scored 1470 ppm Pb, proving the high extent of pollution. Such pollution with Pb will affect the underground water in the vicinity of the polluted soil through translocation.

3.1. Adsorption isotherm studies:

Under different aqueous equilibrium concentrations, adsorption efficiency can be demonstrated by the adsorption isotherm. Modeling the experimental adsorption isotherm data is an essential way for predicting the mechanisms of adsorption. Adsorption is an attraction force between the adsorbate, such as liquid or gas, and the adsorbent, which can be a solid or liquid that forms a thin layer or film on the surface of a suitable support. A bond is created between the adsorbent and adsorbate, which can be a chemical or physical one. And the film can be single or multiple layers. It is possible to separate the adsorbate, once again, from the adsorbent through a process called desorption [24]. The most frequently used isotherms include Langmuir, Temkin, Frumkin, Hill, Flory-Huggins, and Freundlich. In this study, three equilibrium isotherm models were applied to help in the description of the adsorption process. The Langmuir isotherm model postulates that the adsorption of dissolved ions on the monolayer surface of the adsorbent takes place without any interaction between the adsorbed particles and assumes that the active sites of the adsorbent have the same ability to adsorb impurities [25]. The Langmuir isotherm was tested for the experimental data and is given by the following equation:

$$\theta/(1-\theta)=KC \quad (1)$$

where C is the concentration of coagulant (dose), θ is the degree of surface coverage (amount of color removed %), and K is the equilibrium constant of the adsorption process. The Langmuir adsorption isotherm can be plotted (Figure 4) according to equation 2:

$$C/\theta=1/K+C \quad (2)$$

where K = 1/ intercept

The Temkin isotherm model was also applied in this study for equilibrium description. This model takes into account the interactions between the adsorbent and the adsorbed ions by ignoring the extremely low and large values of concentration. It postulates that the energy of adsorption of molecules decreases linearly with the surface coverage due to the adsorbent-adsorbate interaction [26,27].

The characteristic of the isotherm is given by equation 3:

$$a\theta = \ln K.C \quad (3)$$

When

$$\theta=2.303/a \text{ Log } K + 2.303/a \text{ Log } C \quad (4)$$

where a is a molecular interaction parameter depending upon the molecular interactions in the adsorption layer and the degree of heterogeneity of the surface.

Slope = 2.303/a, Intercept = 2.303/a log K

The most important multisite adsorption isotherm for heterogeneous surfaces is the Freundlich adsorption isotherm [28] with different active sites [25]. The linear form of this isotherm is expressed as in equations 5 & 6:-

$$\theta=KC^n \quad (5)$$

$$\text{Log } \theta=\text{Log } K + n\text{Log } C \quad (6)$$

Slope = n, Intercept = log C

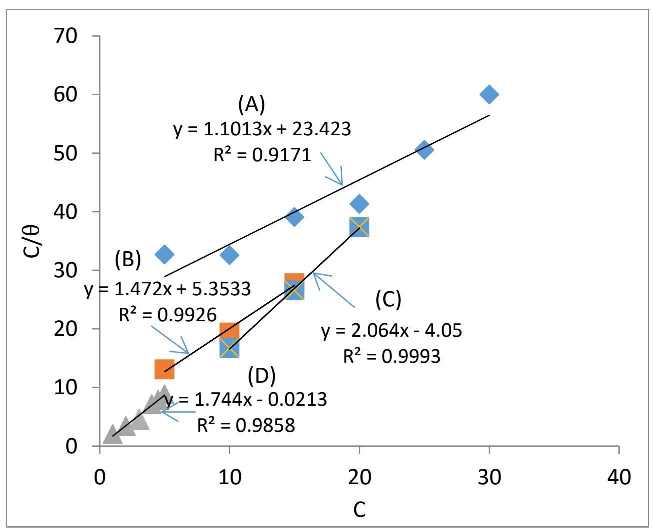

Fig.4. Langmuir isotherm plots for the adsorption of the colored compounds in the sugar juice by the adsorbent *Moringa oleifera* seeds powder.

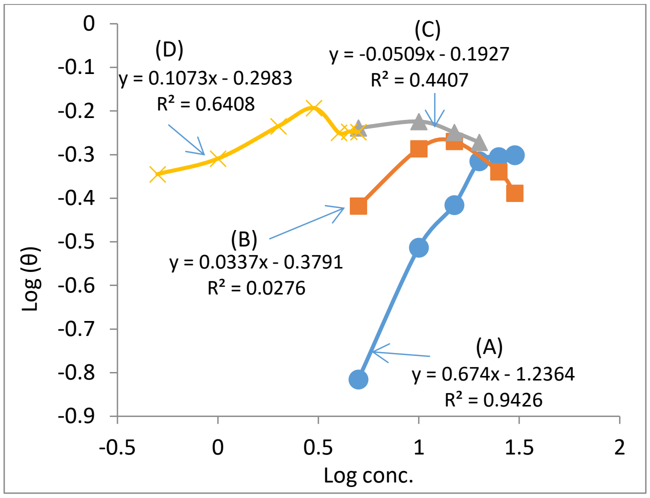

Fig. 5. Freundlich isotherm plots.

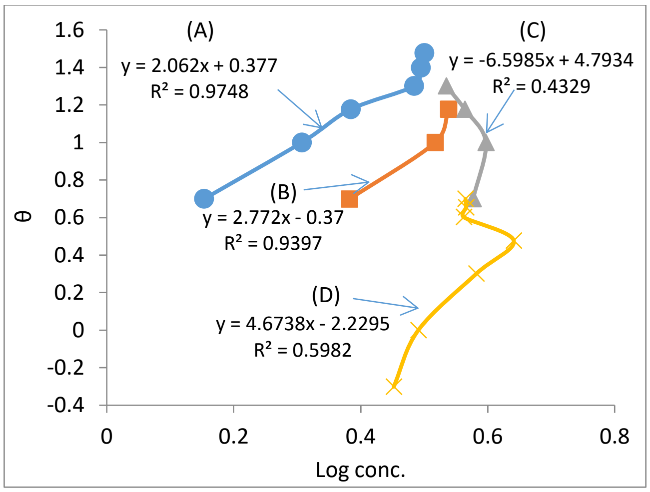

Fig. 6. Temkin isotherm plots.

The following are different ways that the *Moringa oleifera* seed powder as the adsorbent of the colored compounds in the sugar juice can be utilized:

A-Use of *Moringa oleifera* aqueous solution as a coagulant.

B- *Moringa oleifera* seeds using 1M NaCl solution at ambient temperature.

C- *Moringa oleifera* in 1M NaCl and heating in a water bath for 1 hour.

D- *Moringa oleifera* seeds powder directly as coagulant.

The adsorption isotherm parameters of the adsorption removal of the colored compounds in the sugar juice on the adsorbent *Moringa oleifera* aqueous solution are illustrated in Table 5.

Adsorptionis a spontaneous process that takes place if the free energy of adsorption, ΔG_{ads}, is negative, equation 7:

$$\Delta G^o = - RT \ln K \qquad (7)$$

Where ΔG^o is Gibbs free energy of adsorption, T is the temperature in Kelvin and K is the equilibrium constant for the adsorption process. Table 5 illustrates that the experimental data of the aqueous *M.o* soln. fits three models, *viz*,.Temkin, Freundlich, and Langmuir isotherms, respectively. They indicate the spontaneity of the adsorption process and the stability of the adsorbed species on the surface of the *M.o* seeds powder. While in the case of its 1M NaCl soln., the experimental data fit the Langmuir and Temkin models only. In the case of the use of both the 1 M NaCl *M.o* heated soln. and the seed powder directly, the experimental data fitted the Langmuir isotherm, as proved by their high correlation coefficient values. The value of ΔG=-9.535kJ/mol indicates the spontaneity of the adsorption process and the stability of the adsorbed species on the *M.o* seeds powder surface.

Table 5. Adsorption isotherm parameters for *M.o* seeds powder adsorbents.

Solution	Isotherm parameter	Langmuir	Freundlich	Temkin
M.o aqueous soln. (a)	R	0.9179	0.942	0.974
	K	0.0426	0.058	1.52
	ΔG(kJ/mol)	7.818	7.053	-1.037
M.o 1M NaCl soln. (b)	R	0.9926	0.9397	0.0276
	K	0.186	0.736	0.417
	ΔG(kJ/mol)	4.167	0.759	2.167
M.o heated 1M NaCl soln. (c)	R	0.9993	0.432	0.4407
	K	0.246	0.187	0.641
	ΔG(kJ/mol)	3.474	4.154	1.101
M.o seed's powder. (d)	R	0.985	0.598	0.6408
	K	46.94	0.33	0.503
	ΔG(kJ/mol)	-9.535	2.746	1.702

3.2. The cost of the adsorbents

From an economic point of view, the cost of the adsorbent is of great importance. During the period of the beet juice work season, which extends to five months/year, the daily consumption of the lead acetate solution in the quality control lab amounts to 2-3 liters (350 g/L); this means that the consumption/season may exceed 150 kg of lead acetate. If the price of one kilogram of the cheapest quality (Table 6) equals 66.90 €, the cost of the lead acetate reagent used in one working season amounts to ≈ 10,035 €.

Table 6. List of some prices for lead acetate of some companies.

Product specification	SKU-Pack Size	Pack Size	Price (EUR)
32306 Supelco 1- Lead (II) acetate basic anhydrous, for sugar analysis according to Horne, ≥33.0% basic Pb (as PbO) basis, ≥75.0% total Pb (as PbO) basis	32306-1KG	1 kg	66.90
CAS Number 51404-69-4 EC Number 257-175-3 MDL number MFCD00011154	32306-5KG	5 kg	293.00
1.07375 Supelco 2- Lead (II) acetate trihydrate for analysis EMSURE® ACS,Reag. Ph Eur	1073750250	250 g	45.70
CAS Number 6080-56-4	1073751000	1 kg	80.60
EC Index Number 206-104-4 32307 Sigma-Aldrich 3- Lead (II) acetate trihydrate puriss. p.a., ACS reagent, reag. ISO, reag. Ph. Eur., 99.5-102.0%	 32307-100G 32307-250G 32307-1KG	 100 g 250 g 1 kg	 23.70 45.80 118.00
CAS Number 6080-56-4 EC Number 206-104-4	32307-50KG-H		1,940.00
215902 Sigma-Aldrich 4- Lead (II) acetate trihydrate ACS reagent, ≥99%	215902-25G 215902-500G	25 g 500 g	37.20 83.50
CAS Number 6080-56-4 EC Number 206-104-4	215902-2.5KG	2.5 kg	274.00
467863 Sigma-Aldrich 5- Lead (II) acetate trihydrate ≥99.99% trace metals basis	467863-50G	50 g	84.80
CAS Number 6080-56-4	467863-250G	250 g	339.00
EC Number 206-104-4			
316512 Sigma-Aldrich 6- Lead (II) acetate trihydrate 99.999% trace metals basis	316512-5G 316512-25G	5 g 25 g	42.00 61.70
CAS Number 6080-56-4 EC Number 206-104-4	316512-100G	100 g	161.00

There is no way to compare the exorbitant price of lead acetate to the cost of naturally and available occurring moringa seeds. Thus, the harmful effects of lead acetate on humans and the environment are prevented, and the high cost is checked. Besides, *M.o* seeds powder is a green coagulant, which is generally nontoxic, eco-friendly, and renders a safer and cheaper method for clarifying sugar beet juice. The sludge volume generated by the coagulation activity from the seeds powder is lower compared to that of alum or other ferric salts [29]. An additional benefit is that a number of useful products may be extracted from the seeds [30]. After the extraction of the bioactive substances from the seed, the remaining solid is used as animal feed and fertilizer, while the shell is used as an adsorbent after its activation [31]. *M.o* pods contain carbohydrate compounds such as cellulose, hemicellulose, lignin, and crude fiber. In their matrix, the carboxylic carbonaceous fiber and amino functional groups may dissociate at different pH values. And based on this, the adsorption process occurs. Therefore, pH has a pronounced effect on the adsorption process of the components onto the *M.o* [32].

3.3. Desorption studies

We have studied the desorption of the adsorbed *M.o* seeds powder. A solution of 1N HNO_3, as the desorption medium, was constantly stirred with the loaded adsorbent for 1 hr. After centrifugation and washing with distilled water till the washings were neutral, it was dried in an oven at 70°C for 72 hours. It was noticed that the obtained weight of the adsorbent amounted to ≈ 50% of its original weight. It is noteworthy to refer to the difficulty in determining the type and nature of the non-sugars because both the beet and cane sugar juices have many compounds that differ according to the nature of the harvested beet and cane sugar, as well as the cultivated land. From this study, we concluded that a part of the *Moringa oleifera* seeds' powder absorbed a part of the non-sugar compounds that were present in the juice, i.e., through a chemical reaction, besides the essential part that took place through adsorption. It was reported [30] that *M.o* seeds contained some functional groups that combine with some non-sugars in a ratio that reaches ≈ 50%. There are two types of adsorption: 1) physical adsorption (physisorption) that occurs due to the presence of weak Van der Waals attraction forces between the adsorbent and adsorbate, which is reversible in nature with a low enthalpy value near 20 kJ/mol and 2) chemical adsorption (chemisorption) in which there is irreversible chemical bonding between the adsorbent and adsorbate, having a higher enthalpy than physical adsorption which equals 200 kJ/mol. *Moringa oleifera* is commonly known as the horseradish or drumstick tree and is native to the sub-Himalayan region of northwest India but is also naturalized in Sudan and other parts of Africa [33]. It is one of the most widespread plant species that grow quickly at low altitudes in the whole tropical belt, including arid zones. It can grow on medium soils having relatively low humidity. *M.o* seeds, which grow across the tropical belt, contain cationic proteins of sizes ranging from 3 to 60 kDa that have active coagulation properties and are being used to remove impurities [34-36]and cations [37]. The seeds act as a flocculent that attracts and aggregate particles, then precipitates them and can be used as a source of oil. And the cake is being employed as a biocoagulant for point-of-use water treatment in developing countries [38]. *M.o* has a wide distribution because of its excellent and diversified applications in many fields of human life. Health wise, naturally occurring coagulants are regarded as safe, while other coagulants may cause some diseases. Aluminum sulfate is one coagulant that causes Alzheimer's disease and needs a critical pH adjustment [39,40]. Even residuals of carbon nanotubes and traditional water treatment chemicals generally used in drinking water purification have an effect on human health [41] in comparison with *M.o. M.o* also possesses numerous health benefits such as being anti-ulcer, hepatoprotective, anti-bacterial, anti-fungal, anti-hypertensive, anti-tumor, anti-cancerous, and not to mention diuretic and cholesterol-lowering [42]. *M.o* seeds, which are not harmful to humans and do not have significant drawbacks, has been applied for wastewater treatment. In this way, *M.o* seeds have been used as an alternative coagulant. On the one hand, they don't suffer the disadvantages of the high cost and pH alteration that chemical coagulants have exhibited. On the other hand, the *M.o* coagulant is biodegradable, non-toxic, non-corrosive, and easy to use. The ability of *M.o* to remove some contaminants may be better than other coagulants, such as its ability to remove humic acid more effectively than poly aluminum chloride [43,44]. Many types of research have investigated its ability to remove heavy metals [15], different types of dyes (about 99%) [42], organic pollutants from aqueous solutions [32], and the treatment of laundry wastewater [46]. Also, tetracycline has been removed from contaminated water by *M.o* seed preparations [47]; it has been used to clarify pharmaceutical wastewater [48]. Recently, a water extract from *M.o* seeds and water-soluble lectin isolated from it were investigated for insecticidal activity against *S. zeamais* adults [49].

4. Conclusion

A reference diluted molasses sample was run using the traditional coagulant lead acetate to assess the removal percentages of tried coagulants. Different doses of four forms of *Moringa oleifera* seed powder (aq. soln., extract in 1M NaCl soln., heated1M NaCl extract soln. and the fine solid powder) were tested as clarifying coagulants for sugar beet juice. Three grams of *M.o* seed powder proved as an efficient coagulant, achieving 64.14 % removal of non-sugar compounds. The correct sugar polarimetric measurements were achieved based on the preceding clarification step. The suggested coagulant is a green one, which is generally nontoxic, eco-friendly, and renders a cheaper method for clarifying sugar beet juice.

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