DEMOCRATIC REPUBLICA OF CONGO MORINGA SEEDS OIL EXTRACTION, POTENTIAL MIGHTY ANTIPOISON

ABSTRACT

Background: The poisoning, one of the nowadays most serious problem of public health in Democratic Republic of Congo since two decades, has made many victims because of the lack of informations and because of the population impoverishment unable to accede to health care. The Democratic Republic of Congo has a very rich and diversified vegetable patrimony with known therapeutic properties needing only appropriate technology to deal with the extraction process of oils or active principles.

Aim and objective: The overall purpose pursued is to endue the country with home technology to solve somewhat the public health problem in DRC. The kinetic study of oil transfer from liquid- solid extraction has been undertaken in view of the phenomenon uptake in order to make possible home technology of reactors sizing, nowadays absent in underdeveloped countries.

Methodology: KUNYIMA method has been successfully extended to the Moringa seeds oil extraction in petroleum ether using Soxhlet device to assess its validity. The figures have been plotted by means of Origin 8 program.

Results: When $log\frac{1}{m_{oe}-m_e}$ is plotted as a function of time, linear behavior has been obtained at constant temperature (56 °C) in dilute medium.

The global kinetic constant of this time dependent phenomenon has been calculated [$(k = 1.2607 \pm 0.0591)h^{-1}$] to make possible the reactor building for the oil production. The comparison of extraction some parameters $(m_e, k, \ldots)$ between Gourd seeds oil and Moringa seeds oil measured and calculated in the same experimental conditions shows in petroleum ether a greater kinetic activity of solvent for Groud seeds oil than for Moringa seeds oil followed by significant extraction of Gourd seeds oil as fast as the time advanced $(k_{GSO} > k_{MSO})$.

This observation suggests the existing difference of structures between the two species as it is hereby discussed. Moreover it has been pointed out previously that if the difference Δm in absolute value is not of the same errors magnitude order it would interpret the solvent effect. It should be noted however it has been observed the ratio $\frac{m_s}{m_e} > 1$ where the kinetic constant is high (Gourd seeds oil) and $\frac{m_s}{m_e} < 1$ where the kinetic constant is low (Moringa seeds oil) and this ratio might likewise better give informations on solvent effect. Prediction is done of getting possibility of sigmoid curve in the case of the presence of solvation different equilibriums. Also the sigmoid obtaining depends likely on both the structure of extractant solvent and the structure of extracted material. In that case the kinetic constant will be calculated in the upright region of sigmoid curve.

Conclusion: KUNYIMA method has been successfully used in the case of Moringa seeds oil extraction. KUNYIMA Method consists in best uptake of the phenomenon, in expressing it in suitable mathematical model in order to determine its velocity through its kinetic constant before sizing the experimentation reactor. The reactor volume depends on both the sizing factor and the desired volumic debit. According to its wonderful properties, Moringa (leaves, roots and seeds) might be a potential mighty antipoison particularly for heart and for entire body in general.

Keywords: KUNYIMA method, Home technology, Moringa seeds, Sizing factor, Solvent effect, Sigmoid curve.

Comment [h1]: information

Comment [h2]: information

Comment [h3]: Check

ABBREVIATIONS: Kinetic constant Gourd seeds oil (k_{GSO}), Kinetic constant Moringa seeds oil (k_{MSO}), Reactor volume (V_r), Volumic debit (Q).

1. INTRODUCTION

Moringa oleifera has been extensively studied (Moringa leave and Moringa seeds). There is abundant literature where it is reported its benefactions [1,2,3,4]. Its high rates in vitamins A, B and C; its important contents in minerals and chemical elements such as iron, zinc, calcium, copper, potassium, magnesium, manganese, phosphorus, sulfur, selenium, sodium, molybdenum …; the total absence of cholesterol; its impressive amount in fibres and the presence of essential aminoacids make it called "the life tree" used in various fields of science such as medicine (phytotherapy), water science, stock breeding, agriculture, cosmetics and perfume, nutrition, thin paint and so forth. Moringa seeds contain 40% of super quality oils like olive oil with 73% of oleic acid [5,6,7,8].

Comment [h4]: Amino acids

With respect to the medical side, Moringa intervenes in the prevention and treatment of diabetes, hypertension, cardiovascular diseases, sleep, hairs and skin problems [2,5]. Several bioactive compounds isolated from:
- seed like glucosinolates and isothiocyanates, hemagglutinins possess anti-cancer, antibiotic, anti-inflammatory and agglutinogenic effects [9].
- moringa leaves such as glucosinolates, thio carbamates and carbamates as well as other nitrile groups. These compounds are responsibles for several beneficial effects such as: hypotensive, hypolipidemic and antiatherosclerotic, hypoglycemic, antifungal, regulation of the thyroid status [10,11,12,13,14].

Comment [h5]: responsible

The action of the roots is mainly antiseptic, anti-inflammatory, sedative, cardiotonic, potentiator of some analgesic and antidepressive drugs. These actions are mainly due to the presence of alkaloids such as Moringin, Moringinine a powerful fungicide, bactericide Pterygospermine or Anthonin and Spirochine
[15,16].
This medical aspect of Moringa seeds has interested our laboratory (LACOPA) because indeed it has been already tried successfully in it to use Moringa as an antipoison. Its effect has been highly appreciated. By adjunction Curcuma to Moringa seeds the antipoison effect has been extraordinarily enhanced.

The tests are continuing and will wait for a fit required scientific sample to be published. Anyway the preoccupation of Laboratory is to make possible the heart normal acting beyond one century without any problem by improving and stabilizing the cardiac exergetic yield [17,18].

2. MATERIALS AND METHODS

a) Materials

Drying oven, Balance (mark OHAUS), watch glass, desiccator, heating skull cap, spade, beaker, cellulose cartridge (33 × 205 mm), thermometer, gel of silicone, aluminium paper, thermostat, rotary evaporator, chronometer, mortar and pestle, burettes, distillate water and petroleum ether have been used. Origin 8 program has served in this work. Moringa seeds with the following characteristics have been used in this research [19,20,21]:

Reign: *Plantae*
Family: *Moringaceae*
Division: *Magnoliophyta*
Order: *Capparales*
Class: *Magnoliopsida*
Gender: *Moringa*
Species: *Oleifera*

Fig.1. Moringa Tree

Fig.2. Moringa Seeds

Fig.3. Moringa Powder

Fig.4. Moringa Seeds Oil at 27 °C

b) Methods

- **Oil extraction protocol**

Moringa seeds have been husked, afterwards dried at 50 °C for four days in the drying oven (mark memmert). These seeds were pounded and the obtained powder was preserved in a desiccator. Ten grammes of this powder were introduced in cellulose porous cartridge of 33 × 205 mm and put in Soxhlet extractor.

In a three necked flask fitted balloon - c fitte hermometer, 450 mL of petroleum ether (40 – 60 °C, ρ_{solv} = 0.65 L) so re used for the extraction.

The fitting out of Soxhlet was done on heating skull cap (mark thermos scientific) in fixing the temperature at 56 °C. To maintain constant the temperature during experiments, the heating skull cap was covered of aluminium as a heat insulator. The ambient temperature has been kept at 24 – 25 °C [22,23,24,25].

After a given extraction time, the cartridge was dried in a drying oven at 50 °C for 24 hours in order to get rid of traces of solvent. The solvent in the oil – solvent mixture was recovered using a rotary evaporator at 60 °C and placed finally in drying oven to get totally rid of solvent traces. After this, the balloon flask with oil has been cooled in a desiccator and weighed. The difference between the balloon flask containing oil and the empty one determines the extracted oil mass at a ***t*** time in gramme.

- Equation (1) has been used in calculation [22].

$$\log\left(\frac{1}{m_0 - x}\right) = \log\left(\frac{1}{m_{0e} - m_e}\right) = \frac{k}{2{,}3}t + \log\frac{1}{m_0} \quad (1)$$

- For the sizing of extraction reactor, the following equation has been used [22,26]:

$$V_r = \frac{\gamma}{k(1-\gamma)}Q = AQ \quad (2)$$

where A is the sizing factor γ the conversion degree [22].

3. RESULTS AND DISCUSSION

The extraction phenomenon depends on physical properties of extractant solvent such as its dielectric constant, its polarity, its polarizability, its refractive index and on the structure of the extracted material. Also the experimental conditions such as temperature, medium p^H, committed concentrations, sampling… etc. should be taken into account.

Comment [h6]: Be specific

In any extraction process two steps are to be considered: solubilisation and transfer (diffusion). The spontaneous phenomena of solubilisation occur when $\Delta G < 0$ (generally exothermic phenomena). There exists however the willing endothermic phenomena promoted usually by the increase of temperature.

Table 1. Shows measured and calculated parameters of Moringa seeds oil extraction.

Time (h)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0	0.0000±0.0000	2.6105±0.2901	2.6105	0.3831	−0.4167	−0.4167
0.5	1.6457±0.1767	2.6105±0.2901	0.9648	1.0365	0.0156	−0.4167
1	2.0361±0.2650	2.6105±0.2901	0.5744	1.7409	0.2408	−0.4167
1.5	2.2611±0.0960	2.6105±0.2901	0.3494	2.8620	0.4567	−0.4167
2	2.3550±0.1454	2.6105±0.2901	0.2555	3.9139	0.5926	−0.4167
2.5	2.5244±0.2889	2.6105±0.2901	0.0861	11.6144	1.0650	−0.4167
3	2.5635±0.3031	2.6105±0.2901	0.0470	21.2765	1.3279	−0.4167
3.5	2.5831±0.3080	2.6105±0.2901	0.0274	36.4964	1.5622	−0.4167
4	2.6105±0.2901	2.6105±0.2901	0.0000	–	–	–

In this table m_e is experimental extracted mass of Moringa seeds oil while m_{o_e} is total experimental extractible mass of Moringa seeds oil for a given solvent hereby petroleum ether and for a given sample which can be obtained as shown in figure 5.

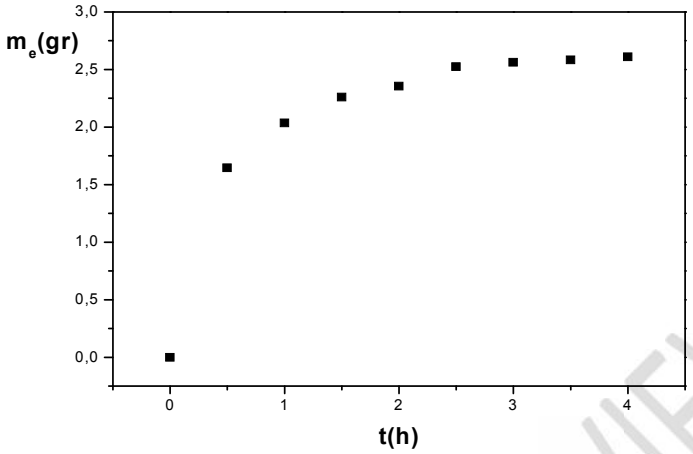

Fig.5. Experimental extracted mass as a function of time.

In this table each value is a mean value of three measurements. When $log\frac{1}{m_{oe}-m_e}$ is plotted versus time using origin 8 program a right line is obtained; its slope gives the kinetic constant, a measure of kinetic activity of solvent, and its intercept gives m_{os} called total statistical experimental extractible mass of Moringa seeds oil in petroleum ether and for a given sample different from m_{oe} as it is shown in figure 6.

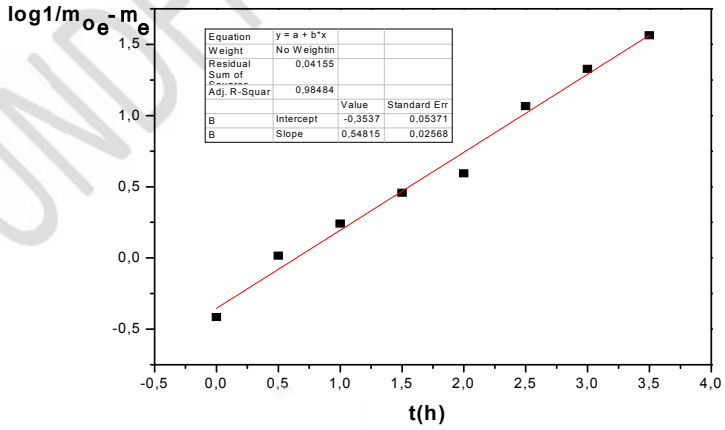

Fig.6. $log\frac{1}{m_{oe}-m_e}$ **versus time**

The kinetic constant has been found $k = (1.2607 \pm 0.05691)\text{h}^{-1}$. The intercept allows to calculate m_{o_s} as follows.

$$\log m_{os} = 0.3537 \pm 0.0537$$

$$\overline{m}_{os} = \overline{m}_{o_{th}} = 10^{(0.3537 \pm 0.0537)}$$

$$m_{o_{1s}} = m_{o_{1th}} = 10^{(0.3537 + 0.0537)} = 2.55541$$

$$m_{o_{2s}} = m_{o_{2th}} = 10^{(0.3537 - 0.0537)} = 1.9954$$

$$\overline{m}_{os} = \overline{m}_{o_{th}} = \frac{m_{o_{1s}} + m_{o_{2s}}}{2} = 2.2754 \qquad (3)$$

$$\overline{m}_{os} = 2.2754 \pm 0.2800$$

So the statistical mass (m_s) of Moringa seeds oil as a function of time has been calculated by means of the relation

$$m_s \approx m_{o_s}(1 - e^{-kt}) \qquad (4)$$

All those values have been inscribed in table 2 and compared to Gourd seeds oil extraction values [22].

Table 2. Comparison of the extraction parameters at 56 °C between Gourd seeds oil and Moringa seeds oil.

	Gourd Seeds Oil					Moringa Seeds Oil				
Time (h)	$\overline{m}$ (gr)	$\overline{m}$ (gr)	$\overline{\frac{dm}{dt}}$ (gr/h)	$\overline{m}_{os}$	$\overline{k}$	$\overline{m}$ (gr)	$\overline{m}$ (gr)	$\overline{\frac{dm}{dt}}$ (gr/h)	$\overline{m}_{os}$	$\overline{k}$
0	0.0000±0.0000	0.0000±0.0000	0.0000	0.0000	1.6411±0.0712	0.0000±0.0000	0.0000±0.0000	0.0000	0.0000	1.2607±0.0591
0.5	–	–	–	–		1.6457±0.1767	1.0640±0.1567	0.5817	0.6465	
1	4.0485±0.8790	4.8339±0.8432	0.7854	1.1940		2.0361±0.2650	1.6304±0.1464	0.4057	0.8007	
1.5	4.6640±0.5862	5.4843±0.9174	0.8203	1.1760		2.2611±0.0960	1.9320±0.1388	0.3291	0.8544	
2	5.1423±0.5888	5.7706±0.9399	0.6283	1.1222		2.3550±0.1454	2.0926±0.1334	0.2624	0.8886	
2.5	5.2212±0.3131	5.8966±0.9453	0.6754	1.1294		2.5244±0.2889	2.1781±0.1296	0.3463	0.8628	
3	5.2587±0.3562	5.9521±0.9458	0.6934	1.1318		2.5635±0.3031	2.2236±0.1644	0.3399	0.8674	
3.5	5.2950±0.4075	5.9765±0.9451	0.6815	1.1287		2.5831±0.3080	2.2478±0.1256	0.3353	0.8702	
4	5.3118±0.4193	5.9872±0.9444	0.6754	1.1272		2.6105±0.2901	2.2607±0.1246	0.3498	0.8660	

When this table 2 is analyzed, it can be firstly observed that the kinetic activity of petroleum ether is greater in Gourd seeds oil than in Moringa seeds oil ($k_{GSO} > k_{MSO}$). Secondly the extracted oil as a function of time in Gourd seeds is large amount compared to Moringa seeds oil. This observation suggests the existing difference of structures between Gourd seeds and Moringa seeds. Indeed, in a crystal the molecules are organized. In amorphous compound, there is no organization. In melting, a crystal is converted from an organized state to an unorganized one.

The are intermediate states between crystalline state and amorphous state called mesomorph substances that can be divided into two classes according to the type of organization namely smectic compounds where the molecules are oriented in parallel and on parallel surfaces and nematic compounds where the molecules are oriented in parallel without any order. Concerning some substances, there are successive passages [27,28] :

Crystal ⟶ Smectic state ⟶ Nematic state ⟶ Amorphous state

The organic materials with long chains are generally mesomorphs (Smectic and Nematic structures) for example ammonium oleate.

So Gourd seeds can be identified to amorphous compound while Moringa seeds to mesomorph material. Furthermore it has been previously [27,28] signalized that if $\Delta m = m_s - m_e$ in absolute value is not of the same order of magnitude of errors it would give informations on the solvent effect. It should be noted however that the observation of this table 2 shows the ratio $\frac{n_s}{n_e} > 1$ for Gourd seeds oil where the kinetic constant is high while $\frac{n_s}{n_e} < 1$ for Moringa seeds oil where the kinetic constant is low. This ratio might be used likewise to diagnose the solvent effect. Prediction can be raised on the possibility of obtaining sigmoïd curves in the case of the presence of solvation different equilibriums.

Also the sigmoïd getting may depend likely on both the structure of extractant solvent and the structure of the extracted material. The structure containing the extracted oil and the committed concentrations should be taken into account.

In that case the kinetic constant will be calculated in the upright region of sigmoid curve. Now it is possible to calculate the sizing factor and to size a discontinuous stirrer vat reactor of oil production by the below-mentioned equation [22,26,29] :

$V_r = \frac{\gamma}{k(1-\gamma)} Q$, as it is shown in table 3 and figure 7.

γ has been found 26.0827 ± 1.1212 %

Table 3. Reactor volume (V_r) as a function of desired volumic debit (Q)

Q (l/h)	*V_r (l)*
0	0.0000±0.0000
0.5	0.1399±0.0147
1	0.2798±0.0294
1.5	0.4197±0.0440
2	0.5596±0.0587
2.5	0.6995±0.0734
3	0.8394±0.0881
3.5	0.9793±0.1028
4	1.1192±0.1174
4.5	1.2591±0.1321
5	1.3990±0.1468

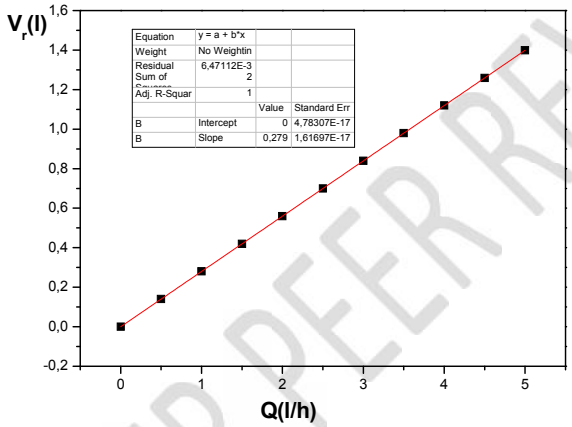

Fig.7. V_r versus Q

4. CONCLUSION

KUNYIMA method [22] has been successfully used in the case of Moringa seeds oil extraction. The laboratory is interested in extraction of medicinal plant oil aiming to better the heart acting.

According to its wonderful properties, Moringa (leaves, roots and seeds) might be a potential mighty antipoison particularily for heart and for entire body in general.

Moringa seeds can be identified to mesomorph structure while Gourd seeds are (made) of amorphous texture [28,30,31].

Gourd seeds oil, Moringa seeds oil, Curcuma, Ginger, Garlic, Arachis hypogaea oil and so forth are intensively studied in laboratory looking for home

technology [22,32,33].Their conjunctions in different proportions give extraordinary healing properties.

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