Original Research Article

EXPERIMENTAL EVIDENCE OF THE DEPENDENCE OF OIL EXTRACTION RATE ~~DEPENDENCE~~ ON ~~BOTH~~ EXTRACTION TIME AND STRUCTURE OF GENERATIVE MATERIAL ~~STRUCTURE~~

ABSTRACT

Background : ~~A kinetic~~ Kinetic and thermodynamic ~~study~~ studies of the extraction of oils from pumpkin seeds, sesame seeds and Moringa seeds ~~has~~ have been carried out at temperatures of 56 and 54°C. ~~for the first time and has shown that T~~the extraction ~~is an~~process was found to be exothermic ~~balanced phenomenon and has made it possible to determine~~ and the kinetic constants in the three cases determined. It was also observed that the rate of extraction was dependent on extraction time and structural organization of the seeds.
The~~se~~ kinetic constants are expected to ~~can~~ provide ~~an indication~~information ~~of~~ on the ~~organic~~ structural organization (crystalline, smectic, nematic or amorphous) of the seeds generating these oils ~~(crystalline → smectic → nemotic → amorphous)~~. ~~In addition, they made it possible to calculate the~~ The enthalpies and ~~the~~ entropies of extraction were calculated and a comparison of ~~all these~~the kinetic and thermodynamic parameters obtained in the 3 cases was made. ~~in the 3 cases.~~

Aim and Objective : This work was designed to extract oils from pumpkin , sesame and Moringa seeds and to determine the kinetics and thermodynamics of the extraction process at the given temperatures using petroleum ether as solvent. ~~It is demonstrated in this work for the collective imagination that the speed of extraction of oils from pumpkin seeds, sesame seeds and Moringa seeds depends not only on the extraction time, but also on the organic structural organization of seeds generating these oils under given temperature and pressure conditions using petroleum ether as extractant solvent .~~

Methodology : ~~The measurements and calculations have been our methodology of work . The comparison between kinetics and thermodynamics parameters of the three species have been done . The figures have been plotted by means of excell program. The Study has been performed in dilute medium.~~ **Tell us what extraction method was used and how exactly it was done**.

Results : ~~The results are satisfactory and are hereby commented . The oils extraction rates of these three species of seeds~~,The kinetic constants, enthalpies and entropies of the extraction process of the oils from the three different seeds ~~are~~ were calculated and compared. In all cases, the rate of oil extraction was found to be directly proportional to time of extraction and structure of the seeds.

Conclusion: The kinetic and thermodynamic study of the extraction of oils from pumpkin, sesame and Moringa seeds ~~has~~ show~~n~~ that the extraction ~~is~~ was an exothermic balanced phenomenon. ~~and therefore the~~ The energy thus released by this operation can be used to perform mechanical or electrical work~~.~~ As for the kinetic constants, they are greater in an amorphous body where the entropy is greater. In such a case, the oil ~~is~~ extracted was much more ~~easily extracted~~ under ~~determined~~ the same temperature and pressure conditions for a given solvent. Under these conditions, the extraction ~~is~~ was dependent not only on time, but also on the structural organization of the material generating the oil. ~~Also, the rate constant can give information on the differentiation of these structures.~~

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1. INTRODUCTION

In our previous work [1,2,3], it was shown that~~e~~ gourd seeds like, pumpkin, sesame and Moringa are made up of chemical compounds. ~~that make up gourd seeds, sesame seeds and Moringa seeds [1,2,3]~~ These compounds are of particular importance in the health of the populace~~tion~~ as recommended by several studies [4,5,6,7,8,9,10,11,12].

~~These compounds are of particular importance in the health of the population as recommended by several studies [4,5,6,7,8,9,10,11,12].~~ The major concern of Lacopa -PCC was to provide the country (DRC) ~~in a rational way~~ with appropriate technology ~~to~~ that solves the eternal problem of knowledge transfer in order to ~~be able oneself to~~ produce large quantities of oil for the ~~population~~ populace and ~~why not for~~ the world. at large if possible[13,14,15].

The title of this work ~~announces what~~ is intuitively known by any researcher in this field .~~,~~ ~~but which~~However, we have the honor to prove this by experimental evidence.

In ~~this same register of concerns~~ similar researches, KUNYIMA method [1,2,3] has been developed and successfully applied to the extraction of oils from these three ~~kinds~~different ~~of~~ seeds. ~~which~~ These seeds ~~have~~ are ~~extraordinarily~~ proven to have nutritional and therapeutic ~~virtues~~ values.~~;~~ ~~and we took the opportunity~~We thus ~~to~~ recommend them to the rulers of DRC.for a mechanized culture ~~to the rulers of DRC.~~ It should be remembered that the DRC has a very rich and diverse plant heritage in a favorable climate all year round ~~so that it~~which constitutes a source of wealth creation not only for its population, but also for Africa and ~~for~~ the entire world.

This work compares the ~~evolution of the~~ extraction speed of oils from pumpkin seeds, sesame seeds and Moringa seeds ~~with the extraction time~~ in petroleum ether at ~~the~~ temperatures of 56 °C for pumpkin and Moringa seeds ~~,~~ and 54 °C for sesame seeds.

The kinetic constants of the extractions were calculated at these temperatures. ~~and~~ The values ~~have been commented on. They are~~ were all different for the different seeds and seem to reflect the differences in the structure ~~between different seeds.~~of the seeds. The two constants ~~measured~~ at 56 °C ~~can be~~are ~~compared~~comparable~~,~~ but ~~except~~ differ from that calculated at 54 °C ~~for sesame seeds which nevertheless give an idea of its evolution in the same direction as the others, especially since the difference of 2 ° C is not great.~~The results have discussed ~~We made this~~inline with this comparison.~~ in the discussion without being afraid to distort our reasoning.~~

2. MATERIALS AND METHOD

The materials and method ~~have been mentioned in~~are same as in previous work where soxhlet extraction was used [1,2,3].

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The kinetic constants calculated in our previous work were used to calculate the rates of extraction using the formula below.

$$m_e = m_o(1 - e^{-kt})[1,16]$$

$$m_o - m_e = m_o e^{-kt}$$

but

Thus,

$$v = k(m_o - m_e)$$

v=dX/dt=k(mo-me)

where v is the extraction speed in g/hr.

k is the kinetic constant or rate constant

m_o = extractable mass of oil in petroleum ether (it is usually considered constant).

m_e = extracted mass of oil at a time t expressed in hours (hr.).

To calculate enthalpy and entropy of extraction, a formula similar to that of Arrhenius was used[17]

k = Ae $^{-E/RT}$

where E is activation energy of a chemical reaction. But, extraction processes involve molecular interactions and not chemical reaction. Therefore, the E in Arrhenius equation can be called interaction or extraction energy. Hence, on expansion the equation becomes

$$\ln k = \ln A - \frac{E}{RT}$$

$$\ln k = \ln A - \frac{E}{RT}$$

$$\ln k = \ln A - \frac{E}{RT} = \ln A - \frac{\Delta H - T\Delta S}{RT}$$

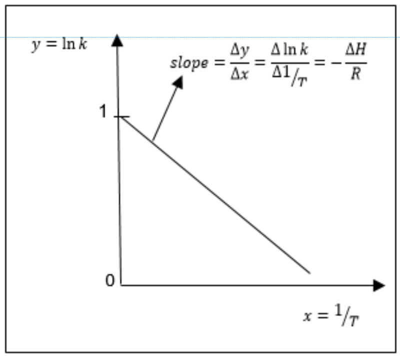
Suppose E = ΔG and ΔG=ΔH - TΔS, then

$$\ln k = \ln A - \left(\frac{\Delta H - T\Delta S}{RT}\right)$$

$$\ln k = \ln A - \frac{\Delta H}{RT} + \frac{T\Delta S}{RT} = \ln A + \frac{\Delta S}{R} - \frac{\Delta H}{RT}$$

$$\ln k = \ln A + \frac{\Delta S}{R} - \frac{\Delta H}{RT}$$

$$\ln k = B - \frac{\Delta H}{RT}$$



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$$slope = \frac{\ln k1 - \ln k0}{\left(\frac{1}{T1} - \frac{1}{T0}\right)} = -\frac{\Delta H}{R}$$

This equation is ambiguous as k1, k0, T1 and T0 are undefined

If T (is it T1 or T0)=≠≠ ∞Δ → $\ln k0 = 0$

$$\frac{1}{T} = 0$$

$$slope = \frac{\ln k1}{\frac{1}{T1}} = -\frac{\Delta H}{R}$$

$$T1 \ln k1 = -\frac{\Delta H}{R}$$

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$$\Delta H = -RT \ln k$$

Please harmonize these equations and define all symbols used,

The reason why E is not equated to ΔG has been explained under results and discussion

,

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but E = ΔH and ΔG = 0

Therefore,
$$\Delta S = \frac{\Delta H}{T} = -R \ln k$$

The following expression is used to calculate the error on E (ΔH)

$$\ln k = \ln A - \frac{E}{RT}$$

$$\frac{dk}{k} = \frac{dA}{A} - \left[\frac{dE.RT - d(RT).E}{(RT)^2}\right]$$

$$\frac{dk}{k} = -\frac{RTdE}{(RT)^2}$$

$$\frac{dk}{k} = -\frac{dE}{RT}$$

$$\frac{\Delta k}{k} = \frac{\Delta E}{RT}$$

$$\Delta E = \frac{RT\Delta k}{k}$$

~~Work formula~~

It should be noted that this method helps to obtain the values of the extraction energies with 0 as an error since the derivative of a constant (kinetic constant) is zero (dk/k)

3. RESULTS AND DISCUSSION

Table 1 gives the values of the measured and calculated parameters for the extraction of oil from pumpkin seeds.

Table 1 : The values of rate of oil extraction, time of extraction and other parameters involved in the extraction of oil from pumpkin seed using petroleum ether as solvent.

Time (h)	$m_0(g)$	$m_e\,(g)$	$v\,(gh^{-1})$
0	5.3118±0.4193	0.0000±0.0000	8.7171
1	5.3118±0.4193	4.0485±0.8790	2.0732
1.5	5.3118±0.4193	4.6640±0.5862	1.0631
2	5.3118±0.4193	5.1423±0.5888	0.2782
2.5	5.3118±0.4193	5.2212±0.3131	0.1487
3	5.3118±0.4193	5.2587±0.3562	0.0871
3.5	5.3118±0.4193	5.2950±0.4075	0.0276
4	5.3118±0.4193	5.3118±0.4193	0.0000

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Table 1 shows the values of the rate of extraction, the corresponding time, extractable and extracted masses of of pumpkin gourd seeds oil It is observed in this table that the extraction speed decreases with the extraction time.

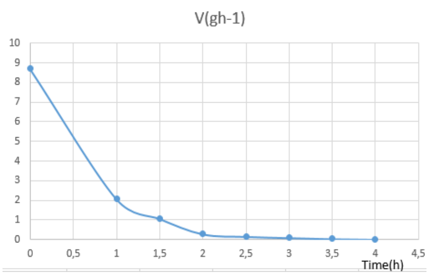

Figure 1 : Plot of extraction rate versus time for Gourd seeds oil.

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This decrease in speed seems logical given that the solvent tends to saturation with time..

Table 2 : Values of the speed and times of extraction as well as the extractable and extracted masses of oil for sesame seeds

Time (h)	$m_0(g)$	$m_e\,(g)$	$v\,(gh^{-1})$
0	5.3911±0.1753	0.0000±0.0000	8.3778
0.5	5.3911±0.1753	2.0773±0.3029	5.1496
1	5.3911±0.1753	4.7635±0.2632	0.9753
1.5	5.3911±0.1753	5.1920±0.1853	0.3094
2	5.3911±0.1753	5.2522±0.1770	0.2158
2.5	5.3911±0.1753	5.2916±0.1859	0.1592
3	5.3911±0.1753	5.3337±0.1753	0.0892
3.5	5.3911±0.1753	5.3711±0.1753	0.0311
4	5.3911±0.1753	5.3911±0.1753	0.0000

Table 2 gives the values of the experimental parameters for the extraction of sesame seeds oil.

The experimental results obtained (Table 2 and Figure 2) are similar to those of pumpkin seeds. , The decrease in rate of extraction as time increased shows the saturation of the extracting solvent in the extracted substance with time.

Figure_2_ Plot of sesame seeds oil extraction rate versus time.

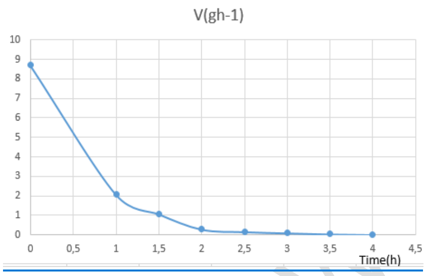

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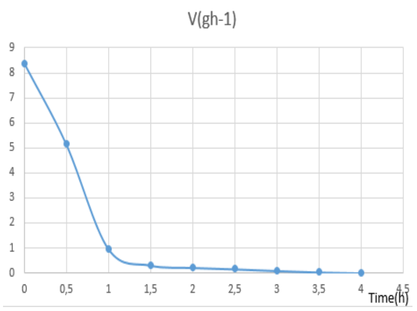
Table 3 and Figure 3 give the data Table 3 and Figure 3 give the data obtained for moringa seed oil extraction. These values followsimilar trend to those obtained previously.

Table 3. Values of extraction rate and the corresponding times for the extraction of Moringa seeds oil.

Time (h)	$m_0(g)$	$m_e\,(g)$	$v\,(gh^{-1})$
0	2.6105±0.2901	0.0000±0.0000	3.2910
0.5	2.6105±0.2901	1.6457±0.1767	1.2156
1	2.6105±0.2901	2.0361±0.2650	0.7241
1.5	2.6105±0.2901	2.2611±0.0960	0.4405
2	2.6105±0.2901	2.3550±0.1454	0.3221
2.5	2.6105±0.2901	2.5244±0.2889	0.1085
3	2.6105±0.2901	2.5635±0.3031	0.0592
3.5	2.6105±0.2901	2.5831±0.3080	0.0345
4	2.6105±0.2901	2.6105±0.2901	0.0000



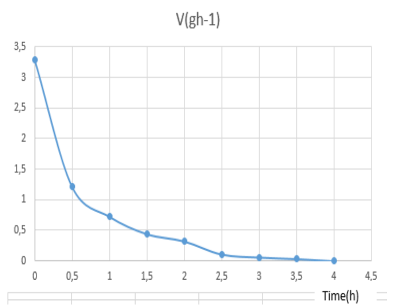


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Figure 3 : Extraction rate versus time of extraction of Moringa seeds oil

The superposition of the results of the oils of these three species clearly highlights the variation in the extraction speed not only with time but also with the nature of the species engaged in the extraction as shown in Figure 4.

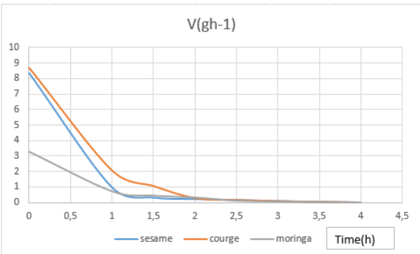

Figure 4 : Plots of rates of oil extraction versus time for the three seeds analysed.

Kinetic and thermodynamic studies were undertaken to account for the influence of structure on the extraction speed. The results show that at a given temperature and pressure, the kinetic constant depends on the nature and structural arrangement of the seeds that generate the oils..

The extraction enthalpies and entropies were calculated using the Arrhenius relation :

$$k = Ae^{-\frac{E}{RT}} \qquad [17]$$

.

The Soxhlet extraction that we carried out constitutes an extraction operation in a closed system and in such a closed system,

dG =-SdT+VdP and dH = TdS + VdP

Since the extraction was carried out at constant temperature and pressure, ∆G = 0 and ∆H = T∆S

The energy required for extraction is not zero as ∆G, but equal to the change in enthalpy, ∆H given as

$\Delta H = -RT \ln k$ The entropy change of the extraction is related to the enthalpy change by

$$\Delta S = \frac{\Delta H}{T}$$

$$\Rightarrow \Delta S = -R \ln k$$

The values of change in enthalpy and entropy for the extraction of the oils from the different seeds are tabulated in Table 4. These experimental values are negative for for all the seeds studied. It means that the energy released in the extraction process can be used to producemechanical or electrical work . . However, the magnitude of the energy involved in extraction, ∆H and that of agitation, ∆S, are largest for pumpkin seeds and least for moringa..

Indeed, in a crystal, the molecules are organized. In an amorphous body, there is no organization. As it melts, a crystal changes from an organized state to an unorganized state. There are intermediate states between the crystalline state and the amorphous state. These are the mesomorphic bodies divided into two classes according to the type of organization :

Smectic bodies where the molecules are oriented parallel and unparallel surfaces and nematic bodies where the molecules are oriented parallel but without any other order.

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For some bodies, there are successive passages : Crystal → sméctic state → nematic state → amorphous state .

Table 4 : Kinetic and thermodynamic parameters obtained from the extraction of oils from the three species of seeds studied.

	$k\left(h^{-1}\right)$	$\Delta H\left(Jmol^{-1}h^{-1}\right)$	$\Delta S\left(Jmol^{-1}h^{-1}K^{-1}\right)$
Grourd seeds oil	$1.6411 \pm 0,0712$	-1355.0706 ± 0.0000	-4.1187 ± 0.0000
Sesame seeds oil	$1.5540 \pm 0,1404$	-1198.3569 ± 0.0000	-3.6647 ± 0.0000
Moringa seeds oil	$1.2607 \pm 0,0591$	-633.7856 ± 0.0000	-1.9264 ± 0.0000

As for the values of the rate constants, they are consistent with the species studied.

Their change suggests that the kinetic constant which is a measure of the ease with which the solvent extracts the oil is greater for pumpkin seed oil than for sesame seeds oil and the latter exhibits a kinetic constant greater than Moringa seeds under the same temperature and pressure conditions for a given solvent.

Thus, in a more amorphous and therefore more disordered structure, oil extraction is easier.

4. CONCLUSION

The kinetic and thermodynamic study of the extraction of oils from pumpkin seeds, sesame seeds and Moringa seeds has shown that the extraction of oils from these seeds is an exothermic balanced phenomenon. Therefore, the energy released by this operation can be harnessed to perform mechanical or electrical work.

As for the kinetic constants, they are greater in a more amorphous body where the entropy is greater for a given temperature, pressure and solvent.
In such an amorphous body, oil extraction takes place more easily. The oil extraction speed was also found to be dependent not only on the extraction time but also on the structure of the oil generating material. This asertion was possible through the evaluation of rate constants of the extraction process.

5. REFERENCES

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