

THERMAL DEGRADATION OF COPPER (II) GROUNDNUT SOAP COMPLEXES

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ABSTRACT

Oil occurred natural sources are considered to be the essential category of renewable sources and can be produced as of natural plants such as groundnut, they comprise generally of triglycerides. The main object of this work gives an outline of innovative result in the area of thermo gravimetric analysis for Copper (II) groundnut soap complexes. Solid state kinetics has fascinated the awareness of precise society not only due to its abundant applications in environment, energy, waste water treatment, pollution control and green chemistry but also due to their extensive variety of biological activities. TGA method has been useful to Copper (II) groundnut soap complex used for its thermal study and estimation of activation energy and pre-exponential factor. Thermodynamic parameters such as heat of dissociation ΔH , free energy change ΔG and entropy change ΔS have been estimated for the different steps of degradation with the fundamental method of Coats-Redfern, Broido, Horowitz-Metzger and Piloyan-Novikova method. The outcome of thermo gravimetric analysis expose that Copper (II) groundnut soap complex experience stepwise thermal degradation of ligand, saturated, mono- and polyunsaturated fatty acid segments of edible oils. It has been experiential to facilitate used for every equations applied, the stepwise energy of activation follow the array – Step III > Step II > Step I.

Keywords: *Groundnut, Thermal Degradation, Activation Energy, Thermodynamic Parameters, TGA, Edible Oils.*

Introduction

Soaps are a group of surface active compounds that produced by natural oils and fats. Groundnut provides a realistic resource of high excellence dietary protein along with oil. Its most important part fatty acids are oleic acid (56.6%) and linoleic acid (26.7%) [1-2]. That properties construct it valuable in soap production industry, it is not attractive as a unprocessed substance for the reason that of its fiscal [3] and enriched implications [4-5]. Metallic soaps can be occurred from natural edible oils, which are eco-friendly and biodegradable. Thermo gravimetric analysis (TGA) is a technique in which substance is decayed due to enhance of high temperature which causes chemical bonds to split in the molecule. The outline of TGA arc depends normally ahead the kinetics parameters. The predictable values of the kinetic parameters are extremely significant in study of the thermal stability of the complexes [6]. That can be perform as extra safer and green chemicals which are commercially essential as they uncover make use of in a variety of applications in diverse industries associated by means of agrochemicals, Pharmaceuticals, paint or inks, as components of lubricating greases, catalysts and water

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proofing agents [7-8]. Several applications are connected to the thermal properties of these complexes and the thermal behavior of metal soaps in expressions of decay process is of huge significance.

Methods and Material

Copper (II) groundnut soap has been synthesized from direct metathesis procedure. In this procedure, the groundnut oil has been refluxed through 2N KOH solution along with ethyl alcohol intended for about three hours. 1N HCl has been used in support of neutralization of surplus KOH. Once preliminary aeration in air oven at 110-125 °C, the copper soap has been more purified by recrystallization with hot benzene several times. The copper metal has been analyzed through usual process [9-10]. These copper soaps have been green in colour. Care has been taken to stay away from traces of water which were institute to hydrolyze the soap.



The copper (II) soap complexes have been synthesized via reacting ethanol solution of ligand (Urea and Thiourea) among copper (II) soap in 1:1 molar proportion. In 25-35 ml of ethyl alcohol, 0.001 moles of ligand fragment has been dissolved and in 10-15 ml of benzene, 0.001 moles of copper (II) groundnut soap has been dissolved and then ethanol solution of ligand has been added in it. Following reaction mixture have been refluxed for about two hours through continuous stirring. The solid precipitate has been separated and filtered, washed through warm distilled water and ethyl alcohol and dehydrated in vacuum [11-12]. Then dry complexes have been purified and recrystallized through warm benzene twice.

Results and Discussion

Perkin Elmer Thermal Analysis apparatus was used for TGA curves obtained from thermal degradation under nitrogen atmosphere. TGA was done in between 50 °C - 750 °C at heating rate 10 °C per minute. The data was obtained as plots of weight loss v/s temperature and weight loss v/s time. The weight change in a complex as a function of temperature and time has been observed through TGA technique in a controlled environment [13]. This technique is extremely valuable to examine the thermal stability of copper (II) groundnut soap complexes. The technique can be used in the examination of absorptive surfaces collectively by means of the character and processes involved in the thermal decomposition [14] and oxidation procedure. As the heating rate is increased, the onset of decomposition is stimulated to higher temperatures.

The predictable kinetic parameters through these methods do not vary considerably, As a result the four techniques have engaged at the present research work. The kinetics be considered on behalf of every three stages of degradation of the complex. The degree of conversion, α , is defined because the ratio of actual weight loss to total weight loss. α is calculated according to

$$\alpha = \frac{W_0 - W}{W_0 - W_f}$$

W_0 is the initial mass of the substance, W is the mass of the substance at a time and at temperature T(K) and W_f is the final mass of the substance.

In the thermal decomposition of copper (II) groundnut soap complex derived from groundnut oil the first step at temperature range 160 °C to 270 °C (433 K to 543 K) corresponds to loss of ligand moiety with weight loss 10.09%. The second step involves decomposition of the polyunsaturated and monounsaturated fatty acid component at temperature range 240 °C to 350 °C (513 K to 633 K) with weight loss 18.87% and the third step corresponds to decomposition of saturated fatty acid component at temperature range 350 °C to 460 °C (623 K to 733 K) with weight loss 25.14%.

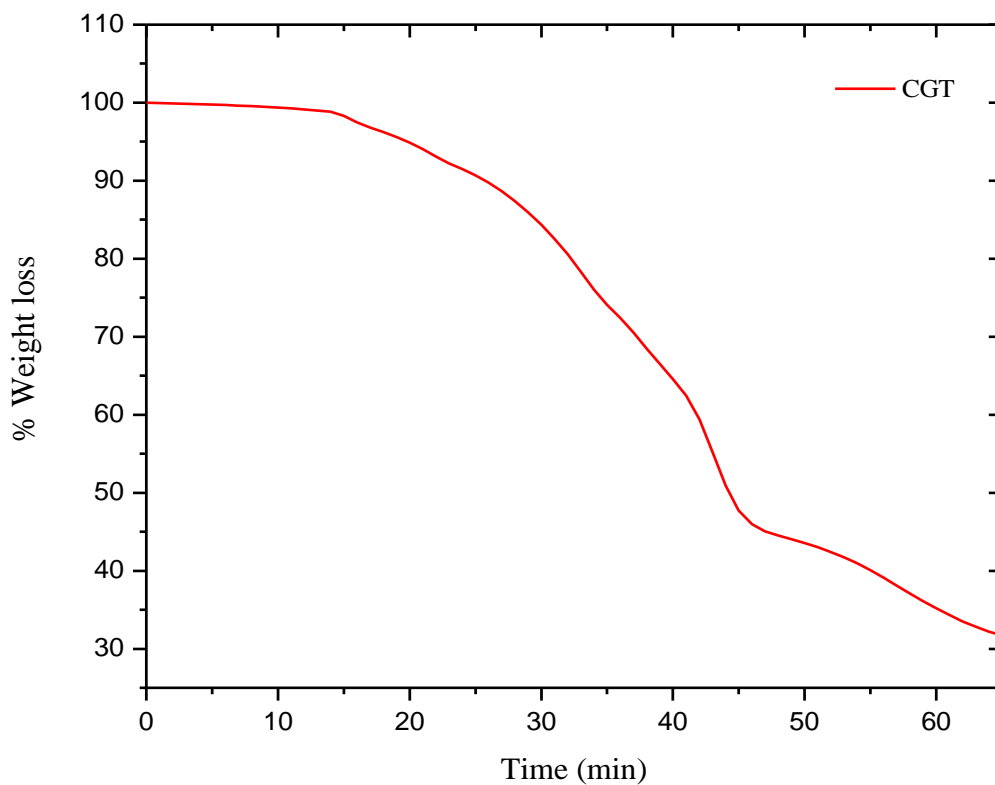


Figure 1: Plot of % weight v/s time depicting thermal degradation of CGT.

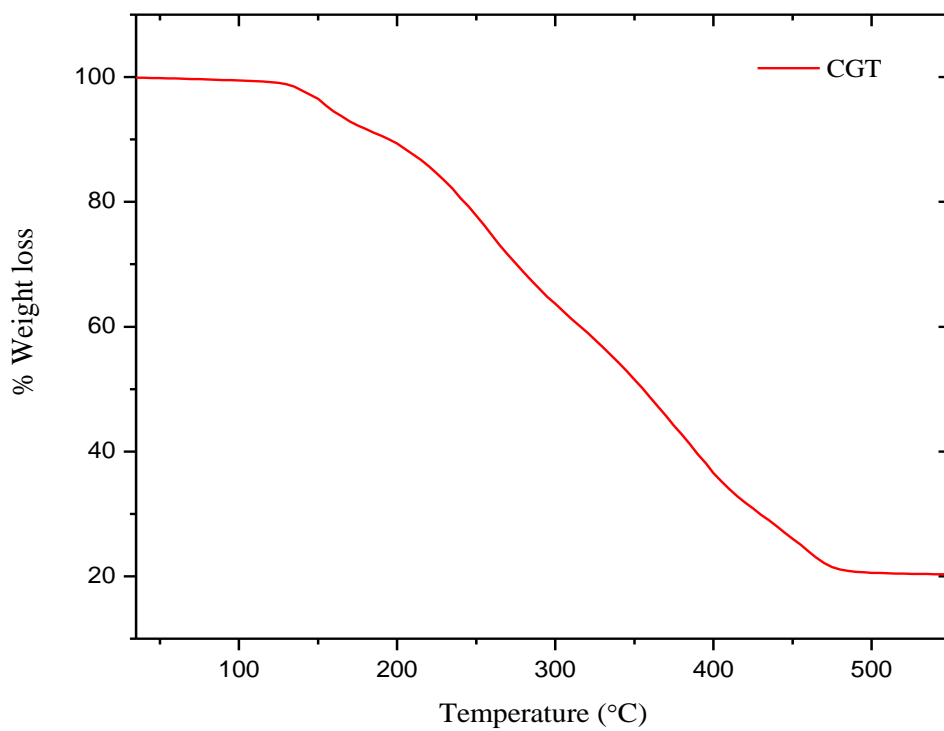


Figure 2: Plot of % Weight v/s Temperature Depicting Thermal Degradation of CGT

In this research work, four procedures such as Coats-Redfern, Horowitz-Metzger, Broido, and Piloyana-Novikova have been designed for calculating the kinetic and thermodynamic parameters such as activation energy (E), pre-exponential factor (Z), entropy of activation (ΔS), enthalpy of activation (ΔH) and free energy of activation (ΔG). The values of energy of activation (E_a) reveal to facilitate for every equation applied the stepwise energy of activation follow the array:

Step III > Step II > Step I

The three steps corresponding to the decomposition of ligand moiety, polyunsaturated and monounsaturated fatty acid components and saturated fatty acid components respectively.

Conclusion

In conclusion, the present study reveals that the increase of activation energy for different steps in thermal decomposition of the system studied, occurred owing to the probable break in the ligand-complex bond initially than molecular bonds of unsaturated fatty acids, which be a smaller amount stable than the molecular bonds of stable saturated fatty acids, which requires higher activation energy of degradation.

References

1. Gunstone F.D., An introductions to the chemistry of fats and fatty acids, Chapman and Hall Ltd, London; c1958. 63-64.
2. Coupland J.N., McClements D.J., Physical properties of liquid edible oils, J Amer Oil Chem Soc. 1997;74(12):1559-1564. <https://doi.org/10.1007/s11746-997-0077-1>
3. Malik S., Khan S.A., Design and evaluation of new hybrid pharmacophore quinazolino-tetrazoles as anticonvulsant strategy, Med Chem Res. 2014;23:207-223.
4. Meena A., Sukhadia V., Sharma R., Solid state kinetics and antimicrobial studies for copper (II) sesame and copper (II) groundnut complexes with substituted benzothiazole ligand. Letters in Organic Chemistry, 2021;18:477-489. <http://dx.doi.org/10.2174/1570178617999200812134745>
5. Meena A., Characterization and antibacterial screening of copper surfactants. International Journal of Chemical and Biological Sciences. 2022;4(2):25-29. DOI: <https://doi.org/10.33545/26646765.v.i.43>
6. Tank P., Sharma A.K., Sharma R., Thermal behavior and kinetics of copper (II) soaps and complexes derived from mustard and soyabean oil. J. Anal. Pharm. Res, 2017, 4(2), 1-5. <https://doi.org/10.15406/japlr.2017.04.00102>
7. Orvig C., Abrams M.J., Medicinal inorganic chemistry: Introduction. Chem. Rev.;99:2201-2204, 1999. <https://doi.org/10.1021/cr980419w>
8. Creaven B.S., Duff B., Egan A.D., Anticancer and antifungal activity of copper(II) complexes of quinolin-2(1H)-one-derived schiff bases, Inorg. Chim. Acta.;363(13):4048-4058, 2010. <https://doi.org/10.1016/j.ica.2010.08.009>
9. Meena A., Antimicrobial Studies of Copper (II) Sesame Urea and Thiourea Complex Against *Staphylococcus Aureus*. International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Vol. 10(2), 757-763, 2023. doi :<https://doi.org/10.32628/IJSRSET219416>
10. Meena A., Biological importance of copper (II) sesame soap-urea complex, International Journal of Advanced Chemistry and Research, 2022, 4(2), 329-331.
11. Souza A.G., Santos J.C.O., Conceicao M.M., Dantas S.M.C., Prasad S. A thermoanalytic and kinetic study of sunflower oil. Brazilian J Chem. Engg. 2004;21(2):265-273. <https://doi.org/10.1590/S0104-66322004000200017>
12. Souza J.C.O., Souza I.M.G., Conceicao M.M., Thermoanalytical, kinetic and rheological parameters of commercial edible vegetable oils. An. Assoc. Bras.Quim.2004;75:419-428. <https://doi.org/10.1023/B:JTAN.0000027128.62480.db>
13. Santos J.C.O., Santos A.V., Souza A.G., Prasad S, Santos I.M.G., Thermal Stability and Kinetic Study on Thermal Decomposition of Commercial Edible Oils by Thermogravimetry. J Food Science. 2002;67(4):1393-1398. <https://doi.org/10.1111/j.1365-2621.2002.tb10296.x>
14. Meena A., Biocidal Properties of Copper (II) Groundnut Urea Complex, IJMERSSET, Vol. 7(8), 2024, DOI: 10.15680/IJMERSSET.2024.0708029.

