International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 4, Issue 1, 2025
DOI: https://doi.org/10.5281/zenodo.14916337

Extraction and Physicochemical Characterization of Dika Wax as Excipient for Drug Delivery

S.O. Abali[1]; Faithfulness Ochen[2]; S. Olue[3]; C.C. Mbah[4]; G.C. Onunkwo[5]

[1,3] University of Port Harcourt, Rivers State, Nigeria
[2] University of Port Harcourt
[4,5] University of Nigeria, Nsukka, Enugu State, Nigeria

Publication Date: 2025/03/01

Abstract

The plant Irvingia gabonensis contain lipids and polymer extracts that can be a good source of excipients for drug delivery. This study aims to extract and determine the proximate composition/ physical properties of dika wax. Purchased and identified samples were sorted out, air-dried and milled. The Soxhlet apparatus was loaded with 60g of the powdered seed of Irvingia gabonensis and the 500ml volumetric flask was filled with about 200ml of n-Hexane which was heated with an electric heating mantle at 70 ºC until the extraction process was complete. The proximate composition of the extract obtained was determined. A creamy-white, hard amorphous dika wax with pleasant fragrance was successfully extracted with a percentage yield of about 60%. The melting point of 40.6 ºC agreed well with earlier reported value of 40°C. The extracted dika wax had no moisture, crude protein was 0.5%, fat/oil was 95%, mineral ash was 0.5% and no fibre. The proximate composition of dika wax suggest that it is a rich source of fat/oil, the ash value which refers to the level of impurities was minimal (0.50%) while the total dissolved solids which could be the remaining polymeric material that may still be left undissolved in the wax was also minimal (4%). The significant yield of Dika wax from Irvingia gabonensis nut of about 60% showed that dika wax (with acceptable color and odor) is a reliable source of raw material for drug delivery.

Keywords: *Dika Wax, Irvingia Gabonensis, Proximate Composition, Drug Delivery.*

I. INTRODUCTION

Irvingia gabonensis, commonly known as bush mango, is a tall deciduous tree native to West and Central Africa. It grows up to 30–40 meters in height and thrives in primary and secondary forests. The tree's leaves are elliptical, dark green, and glossy, while its fruits mature between July and September, producing a fibrous pulp and oil-rich kernel enclosed within a stony nut. This kernel is commonly used in traditional soups across Africa, highlighting its culinary importance (1).

The kernel of I. gabonensis is also a source of Dika wax, an edible vegetable wax widely recognized for its high myristic (61.7%) and lauric (27.6%) acid content. The fatty acid profile of Dika wax closely resembles that of coconut and palm kernel oils. Due to its favourable composition, Dika wax has gained attention as a potential excipient in pharmaceutical formulations, particularly for delivering lipophilic drugs (2,3). In recent years, studies have shown that formulations incorporating Dika wax improve drug release profiles and enhance absorption in the gastrointestinal tract (4).

Given its high lipid content and low impurity levels, Dika wax has been identified as a promising raw material for solid lipid microparticles (SLM) and solid lipid nanoparticles (SLNs) in drug delivery systems (5). This study aims to explore the extraction and physicochemical characterization of Dika wax to assess its potential as a pharmaceutical excipient.

II. METHODS

A. Procurement and Identification of Seeds of Irvingia Gabonensis

Fresh Bush mango (*Irvingia gabonensis*) kernels were acquired from Aba new market in Abia State of Nigeria. The sample procured was identified by Ekeke, Chimezie (Ph.D) from the Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt and a herbarium number was assigned.

Abali, S., Ochen, F., Olue, S., Mbah, C., & Onunkwo, G. (2025). Extraction and Physicochemical Characterization of Dika Wax as Excipient for Drug Delivery. *International Journal of Scientific Research and Modern Technology*, 4(1), 117–122. https://doi.org/10.5281/zenodo.14916337

B. Pre-Extraction Processes of Seeds of Irvingia Gabonensis

The purchased Fresh bush mango (*Irvingia gabonensis*) seeds were sorted out by separating the bad seeds from the good seeds. The brown seed coats of the good fresh bush mango seeds (*Irvingia gabonensis*) were removed with the use of a knife and air dried for 3 days. The seeds were milled, and weighed to determine the total weight of the sample.

C. Extraction of Dika Wax with N-Hexane

The Soxhlet apparatus was loaded with 60g of the powdered seeds of *Irvingia gabonensis* and the 500ml volumetric flask was filled with about 200ml of *n*-Hexane which was heated with an electric heating mantle at 70 ºC until the extraction process was complete. Then, the residue was removed and the soxhlet extractor was filled again with another 60g of the powdered sample and the extraction was continued. The solvent was used to extract 3 portions of the 60g of the powdered sample before it was then removed and replaced. The wax was separated from the solvent by air-drying at room temperature to eliminate the solvent (6).

D. Determination of Physical Properties of Dika Wax

The physical properties of the extracted dika wax such as colour, odour and texture were observed and recorded.

E. Determination of Proximate Composition of Dika Wax

➢ *Determination of Percentage Yield of Dika Wax*

About 60g of the powdered sample (*Irvingia gabonensis* nut) was weighed, extracted and the formula below used for the determination of percentage yield.

$$\%Yield = \frac{X}{y} \times 100$$

Where, X= Weight of the Dika Wax

Y= Weight of the Sample.

➢ *Determination of Moisture Content*

In order to assess the moisture content of dika wax, 2g of the dika wax sample was measured and placed into a pre-ignited and pre-weighed silica dish. After that, the sample was dried at 100°C in an oven until it reached a constant weight and it was subsequently cooled in a desiccator before each weight measurement was recorded (7).

$$\%Moisture = \frac{weight\ of\ dish + weight\ of\ Wax\ before\ drying - weight\ of\ wax\ after\ drying}{weight\ of\ Wax\ Before\ Drying} \times 100$$

➢ *Determination of Ash Content*

After being cleaned and dried at 100 °C in the oven, a crucible was weighed after cooling in a desiccator. The crucible was then filled with 2g of dika wax. To remove the less volatile organic components, a pre-ash procedure was conducted using a heater in a fume cabinet. The pre-ashing was considered complete when smoke ceased to emit. The crucible was then placed in a cool muffle furnace and heated to 600°C, keeping it there until only a white-gray residue was left behind. After cooling in a desiccator, the residue left following the decomposition of the organic matter in the sample is known as ash (7).

$$\%Ash = \frac{(Weight\ after\ Ignition) - (Weight\ of\ Crucible)}{(Weight\ of\ Sample\ taken)} \times 100$$

➢ *Determination of Nitrogen Content*

The nitrogen present in the sample undergoes conversion into ammonium-nitrogen by digestion with tetra-oxo-sulphate (VI) acid in the presence of a catalyst. The ammonia liberated during digestion was subsequently reacted with sodium hydroxide, extracted through steam distillation, and captured with a boric acid indicator mixture. Following this process, the collected solution was titrated with 0.1N HCl to determine the nitrogen content in the sample.

To begin, a 2g sample was placed into a Kjeldahl flask, and a 4g mixture of sodium sulphate and copper sulphate was added. Then, 25-30ml of concentrated tetra-oxo-sulphate (VI) acid was added, and the mixture was gently shaken before being heated for digestion. The sample was initially heated gently until frothing ceased, and then more strongly until a clear solution was attained. During this process, the apparatus was steamed for 10 minutes, and the volume of the digest was adjusted to the mark. After shaking the flask properly, 10ml of the sample digest was pipetted into the unit. Subsequently, 10ml of 40% sodium hydroxide was pipetted into the sample chamber, and the freed ammonia was collected in a conical flask at the Markham unit's condenser along with 10 ml of an indicator mixture of boric acid. The distillation was allowed to proceed for another 5 minutes once the boric acid-indicator mixture turned green (7,8).

After the allotted time had passed, the conical flask was removed, and its contents were titrated with 0.1N hydrochloric acid until the indicator mixture and boric acid had returned to their original colour.

$$\%N = \frac{0.1 \times 14.01 \times titre\ value\ 100}{1000 \times weight\ of\ sample\ taken \times aliquot} \times 100$$

$$\%\ Crude\ Protein\ (C.P.) = N \times 6.25$$

➢ *Determination of Oil Content*

The flask was weighed after being allowed to cool in desiccators and dried at 100 °C in an oven. A 2g sample was precisely weighed to the closest milligram, pulverized, and then put into a cotton wool thimble after passing through a 1mm mesh sieve. After that, the extractor was used to remove the sample from the thimble, and petroleum spirit was used for at least four hours. The residue from the thimble was put back into the extraction equipment after being briefly pulverized in a miniature mortar. A little amount of petroleum spirit was used to rinse the mortar, and the washings were then poured into the flask. An extra hour was spent on the extraction process. After removing the thimble, the extractor was filled with the solvent that had been distilled from the flask. The flask was then disengaged, put in an oven set at 100 °C, allowed to cool in the desiccators, and weighed (7,9)

$$\%\ Oil\ content = \frac{Increase\ in\ weight}{weight\ of\ sample} \times 100$$

- *Determination of Crude Fibre*

The organic components or the solid residue left after the wax sample has undergone treatment with sulfuric acid and sodium hydroxide under specific conditions is referred to as "fiber." Samples containing more than 3% calcium carbonates are initially treated with hydrochloric acid. A 2g portion of the sample was finely pulverized to pass through a 1mm mesh sieve, and the oil was extracted, either using ether via Soxhlet extraction or through a process involving stirring, settling, and decanting three times with petroleum spirit. The fat, once air-dried, was then poured into a beaker or flask. A 150 – 200ml of 0.128N tetra –oxo –sulphate (vi) acid was added and heated, this was allowed to boil gently for 30mins. To maintain a steady volume, distilled water was added and the container was periodically rotated to mix the contents and eliminate particles. An 11cm Whatman No. 1 filter paper was placed in a Buchner funnel, and water at boiling temperature was poured into the funnel, allowing it to stand until the funnel became hot. After 30 minutes of boiling, the acid mixture was allowed to remain for about a minute before it was added to a shallow pool of hot water. In order to guarantee that most of the 200 ml of filtration was finished in less than 10 minutes, the suction was adjusted. After that, boiling water was used to wash the insoluble material until the ash washings were neutral when applied to litmus paper. The residue was washed into a flask or beaker, 150 – 200ml of 0.313N sodium hydroxide was added and then boiled for 30mins, this was allowed to stand for approximately 1minute and then clarified using a filter crucible, applying gentle suction. The whole of the insoluble material was transferred to the crucible, this was washed with boiling water several times and 1% of HCl added, alcohol was added and the washing was done three times with hot water. After being dried at 100 °C in an oven, the crucible and its contents were weighed after being allowed to cool in a desiccator. The crucible was then placed in a cool muffle furnace, where it was heated to 500 °C and left there until the ashing process was completed. Following its removal from the muffle furnace, the crucible was allowed to cool in a desiccator before being weighed (7).

$$\%Crude\ fibre = \frac{Loss\ in\ weight\ in\ ignition}{weight\ of\ the\ sample\ taken} \times 100$$

- *Determination of Melting Point of Dika Wax*

A glass capillary melting point tube, sealed at one end and open at the other, was obtained. The open end of the tube was immersed into a pile of dika wax for analysis. The tube was then inverted and gently tapped on the bench to allow the wax to settle at the sealed end. With the closed end facing downward, the capillary tube was repeatedly lowered through a long, slender tube. The dika wax was added until it reached a height of 2-3 mm in the tube when compacted. The capillary tube containing the wax was positioned into a slot located behind the viewfinder of the melting point apparatus. The apparatus was activated, and the settings were adjusted to achieve an appropriate heating rate. The wax within the capillary tube was observed through the viewfinder, providing a magnified and illuminated view of the wax in the apparatus. Subsequently, the wax was heated at a moderate rate throughout, and the approximate melting point was observed, noted, and recorded (10).

III. RESULTS AND DISCUSSION

A. Procurement and Identification of Seeds of Irvingia Gabonensis

Fresh bush mango (*Irvingia gabonensis*) seeds purchased from Aba in Abia state of Nigeria were identified by Ekeke, Chimezie (Ph.D.) from the Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt. The sample was assigned a herbarium number of UPH/P/187 at the Department of Plant Science and Biotechnology Herbarium.

Fig 1Scraped Seeds of Irvingia Gabonensis

Fig 2 Dika Wax

Table 1 Physical Properties of Dika Wax

Physical Properties of Dika Wax			
Colour	Odour	Nature	Melting point
Creamy white	Pleasant fragrance	Hard amorphous solid	40.60 ºC

As reported in table 1 and figure 2 above, the dika wax was a creamy-white solid with a pleasant fragrance. These properties will propel the usability of dika wax as a raw material for product development since most patients/ product consumers will naturally prefer white or brightly coloured medicines/ products with pleasant fragrance. This will certainly enhance compliance to therapy with reduced incidence of treatment failure. The melting point of 40.6 ºC agreed well with earlier reported value of 40°C by Ogaji et al., 2012 (3). The melting point of 40°C is an advantage for the dika wax because medicines/ products made with dika wax will be able to survive some level of tropical and temperate weather conditions. Also, this melting point which is above normal body temperature will be very useful when dika is used in the formulation of sustained drug delivery systems. A study by Akin-Ajani et al., 2019 showed that the mixture of dika fat and cocoa butter in ratio 1:1 as suppository base in the formulation of paediatric paracetamol suppository had melting point range of 33°C - 39°C and showed superior release properties to the suppositories made from cocoa butter alone (11).

B. Percentage Yield of Dika Wax

$$\%\ Yield = \frac{X}{y} \times 100$$

Where X = Weight of dika wax = 34.6 g

Y = Weight of the *Irvingia gabonensis* nut = 60 g

Therefore, $\%\ Yield = \frac{34.6}{60} \times 100$

= 0.5766 × 100%

= 57.66% ≈ 60%

The percentage yield of the dika wax from *Irvingia gabonensis* nut is about 60%. Since 60% is quite a significant yield, it implies that dika wax could be a reliable source of raw material for delivery of drugs and some food products. The percentage yield determined in this present study agreed well with value of 51.3% reported in previous studies by Aremu et al., (12).

Table 2 Proximate Composition of Dika Wax

Chemical Constituent	Percentage Composition (%)
Protein	0.50
Total solid	4.00
Ash	0.50
Fat/oil	95.00
Fibers	Nil
Moisture	0.00

The summary of the proximate composition of dika wax provided in Table 2 showed that dika wax had no moisture, crude protein (0.5%), fat/oil (95%), mineral ash (0.5%) and no fibre. The proximate composition of dika wax suggest that it is a rich source of fat/oil.

Previous study by Ogunsina et al., 2012 reported that the proximate composition of dika wax had moisture, crude protein, crude fat, mineral ash, crude fibre and carbohydrates to the extent of 2.6%, 8.9%, 68.4%, 2.3% and carbohydrate to the extent of 3.6% respectively (13). Also, studies by Onimawo et al., 2003 reported that the proximate composition of dika wax had moisture, crude protein, crude fat, mineral ash, crude fibre and carbohydrates to the extent of 3.36%, 7.70%, 65.46%, 2.26%, 10.23% and 10.93% respectively (14).

The moisture content, protein, mineral ash and fibre determined in the present study showed lower values, while the fat showed higher value compared with earlier reported values by Ogunsina et al., 2012 and Onimawo et al., 2003. Slight variation may exist normally in the composition of agricultural products from one place to another depending on the varietal differences, soil types and agro-climatic changes (Leaky et al) (15).

Ash value which refers to the level of impurities was quite minimal (0.50%) while the total dissolved solids which could be the remaining polymeric material that may still be left undissolved in the wax was also very minimal (4%). More so, the polymeric material may also enhance emulsification process during formation of nanoparticles. There was no fibre and moisture content but the oil/fat (i.e. wax) was 95%w/w which is way above the average and this implies that the wax is about 95% pure (9).

IV. CONCLUSION

Dika wax is abundant in seeds of *Irvingia gabonensis* (60% yield) with good proximate composition having a wax purity level of 95% and excellent physical properties that could improve patient compliance when used as an excipient for drug delivery with excellent melting point that could maintain the physical integrity of solid lipid nanoparticles/ microparticles at atmospheric/ body temperatures.

REFERENCES

[1]. Ross SM. African Mango (IGOB131): A Proprietary Seed Extract of Irvingia gabonensis is Found to Be Effective in Reducing Body Weight and Improving Metabolic Parameters in Overweight Humans. Holist Nurs Pract. 2011;25(4):215-7.

[2]. Taleat AI, Etong DI, Mustapha AO. Physicochemical Properties and Fatty Acid Composition of Dikanut (Irvingia gabonensis) Seed Oil. 2014;4(12):70-4.

[3]. Ogaji IJ, Nan A, Hoag SW. A Novel Extraction Method and Some Physicochemical Properties of Extractives of Irvingia gabonensis Seeds. J Young Pharm. 2012;4(2):66-72.

[4]. Uduma EO, Stephen OM, Emmanuella ON, Harrison TG. Improvement of Oral Efficacy of Erythromycin Ethyl Succinate Using Stearic Acid-Myrj-52-Based SLM. J Chem Chem Eng. 2017;11:37-44.

[5]. Chime SA, Onyishi I, Brown SA, Attama AA. Diclofenac Potassium-loaded Dika Fat Solid Lipid Microparticles: In Vitro and In Vivo Characterization. J Pharm Res. 2013;1(3):227-34

[6]. Orhevba BA, Adeniyi SS. Solvent Extraction and Characterisation of Dika Nut (Irvingia gabonensis) Oil. 2013 [cited 2023 Aug 23]; Available from: http://repository.futminna.edu.ng:8080/jspui/handle/123456789/6905

[7]. Ewere E, Etim O, Usunobun U. Proximate composition, mineral content and amino acid profile of Irvingia gabonensis Oâ€™Rorke baill leaf. International Journal of Scientific \World. 2017;5(1):23–7.

[8]. tonder eben van. Earthworm Express. 2019 [cited 2023 Aug 26]. Counting Nitrogen Atoms – Part 5: The Proximate Analysis, Kjeldahl and Jones (6.25). Available from: https://earthwormexpress.com/2019/01/03/counting-nitrogen-atoms-the-history-of-determining-total-meat-content-part-5-the-proximate-analysis/

[9]. Jaafar RA, Rahman ARBA, Mahmod NZC, Vasudevan R. Proximate Analysis of Dragon Fruit (Hylecereus polyhizus). American Journal of Applied Sciences. 2009;6(7):1341–6.

[10]. Glickman CS. ACS Publications. American Chemical Society; 2002 [cited 2023 Sep 7]. Determination of melting points of special waxes. Available from: https://pubs.acs.org/doi/pdf/10.1021/ac50079a028

[11]. Akin-Ajani O.D., Oluwatoyin A.O., Yusuf B. Formulation of pediatric paracetamol suppositories

using shea butter and dika fat as suppository bases. Trop J Nat. Prod. Res,2019; 3(2): 31-36
[12]. Aremu O., Isimi Y., Ekere K., Agbaje O., Olayemi O., Adedokun M., Emeje M. Comparative evaluation of Irvingia gabonensis seed fat extract and other bases in promethazine hydrochloride suppository formulation. J Res Pharm. 2020; 24(2): 240-250
[13]. Ogunsina B.S., Bhatnagar A.S., Indira T.N. and Radha C. The proximate composition of African bush mango kernels (Irvingia gabonensis) and characteristics of its oil. Ife Journal of Science 2012 Vol. 14, no. 1
[14]. Onimawo I.A., Oteno F., Orokpo G., Akubor P.I. Physiochemical and nutrient evaluation of African bush mango (Irvingia gabonensis) seeds and pulp. Plant Foods for Human Nutr. 2003, 58:1-6
[15]. Leakey R.R.B., Greenwell P., Hall M.N., Atangana A.R., Usoro C., Anegbeh P.O., Fondoun J.M. and Tchoundjeu Z. Domestication of Irvingia gabonensis for tree-to-tree variation in food-thickening properties and in fat and protein contents of dika nut. Food Chem. 2005, 90, 365-378
[16]. Chime SA, Akpa PA, Ugwuanyi CC, Attama AA. Anti-Inflammatory and Gastroprotective Properties of Aspirin - Entrapped Solid Lipid Microparticles. Inflamm Allergy Drug Targets. 2020;14(1):78–88