



## Studies on the utilization of *Hura crepitans* seed oil, aqueous extract of *Curcuma longa* L., aluminium, and magnesium metallic soaps in the preparation of emollient cream

Ibanga O. Isaac<sup>a,b,\*</sup>, Itoro E. Willie<sup>a</sup>, Queen S. Thompson<sup>a</sup>

Received: November 05, 2022 / Accepted: December 20, 2022

© REJOST 2022

### Abstract

Skin is one of the sense organs that if properly cared for not only helps in body temperature regulation but as a means for drug delivery. The use of locally sourced natural products for the preparation of value-added products in the area of health care products such as cosmetics is receiving a boost because of its environmentally benign nature. This study is aimed at using locally sourced triglyceride oils, magnesium and aluminium soaps for the preparation of emollient cream. *Hura crepitans* seed oil (HCSO) was extracted via solvent extraction method and characterized using standard methods. Aluminium and magnesium soaps were prepared from palm kernel oil sodium soap through the precipitation method.

✉ Ibanga O. Isaac: [ibangaisaac@aksu.edu.ng](mailto:ibangaisaac@aksu.edu.ng)

<sup>a</sup> Department of Chemistry, Faculty of Physical Sciences, Akwa Ibom State University, Ikot Akpaden, Akwa Ibom State-Nigeria

<sup>b</sup> Department of Chemical Sciences, Ritman University, Ikot Ekpene, Akwa Ibom State-Nigeria

The metallic soaps were characterized using standard methods. Four emollient cream samples (CAM-1, CAM-2, CAM-3 and CAM-4) were prepared using an aqueous extract of turmeric, the metallic soaps as thickeners and emulsifiers, shea butter and *Hura crepitans* seed oil as the oil phase. The product stability was monitored for two years at ambient temperature. The percentage yield and the iodine, acid and saponification values of HCSO were determined as 87.93%, 145.90 gI<sub>2</sub>/100g, 3.25 mgKOH/g, and 183.34 mgKOH/g respectively. The melting points of aluminium and magnesium soaps were determined as 115 °C and 110 °C respectively. All the cream samples were very stable and exhibited a longer shelf life. Cream sample CAM-3 gave a jelly-like cream texture. HCSO, shea butter and other ingredients if properly harnessed can be a good starting material for the preparation of skincare products.

**Keywords:** aluminium soap; magnesium soap; oil-in-water emulsion; physical stability; shea butter; triglyceride oil; turmeric extract

## 1.0 Introduction

From prehistoric times until now, cosmetics have constituted a part of routine body care among every class of people globally (Bocca *et al.*, 2014; Hall *et al.*, 2007). Under the European Council Directive 76/768/EEC, a cosmetic includes any substance or mixture of substances manufactured, sold or represented for use in cleansing, improving, or altering the skin, hair, lips, nails or teeth (Bocca *et al.*, 2014). Some of the products used by the populace that stipulate this definition include skin-care creams, lotions, powders and sprays, facial makeup, permanent waves, hair colours, deodorants, baby products, bath and shower oils and creams, toothpaste, sunscreens etc. Dry skin and the associated impaired epidermal barrier function are postulated to constitute a major element in the development of atopic dermatitis (Lünneman *et al.*, 2018). The major characteristic of dry skin is the reduced water content in the stratum corneum which entails abnormal enzymic and mechanical properties (Rawlings and Matts, 2005). Daily emollient therapy of the entire body from birth onward may represent a safe and efficacious strategy to prevent atopic dermatitis (Lünneman *et al.*, 2018; Simpson *et al.*, 2014). Skin is also an attractive site for systematic drug delivery (Ishikawa *et al.*, 2012).

Ageing, which causes a functional deficit in the skin through structural and mechanical degradation, resulting in clinical changes, such as wrinkling, colour changes, laxity and non-elasticity has inspired researchers to search for solutions that would prevent the degradation of this sensitive organ. Additionally, the skin represents an excellent and accessible model organ which allows both intrinsic and extrinsic ageing factors to be studied; which both promote the multifaceted process of ageing. However,

intrinsic ageing affects the skin in a manner similar to other organs, whilst extrinsic ageing is restricted to environmental damage to the dermal connective tissues of the skin induced by ultraviolet radiation penetration (Venter *et al.*, 2016). Triglyceride oils are widely used in cosmetics and can be used to treat a growing number of conditions (Nielson, 2006). The seeds produced from plants usually contain natural oils or lipids that are made up of various fatty acids, amines, proteins and esters which are essential for maintaining body skin functioning and can contribute to various favourable properties in personal care and cosmetic products (Venter *et al.*, 2016; Atolani *et al.*, 2016). *Hura crepitans* L. plant, also known as sandbox tree, possum wood, or Jabillo is an evergreen tree of the spurge family (Euphorbiaceae). It has the characteristics of short densely crowded and pointed spines on the trunk and branches. The leaves, stem bark, roots, and seeds of this plant have been reported to exhibit several therapeutic applications, which include the treatment of skin diseases, rheumatism, and intestinal worms in leprosy (Vassallo *et al.*, 2020). *Hura crepitans* L. seed oil (HCSO) contains a high percentage of polyunsaturated linoleic acid (Oyekunle and Omode, 2008), indicating a semi-drying property. It is worth investigating the possibility of using seed oil in the preparation of emollient cream. Presently, there is no specific use of the oil of *Hura crepitans* L. seed in Nigeria, as the seeds are discarded as waste since they have no specific use. In this research, the HCSO was used as the oil phase in the emulsion product, while palm kernel oil (PKO) was used in the preparation of emulsifiers (aluminium and magnesium metallic soaps). Conventional cosmetics contain polymers derived from fossil fuel resources and/or minerals, and toxic metals which are not biodegradable. Hence, the need for research into

an environmentally benign alternative for the production of skincare products.

Turmeric (*Curcuma longa* L.) is a perennial plant from the ginger family (Zingiberaceae) (Sathiyabama *et al.*, 2016). It is used in India and East Asia since antiquity as a dye, medicine and flavouring agent (Anandaraji and Sudharshan, 2011). It is cultivated today in many regions of the world with India being the largest producer and exporter of turmeric and its value-added products. Curcumin (1,7-bis-(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-2,5-dione), a polyphenolic compound is the main active constituent in turmeric that has been shown to have a wide range of biological activities such as antioxidant, anti-inflammatory, anti-mutagenic, anti-carcinogenic, anti-angiogenic, hypolipidemic activities, antimicrobial, antiviral, as well as healing of wound properties, reduction of blood sugar and neurodegenerative diseases-treating activities (Sathiyabama *et al.*, 2016; Karimi *et al.*, 2018; Singh *et al.*, 2021) that makes it an attractive raw material in cosmetic production.

The widely valued product of the shea tree is the shea butter, the edible fat extracted from the seed kernel, consisting of an olein fraction and a stearin fraction along with non-saponifiable (non-lipid) compounds such as acetyl and cinnamyl triterpene esters which act as anti-inflammatory agents and chemopreventive agents in chemical carcinogenesis (Zhang *et al.*, 2018). This makes it a popular component of skin care products and cosmetic formulations. Glew and Lovett (2014), and Adazabra *et al.* (2017) stated that shea butter is highly valued for use in luxury cosmetics such as moisturizing creams, sun lotions and soaps or pharmaceutical products such as cholesterol-lowering and anti-arthritic remedies. Also, it is used traditionally for the preparation of skin ointments, and to treat inflammation, rashes in children, and dermatitis such as sunburn, chapping, and irritation (Oben *et al.*, 2015).

Many artificial and synthetic constituents of cosmetics such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and parabens used as antioxidants or preservatives for skin and hair products usually result in skin damage, dry skin, brittle hair, browning of hair, itching among other things (Atolani *et al.*, 2016). The need for use of naturally sourced raw materials for cosmetic production cannot be overemphasized as it possesses the ability to improve psychological, social, and clinical impulses in users. In view of the prevailing Coronavirus pandemic and the historical Spanish flu of 1918 that killed millions of people globally as well as other global health-related issues, it is therefore of immense scientific interest to explore and exploit the health potentials of the available natural resources in our communities with the aim of finding remedies to these global health pandemics and proposing solutions to future challenges in the global health care delivery (Isaac *et al.*, 2022). This research is therefore aimed at formulating standard skin care products from locally sourced raw materials such as *Hura crepitans* L. seed oil, palm kernel oil, shea butter, and turmeric extracts.

## 2.0 Materials and Methods

### 2.1 Materials

*Hura crepitans* L. seed oil was extracted from the mature seed of the plant, palm kernel oil (PKO) was purchased at Akpan Andem market, Uyo, Akwa Ibom State, analytical grade magnesium sulphate, aluminium trichloride, Sodium hydroxide, cetyl alcohol, shea butter, stearic acid, glycerol, and benzoic acid were obtained from local vendors and used in this research without further purification. An aqueous extract of turmeric was obtained from the turmeric plant. Distilled water was used throughout the whole experimental procedure.

## 2.2 Preparation of *Hura crepitans* L. Seed Oil (HCSO)

Mature seeds of sandbox tree (*Hura crepitans* L.) were collected from Ikot Obio Ndogho, in Mkpata Enin L.G.A, Akwa Ibom state and were authenticated in the Department of Botany, Faculty of Biological Sciences, Akwa Ibom State University. The oil was extracted from the seed following the procedure described by Isaac and Ekpa (2009). The seed oil was labelled HCSO and stored in a plastic container until required.

## 2.3 Preparation and Characterization of Aluminium and Magnesium Metallic Soaps

Aluminium and magnesium soaps respectively were precipitated from PKO alkaline soap using the procedure described by Isaac *et al.* (2014). Physicochemical properties such as moisture content, ash content and total solid content were determined using standard methods (Onwuka, 2005). The melting point was determined using the method described by Gonen *et al.* (2005) as follows. Paraffin oil was poured into a beaker and placed in a heating mantle, the oil was heated to a temperature of 70 °C. A capillary tube containing the metallic soap was tied to a thermometer using thread, and the thermometer supported with a clamp stand was suspended into the paraffin oil such that the oil covers a reasonable portion of the capillary tube and the heating continued. The temperature at which the soap sample changes into liquid was taken to be the melting point. This was done for both soap samples respectively.

## 2.4 Preparation of Aqueous Extract of Turmeric

The *Curcuma longa* L. was purchased at Itam market, Uyo and was brought to the Department of Botany, Faculty of Biological Sciences, Akwa

Ibom State University for identification. The sample was washed and peeled to remove the bark and then ground. The crushed sample was squeezed after mixing with distilled water using a muslin cloth and the yellowish liquid obtained was kept overnight and decanted into a beaker the following morning. The liquid was dried in an oven at a temperature of 105 °C. After drying off the liquid, the solid extract which represents an aqueous extract of turmeric was transferred into a plastic container for further use.

## 2.5 Production and Physicochemical Properties of Emollient Cream

Four cream samples were prepared by varying the quantity of turmeric extract, aluminium and magnesium metallic soaps following the method described by (Awad El-Gied *et al.*, 2015) with slight modification. The recipe for the four samples of the cream is given in Table 1. The cream sample with equal amounts of the two metallic soaps and the highest concentration of turmeric extract was labelled CAM-1. The sample with more magnesium soap and less aluminium soap and turmeric extract was labelled CAM-2. CAM-3 was a cream sample with more aluminium soap and less magnesium soap and turmeric extract and finally CAM-4 was a cream sample with an equal amount of aluminium and magnesium soaps and no turmeric extract. Two 500 ml beakers were washed thoroughly, dried and labelled A and B. While beaker A represented the aqueous phase, beaker B represented the oil phase. The calculated amount of distilled water as shown in Table 1 was weighed into beaker A, followed by water-soluble components such as glycerol and turmeric extract. The temperature of the aqueous phase was raised to 75 °C in a water bath with constant agitation. The oil phase was prepared in like manner using beaker B. The temperature of

the two phases was allowed to reduce to 60 °C and the oil phase was slowly added to the aqueous phase under stirring for 20 mins. Fragrance and colourant were added and stirred for another 5 mins to obtain oil in water emollient cream. The procedure was the same for all four cream samples.

The formulations were monitored visually for colour change, homogeneity, consistency, and phase separation for two years. Other parameters

such as pH and skin irritation were determined for all the cream samples. Human patch testing for any sign of irritation in the cream samples was carried out based on the method described by Michalun and Dinardo (2015). A patch of the cream samples was prepared using tissue paper, the patch was placed on the upper arm of 30 students for two days. The patch was removed to observe any signs of irritation or changes in skin colour.

**Table 1:** Recipe for the Formulation of Emollient Cream Samples

Ingredients	Cream samples			
	(CAM-1)	(CAM-2)	(CAM-3)	(CAM-4)
Cetyl alcohol (g)	5.00	5.00	5.00	5.00
<i>Hura crepitans</i> seed oil (g)	30.00	30.00	30.00	30.00
Stearic acid (g)	5.00	5.00	5.00	5.00
Shea butter (g)	10.00	10.00	10.00	10.00
Aluminium metallic soap (g)	15.00	10.00	10.00	10.00
Magnesium metallic soap (g)	15.00	20.00	10.00	15.00
Glycerol (g)	10.00	10.00	10.00	10.00
Turmeric extract (g)	2.00	0.50	0.50	-
Water (g)	20.00	20.00	20.00	20.00
Benzoic acid (g)	0.50	0.50	0.50	0.50
Perfume (g)	2.00	2.00	2.00	2.00
Colourant (g)	3.00	3.00	3.00	3.00

### 3.0 Results and Discussion

#### 3.1 Physicochemical Properties of *Hura crepitans* Seed Oil

The *Hura crepitans* seed gives golden-yellow oil, which corresponds to the property observed by Ajani *et al.* (2019), and Okolie *et al.* (2012). The specific gravity determined by Okolie *et al.* (2012) was 0.94 while that of Ajani *et al.* (2019) was 0.8, the result from this research given as 0.91 corroborates with those reported in the literature. The acid value was determined as 3.25 mgKOH/g indicating its suitability for use as an oil phase in cream and other body care preparation. The oil yield was relatively high

(calculated as 87.93%) compared to 38.20% obtained by Umoren *et al.* (2001), 47.80% obtained by Oyekunle and Omode (2008) and 36.40% obtained by Ezeh *et al.* (2012). This may be a result of the seed maturity, geographical location, period of sample collection and method of extraction. The high oil yield of this seed makes it an important source of non-edible triglyceride oil, which if properly harnessed can be a better sustainable resource that can be used as industrial feedstock in place of edible seed oils. The iodine value of 145.90 gI<sub>2</sub>/100 g showed that the oil is a drying oil. The saponification value and ester value were

determined as 183.34 mgKOH/g and 180.09 respectively.

### 3.2 Characterization of Aluminium and Magnesium Metallic Soaps

The melting point of aluminium metallic soap determined as 115 °C was slightly higher than that of magnesium soap measured at 110 °C (Table 2). This may be due to a slight difference in metallic character between magnesium and aluminium, the atomic number of the latter being higher than that of the former. Akpakpan *et al.* (2018) determined the melting point of zinc and copper metallic soaps as 86.5 °C and 77.5 °C respectively. This shows that the melting points of aluminium and magnesium metallic soaps are higher than those of zinc and copper. The percentage of ash content which is the mineral constituent of the soap after all moisture and organic components have been removed via the

oxidation process was determined as 0.86% for aluminium soap and 0.34% for magnesium soap (Table 2). The colour of the metallic soaps was white (Figure 1A) and insoluble in an aqueous medium. A similar observation was made by Isaac *et al.* (2014). This shows that metallic soaps are generally insoluble in water.

### 3.3 Turmeric Extracts

The curcumin extracted, had a yellow colour and exists in a powdery form, which was soluble in water. The turmeric extract was observed to have high curcumin content, which is highly concentrated, as observed by its behaviour in the cream. The curcumin gave a fine quality to the cream, given that the cream sample was not staining when applied to the skin. It has the ability to affect its yellow colour in the cream, which is determined by the concentration or proportion used.

**Table 2:** Properties of Aluminium and Magnesium Metallic Soaps

Properties	Values	
	Aluminium metallic soap	Magnesium metallic soap
Melting point (%)	115	110
Ash content (%)	0.86	0.34
Moisture content (%)	3.74	3.31
Total solid content (%)	96.26	96.69
Colour	White	White
Solubility in water	Insoluble	Insoluble
Texture	Powdery	Powdery

### 3.4 Emollient Cream

Four different cream samples were prepared by varying the proportion of the aluminium and magnesium metallic soaps, and turmeric. The first cream sample (CAM-1) has an equal amount of aluminium and magnesium metallic soaps, with a higher concentration of turmeric. This

gave a thick cream texture and a deep yellow colour. The second sample (CAM-2) has a higher proportion of magnesium soap and less proportion of aluminium soap and turmeric extract. This gave a fine creamy texture and light colour. The third sample (CAM-3) has a higher amount of aluminium soap and less amount of magnesium soap and turmeric extract. This gave

a jelly-like cream texture with light colour. While the fourth sample (CAM-4) has an equal amount of aluminium and magnesium metallic soaps, with no turmeric (Figure 1B). This gave a moderate cream texture and brighter colour. The difference in the cream textures and colours was a result of the concentrations and proportions of the aluminium and magnesium metallic soaps and turmeric extract. With the exception of the usage of these soaps in this study as thickeners and emulsifiers, it can also be concluded from these results that aluminium metallic soap acts in addition to the afore mention use as a brightener,

while the magnesium soap acts mostly as a thickener. The turmeric extract also affects the colour of the cream, as the sample with the highest concentration has a very deep yellow colour. The four cream samples did not show any sign of irritation on the skin. The oil-in-water process is also recommended for emollient cream preparation, to ensure the cream quality.

The cream sample was racked for two years to check for the possible separation of the different components. But after this period the products were very stable.



**A** (magnesium and aluminium soaps)

**B** (cream samples)

**Figure 1:** Magnesium and Aluminium Metallic Soaps and Cream Samples

#### 4.0 Conclusion

Magnesium and aluminium metallic soaps prepared from palm kernel oil can serve as thickeners, emulsifiers, and brighteners in cream preparation. Turmeric extract that is rich in curcumin can be used in cream production to protect the skin from photodegradation and ageing. *Hura crepitans* seed oil can be harnessed as the oil phase in the preparation of oil-in-emulsion cream. Shea butter can also serve as a vital raw material in the cosmetic industry due to its medicinal properties.

#### Acknowledgements

The authors are thankful to The Vice Chancellor and Management of Akwa Ibom State University for providing financial support through the undergraduate research scheme (URS) of the institution. We also appreciate Prof. Bassey S. Antia, Department of Chemistry, University of Uyo, Uyo, Akwa Ibom State, Nigeria for his support and review of a draft edition of this paper.

## References

- Adazabra, A.N., Viruthagiri, G., Shanmugan, N., 2017. Infrared analysis of clay bricks incorporated with spent shea waste from the shea butter industry. *Jour. Environ. Mgt.*, 191: 66 – 74.
- Ajani, O.O., Felicia, T.O., Fisayo, E.O., Deborah K. A., Oluwatosin Y. A., 2019. Phytochemical screening and nutraceutical potential of sandbox tree (*Hura crepitans* L.) seed oil. *Foods Raw Mater.*, 7(1): 143 – 150.
- Akpakpan, A.E., Nsi, E.W., Akpanudo, N.W., Ekwere, I.O., Edem, A. J., 2018. Physicochemical characterization of oil and metallic soaps from two varieties of palm kernel oil (*Tenera and Dura*). *Int. Jour. Modern Chem.*, 10(1): 33 – 46.
- Anandaraji, M., Sudharshan, M.R., 2011. Cardamom, ginger and turmeric. In: Verheye, Willy H. (Ed.), *Encyclopedia of Life Support Systems (EOLSS)—Soils, Plant Growth and Crop Production*. EOLSS Publishers, Oxford, UK.
- Atolani, O., Olabiyi, E.T., Issa, A.A., Azeez, H.T., Onoja, E.G., Ibrahim, S.O., Zubair, M.F., Oguntoye, O.T., Olatunji, G.A., 2016. Green synthesis and characterization of natural antiseptic soaps from the oils of underutilized tropical seed. *Sustainable Chem. Pharm.*, 4: 32 – 39.
- Awad El-Gied, A.A., Abdelkareem1, A. M., Hamedelnie1, E.I., 2015. Investigation of cream and ointment on antimicrobial activity of *Mangifera indica* extract. *Jour. Adv. Pharm. Tech. Res.*, 6(2): 53 – 57.
- Bocca, B., Pino, A., Alimonti, A., Forte, G. 2014. Toxic metals contained in cosmetics: A status report. *Regulatory Toxicol. Pharmacol.*, 64: 447 – 467.
- Ezeh, E., Umoren, E., Essien, E.E., Udoh, A.P., 2012. Studies on the utilization of *Hura Crepitans* L. seed oil in the preparation of alkyd resins. *Ind. Crops Prod.*, 36: 74-99.
- Glew, D., Lovett, 2014. Life cycle analysis of shea butter use in cosmetics: from parklands to product, low carbon opportunities. *Jour. Cleaner Production*, 68: 73 – 80.
- Gonen, M., Balkose, D., Inal, F., Ulka, S., 2005. Zinc stearate production by precipitation and fusion process. *Ind. Eng. Chem. Res.*, 44(6): 1627-1633.
- Hall, B., Tozer, S., Safford, B., Caroama, M., Steiling, W., Leneveu-Duchemin, M.C., McNamara, C., Gibney, M., 2007. European consumer exposure to cosmetic products, a framework for conducting population exposure assessments. *Food Chem. Toxicol.*, 45: 2097 – 2108.
- Isaac, I.O., Ekpa, O.D., 2009. Minerals and anti-nutrients in two varieties of African pear oil (*Dacryodes edulis*). *Jour. Food Tech.*, 7(4): 106 – 110.
- Isaac, I.O., Ekpa, O.D., Ekpe, U.J., 2014. Extraction, characterization of African pear (*Dacryodes edulis*). *Int. Jour. Adv. Res. Chem. Sci.*, 1(4): 14 – 22.
- Isaac, I.O., Etesin, U.M., Nya, E.J., Ukpong, E.J., Isotuk, U.G., Ibok, U.J., 2022. Ethnobotanical study, phytochemical composition and in vitro antioxidant activity of the methanol extracts of thirty-two medicinal plants from Southern Nigeria. *Jour. Medicinal Plants Res.*, 16(10): 288-299.



- Ishikawa, A., Fujii, M., Morimoto, K., Yamada, T., Koizumi, N., Kondoh, M., Watanabe, Y., 2012. Oil-in-water emulsion lotion providing controlled release using 2-methacryloyloxyethyl phosphorylcholine n-butyl methacrylate copolymer as emulsifier. *Results in Pharma Sci.*, 2: 16 – 22.
- Karimi, N., Ghanbarzadeha, B., Hamishehkar, H., Mehramuz, B., Kafil, H.S., 2018. Antioxidant, antimicrobial and physicochemical properties of turmeric extract-loaded nanostructured lipid carrier (NLC). *Colloid Interface Sci. Comm.*, 22: 18 – 24.
- Lünneman, L., Lurdriksone, L., Schario, S.M., Sawatzky, S., Stroux, A., Blume-Peytavi, U., Garcia, B.N., 2018. Noninvasive monitoring of plant-based formulations on skin barrier properties in infants with dry skin and risk for atopic dermatitis. *Int. Jour. Women's Dermatol.*, 4: 95 – 101.
- Michalun, M.V., Dinardo, J.C., 2015. *Milady skin care and cosmetic ingredients dictionary 4<sup>th</sup> edn.* Clifton Park, U.S.A., ISBN: 978-1-285-06079-8. Pp. 45 – 52.
- Nielsen, J. B., 2006. Natural oils affect the human skin integrity and the percutaneous penetration of benzoic acid dose-dependently. *Basic Clin. Pharmacol. Toxicol.*, 98: 575 – 581.
- Oben, E.K., Simplicio, F.H., Guerisson, B., Folefoc, G.N., Asongalem, E.A., Lagojda, A., Lamshöft, M., 2015. A new ursane triterpenic acid and other potential anti-inflammatory and anti-arthritis constituents from EtOAc extracts of *Vitellaria paradoxa* stem bark. *Jour. Ethnopharmacol.*, <http://dx.doi.org/10.1016/j.jep.2015.08.014>.
- Okolie, P. N., Uaboi -Egbenni, P. O., Ajekwene, A. E., 2012. Extraction and quality evaluation of sand box tree seed (*Hura crepitans*) oil. *World Jour. Agric. Sci.*, 8(4): 359 – 365.
- Onwuka, G.I., 2005. Food analysis and instrumentation (theory and practice), 1<sup>st</sup> edn. Naphthali Prints, Surulere,- Lagos, Nigeria. ISBN: 97804 7686. Pp 140 – 160.
- Oyekunle, J.A.O., Omode, A.A., 2008. Chemical composition and fatty acid profile of the lipid fractions of selected Nigerian indigenous oil seeds. *Int. Jour. Food Prop.*, 11: 273 – 281.
- Rawlings, A. V., Matts, P.J., 2005. Stratum corneum moisturization at the molecular level: An update in relation to the dry skin cycle. *Jour. Invest. Dermatol.*, 124: 1099 – 1110.
- Sathiyabama, M., Bernstein, N., Anusuya, S., 2016. Chitosan elicitation for increased curcumin production and stimulation of defence response in turmeric (*Curcuma longa* L.). *Ind. Crops Prod.*, 89: 87 – 94.
- Simpson, E.L., Charlmers, J.R., Hanifin, J.M., Thomas, K.S., Cork, M.J., McLean, W.H., 2014. Emollient enhancement of the skin barrier from birth offers effective atopic dermatitis prevention. *Jour. Allergy Clinical Immunol.*, 134: 818 – 823.
- Singh, P.A., Bajwa, N., Baldi, A., 2021. A comparative review on the standard quality parameters of turmeric. *Indian Jour. Nat. Prod.*, 35(1): 2 – 8.
- Umoren, S.A., Ajibersin, K.K., Bala, D.N., 2001. Physicochemical properties of the seed and seed oil of *Hura crepitans*. *Jour. Natural Appl. Sci.*, 1(2): 23 – 26.

- Vassallo, A., Armentano, M.F., Miglionico, R., Caddeo, C., Chirollo, C., Gualtieri, M.J., Ostuni, A., Bisaccia, F., Faraone, I., Milella, L., 2020. *Hura crepitans* L. extract: phytochemical characterization, antioxidant activity, and nanoformulation. *Pharmaceutics*, 12(6): 1 – 14.
- Venter, T., Fox, L.T., Gerber, M., du Preez, J.L., van Zyl, S., Boneschans, B., du Plessis, J., 2016. Physical stability and clinical efficacy *Crocodylus niloticus* oil lotion. *Brazilian Jour. Pharmacognosy*, 26: 521 – 529.
- Zhang, J., Kurita, M., Shinozaki, T., Ukiya, M., Yasukawa, K., Shimizu, N., Tokuda, H., Masters, E.T., Akihisa, M., Akihisa, T., 2014. Triterpene glycosides and other polar constituents of shea (*Vitellaria paradoxa*) kernels and their bioactivities. *Phytochem.*, 108: 157 – 170.