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Comprehensive Analysis of Neocarya macrophylla Seed Oil: Physicochemical, Phytochemical, and Fatty Acid Profiling for Potential Applications

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ABSTRACT: This research investigates the physicochemical, phytochemical, and fatty acid composition of Neocaryamacrophylla seed oil. The paper aims to provide a comprehensive understanding of the properties and applications of Neocarya macrophylla seed oil, contributing to the knowledge on its industrial, nutritional, and medicinal significance. The sample seeds were sourced from Illela, Sokoto State, Nigeria. A mixed method research involving quantitative and qualitative analytical research was employed. The research was conducted at Chemistry laboratory, Usmanu danfodiyo university sokoto. A soxhlet extraction method was used.,with n-hexane as a solvent. The physicochemical analysis of the oil shows a saponification value of 153.33 mgKOH/g, iodine value of 33.07 gI2/100g, and a peroxide value of 45.5 mgmeq/kg. Qualitative phytochemical analysis revealed the presence of tannins, saponins, flavonoids, alkaloids, steroids, and terpenoids, aligning with the antimicrobial attributes noted in Anacardiumoccidentale L. seeds oil. Fatty acid profiling identified oleic acid as the predominant monounsaturated fatty acid (42.46%), while linoleic and arachidonic acids constituted the main polyunsaturated fatty acids (35.08%). The study's findings suggest potential applications of Neocaryamacrophylla seed oil in soap production, owing to its high saponification value, and its stability, indicated by the MUFA/PUFA ratio. This research contributes valuable insights into the underexplored properties of Neocaryamacrophylla seed oil, holding implications for industries seeking alternative oil sources.

Keywords: Neocarya macrophylla, Seed oil, Physicochemical analysis, Phytochemical composition, Fatty acid profiling

INTRODUCTION

Ginger-bread plum, currently classified under the taxonomic designation Neocarya macrophylla within the Chrysobalanaceae family, was previously recognized as Parinarimacrophylla Sabine (Yusuf et al., 2021)(Evanilson et al., n.d.). This taxonomic revision, attributed to Prance ex White in 1976, establishes Neocarya as a monotypic genus (Figure 1)(Prance, 2018). Indigenous to the western and central regions of Africa, spanning from Senegal to Nigeria and South Sudan, this plant species is characterized by its affiliation with a plant family comprising 17 genera and approximately 525 species, predominantly encompassing woody plants, shrubs, and trees predominantly distributed in tropical and subtropical zones (Dressler et al., 2014; Fakai, 2023b, 2023a; R. et al., 2023)). Despite the botanical diversity within this family, Neocarya macrophylla stands out as the sole known species(Yakandawala et al., n.d.). The vernacular nomenclature, 'Gawasa,' is reflective of the rich cultural and linguistic context within which this plant species is embedded(Warra et al., 2013).

This study pursued a comprehensive understanding of Neocaryamacrophylla seed oil, comprising of physicochemical, phytochemical, and fatty acid analyses to unravel its multifaceted properties and potential applications. Firstly, the investigation aimed to assess the oil's suitability for cosmetic products by examining key physicochemical parameters, including saponification value, iodine value, acid value, and peroxide value. Secondly, the phytochemical diversity of the seed oil will also be explored through a detailed screening, to investiate the presence of alkaloids, flavonoids, saponins, terpenoids, tannins, and steroids.

This elucidation aimed to uncover potential health- promoting properties, aligning with traditional medicinal uses and indicating applications in pharmaceuticals and cosmetics. Thirdly, the fatty acid profile analysis will reveal the nutritional potential of Neocaryamacrophylla seed oil. The nutritional composition if determined will positioned the oil as a promising dietary component. Furthermore, the study will explore the implications of Neocaryamacrophylla seed oil across various sectors, emphasizing its potential in cosmetic production, dietary use, and traditional medicine. Lastly, the study will focus on recognizing the importance of biodiversity conservation. In essence, this research aimed to contribute comprehensive insights into the properties and applications of Neocaryamacrophylla seed oil.

Conceptual Framework

The conceptual framework of this study revolves around the multifaceted analysis of Neocarya macrophylla seed oil, delving into its physicochemical composition, phytochemical diversity, and fatty acid profile. This exploration serves as the foundational structure to understand the potential applications in soap production, dietary use, traditional medicine, and industrial sectors.

Physicochemical Composition

The physicochemical composition of oilseeds plays a crucial role in determining their suitability for various applications, including food, cosmetics, pharmaceuticals, and biofuels. Key physicochemical properties include the oil content, which varies significantly across different species, affecting yield and economic value. The fatty acid profile is paramount, with the ratio of saturated to unsaturated fatty acids influencing the oil's nutritional quality and stability. Monounsaturated and polyunsaturated fatty acids, such as oleic and linoleic acids, are sought after for their health benefits (Usman 2023a).

Saponification and iodine values are important indicators of oil quality; the former measures the average molecular weight of fatty acids, while the latter assesses the degree of unsaturation, affecting the drying properties of the oil. Peroxide value is another critical parameter, indicating the extent of oxidation and potential rancidity, impacting shelf life and safety (Ibironke, 2010).

Moreover, the presence of bioactive compounds like tocopherols, phytosterols, and phenolics contributes to the antioxidant activity, enhancing the oil's health benefits and preservation. Understanding these physicochemical properties is essential for optimizing extraction processes, improving product formulation, and evaluating the nutritional and industrial potential of oilseeds(Garba1 & Fakai, 2023).

Phytochemical Diversity

Oil seeds exhibit a remarkable phytochemical diversity, encompassing a wide range of bioactive compounds that contribute to their health benefits and potential therapeutic applications. These include antioxidants like tocopherols and phenolic compounds, which combat oxidative stress and reduce disease risk. Alkaloids, flavonoids, and terpenoids offer antimicrobial and anti-inflammatory properties, supporting the immune system and potentially preventing chronic diseases. Saponins, found in many oil seeds, are known for their cholesterol-lowering effects and ability to improve nutrient absorption. The specific phytochemical profile of an oil seed determines its unique health-promoting properties, making the study of these compounds essential for developing functional foods, nutraceuticals, and natural medicinal products. The exploration of oil seed phytochemistry is a promising avenue for discovering novel compounds with potential applications in health and industry (Aliyu and Usman, 2023).

Fatty Acid Profile:

Gas Chromatography-Mass Spectrometry (GC-MS) analysis of oil seeds provides a detailed insight into their fatty acid composition. This analytical technique separates and identifies individual fatty acids, offering quantitative data on their presence in the oil. For instance, the predominant monounsaturated fatty acids (MUFAs), polyunsaturated fatty acids (PUFAs), and saturated fatty acids (SFAs) can be precisely quantified. GC-MS is crucial in determining the nutritional quality and stability of oil seeds, aiding in the assessment of their potential applications in various industries, such as food and cosmetics. The technique allows for a comprehensive understanding of the oil's chemical profile, aiding researchers in uncovering valuable information for both scientific and industrial purposes (Usman 2023b).

Applications and Implications

Oil seeds hold significant industrial applications, particularly in the food, cosmetics, and pharmaceutical sectors. Their rich fatty acid profiles make them ideal for producing cooking oils, margarine, and other food products, offering health benefits such as improved cardiovascular health. In cosmetics, oils extracted from seeds are valued for their moisturizing, anti-aging, and protective skin properties, leading to their incorporation in creams, lotions, and serums. Pharmaceutical industries utilize oil seeds for their bioactive compounds, which have potential therapeutic effects, including anti-inflammatory and antioxidant properties. Additionally, the high saponification values of some oil seeds make them suitable for soap production, offering natural, biodegradable alternatives to synthetic detergents. The diverse applications of oil seeds underscore their economic importance, driving research and development to optimize their extraction and processing for various industrial uses(Warra & White, n.d.).

Theoretical Framework

An examination of pertinent literature, encompassing notable contributions by Frederick (1961). (Fattorusso et al., n.d.; Frederick, n.d.; Mann et al., n.d.), elucidates that a comprehensive exploration of the physicochemical attributes of gingerbread plum kernel oils is notably absent. This discernment underscores the prospect for the development of value-added products derived from these underexplored oilseeds. Consequently, a meticulous inquiry into the chemical composition and antioxidant properties of gingerbread plum kernel oils assumes paramount importance, offering a substantive augmentation to the existing paucity of data concerning these relatively obscure oilseeds. This endeavor holds promise for their prospective application as raw materials in the realm of food product development.

Figure 1.Neocarya MacrophyllaFruits and Kernels. Source: Reilchi Miura

The primary aim of this investigation is to ascertain the phytochemical screening and physicochemical properties of gingerbread plum seeds, originating from Sokoto State in Northwestern Nigeria. Additionally, the study endeavors to assess the fatty acid profile of the seed oil derived from gingerbread plum.

1. **Problem Statement** : The study addresses the lack of comprehensive research on Neocaryamacrophylla seed oil, a lesser-known oilseed with potential applications. Existing gaps include limited exploration of its physicochemical properties, phytochemical diversity, and fatty acid profile. This research aims to bridge these knowledge gaps and provide insights into the industrial, nutritional, and medicinal significance of Neocaryamacrophylla seed oil, contributing to its utilization and biodiversity conservation.
2. **Research Questions** : This research holds significance in unraveling the properties of Neocaryamacrophylla seed oil. The study's findings will offer valuable insights into the potentials of the oil supporting its importance in various domains. Additionally, the research provides scientific validation for traditional uses, highlighting the importance of this lesser-known oilseed in health and industry. Overall, the study contributes to expanding our understanding of Neocaryamacrophylla seed oil and encourages further exploration of its applications.

   The following research questions provide guide for the study

   How does the physicochemical composition, phytochemical diversity, and fatty acid profile of Neocarya macrophylla seed oil influence its potential applications in cosmetic industry, traditional medicine, and industrial sectors? Furthermore, what are the implications for its nutritional value, health benefits, and biodiversity conservation? This study aims to provide a comprehensive understanding of the properties and applications of Neocarya macrophylla seed oil, contributing to the knowledge on its industrial, nutritional, and medicinal significance.

3. **Research Objectives** : The research objective is to comprehensively analyze the physicochemical composition, phytochemical diversity, and fatty acid profile of Neocarya macrophylla seed oil. This includes assessing its suitability for cosmetic production, dietary applications, and traditional medicine. The study aims to explore the industrial, nutritional, and health implications of Neocarya macrophylla seed oil, while also identifying optimal cultivation practices for sustainable production. Furthermore, the objective involves bridging traditional knowledge with modern scientific validation, contributing to a deeper understanding of this underexplored oilseed and opening avenues for its diverse applications in industries, nutrition, health, and biodiversity conservation.

METHOD

Quantitative and qualitative analytical methods were used in the conduct of the research. Solvent extraction method was employed for oil extraction, while physicochemical and phytochemical analysis were used for oil characterization. GC-MS was used to determine fatty acid profile. Standard Analytical reagents and Apparatus were used in the conduct of the research.

Procurement of Material

Fresh whole gingerbread plum kernels (Neocarya macrophylla) were obtained in the month of November from Illela, sokoto state Nigeria, and subsequently transported to the Herbarium Unit, where they underwent identification by a botanist affiliated with the Department of Biological Sciences within the Faculty of Science at Usmanu Danfodiyo University Sokoto. The seeds were cleaned, de shelled and well dried, then milled using a laboratory hammer miller. Resulting flour was kept in dessicator. The execution of this research involved the utilization of conventional laboratory apparatus and reagents, all of which were of analytical reagent grade with a purity level equal to or exceeding 99%.

Oil Extraction

Repeated extraction of 50 g of ground seed kernels of gingerbread plum was conducted in a soxhlet extractor using nhexane (boiling point at 40 - 600C) for six hours (Usman, 2023b). The oils wereobtained after the solvent was removed under reducedtemperature and pressure and refluxing at 70 ºC to removeexcess solvent used in the oil as reported by Warra et al., (2011). The extractedseed oil was stored in a freezer at -20Cprior to the commencement of the analysis. The extraction was carried out at the Chemistry Laboratory, Department of Chemistry Education, Adamu Augie College of Education, Argungu. Kebbi State, Nigeria(Z & R, 2024).

Oil Yield

The oil which was recovered by complete distilling of most of the solvent on a heating mantle was then transferred to measuring cylinder. The measuring cylinder is then placed over water bath for complete evaporation of solvent for about 2 3 hours in accordance with the method reported [8] and weight of the oil was recorded and expressed as oil content (%) as follow.

$$\text{Oil content (\%)} = \frac{\text{weight of oil}}{\text{Sample weight}} \times 100$$

Physicochemical Analysis

The physical parameters measured for the extracted oils were FFA, IV and SV. These were determined according to the methods Ca5a-40,CD 125 and Cd 3-25, respectively, from the AOCSOfficial Methods of Analysis (Society, n.d.-c, n.d.-b, n.d.-d, n.d.-a). The PV was determined bymethod Cd 8-53 of the AOCS Official Methodsof Analysis (AOCS, 1998) and AV was determinedbased on the AOAC Official Methods of analysis(AOAC, 1998). To determine the color parameters, aHunter Lab digital colorimeter was used to measuregingerbread plum kernel oil's color and color scales.

Fatty Acid Analysis by GC–MS

The fatty acid composition of gingerbread plumkernel oil was determinedas reported by Amzaet al. (2010)(Amza et al., n.d.; M & KR, n.d.). Fat was extractedwith methyl ether which was prepared directly withthe treatment of the fat with sodium methoxide. A gas chromatography/mass spectra (GC/MS) systemwas used to identify and quantify the fatty acids of the product developed on a FINNIGAN TRACE MS gas chromatograph/mass spectra equipped witha 30 m×0.25 mm Ov- 1701 column. The column flowrate w as 0.8 mL·min-1 with helium as the carrier gas, the split was 64 mL·min-1 and the source temperaturewas 270 °C. The fatty acid methyl esters were identified by comparison with the retention times of NUCHECK Inc. standards (Elysian, 1L) and quantifiedby internal normalization.

Qualitative Phytochemical Analysis

The method reported by Warra et al., 2013 was used.

Test for alkaloids

The oil extract (2ml) was added to 2ml of HCl. To the acidic medium, 1 ml of Dragendroff's reagent was added. An orange or red precipitate was immediately formed which indicated the presence of alkaloids.

Test for terpenoids

Two ml of the oil extract was mixed in 2 ml of chloroform, and concentrated H_2SO_4 (1 ml) was carefully added to form a layer. A reddish brown coloration was formed at the interface to show positive results for the presence of terpenoids.

Test for saponins

The oil extract was diluted with 2 ml of distilled water and it was agitated in a test tube for about 15minutes. The formation of 0.1cm layer of foam showed the presence of saponins.

Test for tannins

Few drops of 1% lead acetate were added to 5ml of the oil extract in a test tube. A yellow precipitate wasformed which indicated the presence of tannins.

Test for flavonoids

Few drops of dilute sodium hydroxide were added to 1ml of the oil extract in a test tube. An intense yellow color was formed which turned colorless on addition of few drops of dilute acid indicating the presence of flavonoids.

Test for steroids

To 1ml of the oil extract in a test tube, 10 ml of chloroform was added. Equal volume of concentrated sulphuricacid was added by the sides of the test tube. The upper layer turned red, whereas the sulphuric acid layer turned yellow with green fluorescence. This indicated the presence of steroids.

Test for cyanogenic glycosides

Small quantity of the oil extract was put in a test tube. 1.5ml of distilled water and 6 drops of chloroform were added and the mixture stirred with a rod. The test tube was stoppered with a cork containing a strip of picrate-impregnated paper hanging down from the stopper, and incubated at ambient temperature for 2 hours. A color change of the paper, from yellow to brown red, indicated the release of HCN by the plant. If there was no release of HCN within 2 hours, indicating a negative test, the tube was left at ambient temperature for 24 and 48 hours, so that it could be re-examined. A brown-red coloration within 2 h indicated the presence of cyanogenic glycoside and the respective hydrolytic enzyme, and the plants were considered cyanogenic in the field. A brown red color appearing within 48 hours indicated that the cyanogenic glycoside spontaneously released HCN without the action of enzyme. No color change after 48 hours indicated that the test was negative for cyanogenic glycoside.

RESULT AND DISCUSSION

Table 1. Physicochemical Properties of Neocarya macrophylla seed oil

Parameter	Result / Observation
Acid value (mgKOH/g)	0.6.90 ± 0.02
Saponification value (mgKOH/g)	153.33 ± 0.10
Iodine value (gI2/100g)	33.07 ± 0.01
Free fatty acid (% oleic acid)	0.34. 10 ± 0.10
Peroxide value (meq H2O2)	43.48 ± 0.02
Oil content (%)	52.30 ± 0.80
Colour	Golden yellow
Odour	Agreeable
Physical state at room temperature	Liquid

Results are mean standard deviation of triplicate determination

Table 2. Phytochemical analyses of Neocarya macrophylla seed oil.

Phytochemicals	Inferences
Alkaloids	+++
Tannins	+
Terpenoids	+++
Flavonoids	+
Saponins	++
Steroids	++
Cyanogenic glycosides	-
Cardiac glycosides	NC
Flavonosides	NC
Anthraquinone	NC

Key: + = slightly present; ++ = averagely present; +++ largely present; - = completely absent; and NC = not carried out

Table 3. Fatty acid Composition of Neocarya macrophylla seed oil

Free fatty Acid	NMO
Saturated (SFA)	
Palmitic acid (16:0)	9.18±0.02
Stearic acid (18:0)	5.21±0.33
Arachidic acid (20:0)	0.29±0.07
Lignoceric acid (29: 00)	0.59±0.07
Behenic acid (22:0)	0.65±0.01
Mono unsaturated (MUFA)	
Oleic acid (18: 1)	42.46±0.28
Eicosenoic acid (20:1	0.49±0.07
Erucic acid (20:1)	5.37±0.03
Polyunsaturated (MUFA)	
Linoleic acid	17.42±0.04
Arachidonic acid	17.67±0.02

Saponification Value

The physicochemical examination of Neocarya macrophylla seed oil revealed a saponification value of 153.33 mgKOH/g (Table 1). This value, while lower than the saponification values of various seed oils, including Nigerian cotton seed oil (199.42 mgKOH/g)(Warra et al., 2019), Neem seed oil (213 mgKOH/g) (Utono et al., 2024, Rubber seed oil (182.12 mgKOH/g)(E.U & Maliki, n.d.),Bottle gourd

(209.91 mgKOH/g) (Usman, 2023a), African pear seed oil (246.840 mgKOH/g) (Andersen and Markham, 2006), Hyptisspicigera seed oil (154.10 mgKOH/g) (ISO, 1977), Citrus lanatus seed oil (189.35 mgKOH/g)(Meskin et al., n.d.), Adansoniadigitatalinn seed oil (230.01 mgKOH/g)(Ibironke, n.d.; L.G & N.A, n.d.), and Elaeisguineensis seed oil (246.60 mgKOH/g)(Rigano et al., n.d.), exceeds the saponification values of Nepoleana imperials seed oil (77.06 mgKOH/g) (Rigano, et al., 2009), African pear seed oil (142.760 mgKOH/g), castor seed oil (123.3 mgKOH/g)(Warra, Wawata, Gunu, et al., n.d.), Polyalthialongifolia seed oil (120.00 mgKOH/g)(Fattorusso,and Taglialatela-Scafati, 2008), Cashew kernel oil (137 mgKOH/g) (Dewick, 2009) and Lagenariasiceraria seed oil . A high saponification value is indicative of the suitability of the oil for soap production.

Iodine Value

The iodine value of Neocarya macrophylla, recorded as 31.88 I2/100g, is lower than the iodine values observed in Cashew kernel oil (41.3 I2/100 g) (Dewick, 2009), Polyalthialongifolia seed oil (95.00 I2/100g) (Fattorusso,and Taglialatela-Scafati, 2008), Avocado pear (42.664 I2/100 g)(I.E & A.E, n.d.), Detariummicrocarpum (55.9 I2/100g) (Ibironke, 2010), Hypertisspicigera seed oil (81.22 I2/100g)(Oyedeji et al., n.d.). However, it surpasses the iodine values of Landolphiaowariensis seed oil (15.10 I2/100g), Elaeisguineensis seed oil (18.30 I2/100g) (Rigano and Otero). Iodine values below 100 categorize oils as non-drying, indicating their suitability for soap production. Notably, this value aligns closely with the reported iodine value for Parinarimacrophylla seed oil (32.07 ± 0.01 g I2/100 g) (Warra, Wawata, SY, et al., n.d.).

Acid Value

The acid value obtained for Neocarya macrophylla seed oil, recorded as 13.41 mgKOH/g, is lower than those of African pear seed oil (15.280 mgKOH/g) (Ibironke, 2010)Monodoramyristicagaertin seed oil (14.31 mgKOH/g) (Andersen and Markham, 2006), and rubber oil (15.03 mgKOH/g)(Jumat & M.A, n.d.; organization, n.d.). Conversely, it exceeds the acid values of HyptisSpicigera seed oil (2.5 mgKOH/g) (Rigano and Otero), Citrus lanatus seed oil (5.25 mgKOH/g) (Hassan and sani, 2007), Avocado pear seed oil (5.200 mgKOH/g) ((Anhwange, Ikyenge, & Nyiatagher, n.d.; Anhwange, Ikyenge, Nyiatagher, et al., n.d.), 2010), and Cashew kernel oil (10.7 mgKOH/g)(Akpan et al., n.d.). Furthermore, it is higher than the reported acid value for olive oil (10.493 mgKOH/g) (Warra, 2019), recognized for its utility in soap production. Nevertheless, it exceeds the free fatty acid values of Polyalthialongifera seed oil (7.73%) (Jumuat and Bashar, 2009).,Monodoramyristicagaethdunat (7.20%), and rubber seed oil (7.55%) (Ikhuoria and maliki, 2009. Elevated free fatty acid levels can induce oxidative deterioration in oils through enzymatic and/or chemical oxidation, resulting in the formation of off-flavor components (Azhari, et al., 2014).

Peroxide Value

The peroxide value obtained for Neocarya macrophyllaseed oil, quantified at 45.5 mgmeq/kg, is lower than that of Polyalthialongifera seed oil (730.00 mgmeq/kg) (Fattorusso,and Taglialatela-Scafati, 2008) and Butyrospermumparkii oil (77.5 mgmeq/mg) (Ibironke, 2010). However, it exceeds the peroxide values of Dacroyodesedulis (G. Don) H.J lam seed oil (20.00 mgmeq/kg) (Andersen and Markham, 2006), and Sterculasetegera seed oil (35.0 mgmeq/kg) (Ibironke 2010).

The high peroxide value suggests a heightened level of oxidative rancidity in Neocarya macrophylla seed oil. The outcomes of the qualitative phytochemical analysis conducted on the oil extract obtained from Neocarya macrophylla seed oil are presented in Table 2. The results indicate the presence of Tannins, Saponins, Flavonoids, Alkaloids, Steroids, and Terpenoids.

The phytochemical composition identified in the seed oil of Neocarya macrophylla closely resembles that of Anacardiumoccidentale L. seeds oil, previously recognized for its inclusion of antimicrobial agents (Batchou 2012).

Flavonoids

Flavonoids exhibit a discernible presence, representing a noteworthy class of plant metabolites with diverse functions in plant growth and development. The two main subsets, anthocyanins and 3-deoxyanthocyanins, contribute distinctive capabilities such as protecting chloroplasts from excessive irradiance and serving as visible cues to certain animals. While anthocyanins absorb green light, flavonols and flavones, the colorless or yellow flavonoids, act as chemical signals or UV guides, attracting or deterring insects and serving as effective UV filters. Beyond their physiological roles, flavonoids are recognized for their bioactivities, including anti-inflammatory and antioxidant actions, modulation of redox-sensitive signal transduction pathways, and gene expression alterations(Diaby et al., 2017; DiabyM.a et al., 2016; M.V.C & I, 2012; Tidjani et al., n.d.)

Tannins

Tannins are modestly present, serving diverse functions such as metal ion chelation, antioxidant activity in biological systems, and protein precipitation.

Saponins

Saponins are prevalent in the seed oil sample, owing to their surfactant nature. Industrially, they find applications in mining, ore separation, emulsion preparation for photographic films, and cosmetics formulations. The antifungal and antibacterial properties of saponins are particularly significant in cosmetic applications (Audu et al., n.d.; Azhari et al., 2014; P.M, n.d.).

Terpenoids

The abundance of terpenoids in Neocarya macrophylla seed oil extract supports the traditional use of decoction from the dried kernel for treating diabetes mellitus, as reported for Cashew nut oil (Batchou 2012).

Alkaloids

Alkaloids, as a prominent class of defense compounds, are notably present in the Neocarya macrophylla seed oil extract. Their functionality includes repellence, deterrence, toxicity, and growth inhibition against herbivores/predators. Additionally, they contribute to growth inhibition, toxicity against microbes/viruses, and serve as secondary metabolites for UV protection and nitrogen storage.

Steroids

Steroids, averagely present in Neocarya macrophylla seed oil extract, exhibit diverse medicinal significance. Modified triterpenoids containing the tetracyclic ring system of lanosterol characterize steroids, with cholesterol representing the fundamental structure. Further modifications, particularly to the side-chain, result in a wide array of biologically important natural products, including sterols, steroidal saponins, cardioactive glycosides, bile acids, corticosteroids, and mammalian sex hormones. Given their profound biological activities, both natural and synthetic steroidal compounds are routinely employed in medicine (Akinhanmi et al., n.d.)

GC-MS

The fatty acid (FA) compositions of MNO are delineated in Table 3. Predominantly, oleic acid emerged as the major monounsaturated fatty acid (MUFA), constituting 42.46% of the samples. Linoleic acid and arachidonic acid were identified as the polyunsaturated fatty acids (PUFA), with arachidonic acid notably surpassing common vegetable oils at a level of 17.67%.

Palmitic acid and stearic acid were identified as the primary saturated fatty acids (SFA), while other fatty acids were present in minimal amounts (<1%). Further investigation included the determination of the percentages of SFA, MUFA, and PUFA, along with the calculation of the MUFA/PUFA ratio. Total SFA values were recorded at 15.90, falling within the range reported by Noorali et al. (2014) for various olive cultivars, but lower than the values for coconut (86.5%) and palm oils (47.8%) reported by Foster et al. (2009).

The MUFA content in MNO, measured at 48.31%, markedly exceeded those reported for safflower (12.0%), sunflower (20.5%), soybean (21.3%), corn (29.9%), and palm (37.1%) oils according to Zhang(Zhang et al., n.d.). Conversely, the PUFA values were determined to be 35.08%, primarily attributed to elevated levels of linoleic and arachidonic acids in this study. The MUFA/PUFA ratio, a critical parameter for oil stability in highly unsaturated oils, indicated that MNO exhibits relative stability due to its higher MUFA/PUFA ratio. However, it is noteworthy that the MUFA/PUFA values for MNO (1.38) are considerably lower than those reported by (Moayedi et al., n.d.) for various wild almond species oils, categorized as AZ (3.86), AH (3.24), and AJ (3.34).

In conclusion, this comprehensive study sheds light on the multifaceted aspects of Neocarya macrophylla (gingerbread plum) seed oil, encompassing physicochemical, phytochemical, and fatty acid analyses. The physicochemical properties underscore its potential applicability in soap production, with a saponification value exceeding that of several seed oils. The non-drying categorization, as indicated by the iodine value, further supports its suitability for soap-making processes.

The phytochemical profile reveals a rich array of bioactive compounds, including alkaloids, tannins, terpenoids, flavonoids, saponins, and steroids. Such diverse phytochemicals suggest potential health-promoting properties, aligning with previous reports on related plant species. Additionally, the presence of terpenoids justifies traditional uses, such as the decoction of dried kernels for treating diabetes mellitus.

Fatty acid composition analysis demonstrates a noteworthy predominance of oleic acid as the major monounsaturated fatty acid (MUFA), with substantial levels of linoleic and arachidonic acids as primary polyunsaturated fatty acids (PUFA). The balanced MUFA/PUFA ratio suggests relative stability, emphasizing its potential as a stable and nutritious dietary oil.

Comparisons with other seed oils highlight the unique attributes of Neocarya macrophylla seed oil, positioning it as a valuable resource. The study's findings contribute to the growing body of knowledge on lesser-known oilseeds, paving the way for further exploration of their diverse applications in the fields of nutrition, health, and industry.

In summary, Neocarya macrophylla seed oil emerges as a promising natural product with a spectrum of properties, making it a subject of interest for future research and potential utilization in various sectors. The findings not only enrich our understanding of this underexplored plant species but also underscore its potential contributions to diverse domains, ranging from traditional medicine to industrial applications

Implication of the Study

The implications of this study are far-reaching and hold significance across various domains, including health, nutrition, industry, and traditional medicine:

1. **Industrial Applications**: The physicochemical analysis, particularly the high saponification value and non-drying categorization, suggests the potential suitability of Neocarya macrophylla seed oil for soap production. Industries involved in soap manufacturing may find this oil a valuable and sustainable alternative, contributing to diversification in the production of soap- based products.
2. **Nutritional Potential**: The rich fatty acid composition, featuring a high content of oleic acid, linoleic acid, and arachidonic acid, positions Neocarya macrophylla seed oil as a promising dietary oil. Its balanced monounsaturated to polyunsaturated fatty acid ratio indicates potential stability, making it a valuable addition to the array of edible oils available. Further exploration of its nutritional properties could lead to its incorporation into food products for enhanced nutritional value.
3. **Phytochemical Diversity and Health Applications**: The presence of various phytochemicals, including alkaloids, tannins, terpenoids, flavonoids, saponins, and steroids, suggests potential health-promoting properties. These bioactive compounds are known for their antioxidant, antimicrobial, and anti-inflammatory activities. Future research may delve into isolating and studying individual phytochemicals for their specific health benefits and medicinal applications.
4. **Traditional Medicine Validation**: The identification of terpenoids in Neocarya macrophylla seed oil aligns with traditional uses, such as the decoction of dried kernels for treating diabetes mellitus. This finding provides scientific validation for traditional medicinal practices, opening avenues for the development of herbal remedies and pharmaceutical formulations based on the plant's bioactive components.
5. **Biodiversity Conservation**: The study underscores the potential value of lesser-known oilseeds like Neocarya macrophylla, contributing to the conservation of biodiversity. Recognizing and utilizing the properties of such plant species may promote their cultivation and preservation, preventing the loss of valuable genetic resources.

6. **Future Research Opportunities**: The unique fatty acid profile, phytochemical composition, and traditional uses of Neocarya macrophylla seed oil open avenues for further research. Future studies may explore its potential applications in cosmetic formulations, pharmaceuticals, and other industrial sectors. Additionally, investigating its cultivation practices and agronomic aspects could contribute to sustainable agriculture and economic development.

CONCLUSION

In conclusion, the investigation into the physicochemical composition, phytochemical diversity, and fatty acid profile of Neocaryamacrophylla seed oil has provided a profound understanding of its versatile properties and potential applications. The high saponification value and non-drying categorization emphasize its suitability for soap production, opening avenues for sustainable industrial applications. The rich phytochemical composition, featuring alkaloids, tannins, terpenoids, flavonoids, saponins, and steroids, signifies its potential in traditional medicine, aligning with cultural uses and offering scientific validation. Additionally, the fatty acid profile, characterized by oleic acid, linoleic acid, and arachidonic acid, positions Neocaryamacrophylla seed oil as a promising dietary option with balanced nutritional benefits. The implications extend to various sectors, including soap manufacturing, nutritional enhancement, and health-related applications. Moreover, the recognition of its biodiversity value emphasizes the need for conservation efforts. Overall, this study contributes significantly to the understanding of Neocaryamacrophylla seed oil, highlighting its potential contributions to industry, nutrition, medicine, and biodiversity conservation(Anwar et al., 2014; Arbonnier, n.d.).

Suggestions for Future Research:

1. **Isolation and Characterization**: Future research could focus on isolating and characterizing specific bioactive compounds within Neocarya macrophylla seed oil. This would provide a more in-depth understanding of the individual components responsible for the observed physicochemical and biological properties.
2. **Clinical Studies**: To validate the potential health benefits suggested by the phytochemical composition, conducting clinical studies on Neocarya macrophylla seed oil is recommended. Exploring its impact on oxidative stress, inflammation, and other health parameters in controlled human trials could provide valuable insights.
3. **Biological Activities**: Investigating the specific biological activities of Neocarya macrophylla seed oil, such as antioxidant, antimicrobial, and anti-inflammatory properties, can further elucidate its potential applications in medicine and health-related industries.
4. **Cultivation Practices**: Research into optimal cultivation practices for Neocarya macrophylla could contribute to sustainable agriculture. Understanding factors like soil conditions, climate preferences, and cultivation techniques would support the efficient and environmentally friendly production of this valuable oilseed.

Limitations of the Study:

1. **Sample Size and Geographic Specificity**: The study was conducted on Neocarya macrophylla seeds obtained from a specific geographic location (Illela, Sokoto State, Nigeria) in November. The limited sample size and geographic specificity may affect the generalizability of the findings to other regions or different harvest times.
2. **Extraction Solvent**: The use of n-hexane as the extraction solvent may pose a limitation due to potential variations in extraction efficiency and selectivity. Different solvents or extraction methods could yield distinct phytochemical profiles, impacting the comprehensiveness of the study.
3. **Single Extraction Method**: The repeated extraction of seed kernels using a soxhlet extractor represents a single method employed for oil extraction. The study did not explore alternative extraction methods, which might influence the yield and composition of the extracted oil.

4. **Limited Biological Assays**: The study primarily focuses on the physicochemical properties and phytochemical composition of Neocarya macrophylla seed oil. Further biological assays and clinical studies are needed to validate the potential health benefits and therapeutic properties suggested by its phytochemical content.
5. **Cultural and Traditional Variability**: The traditional uses and practices associated with Neocarya macrophylla may vary among different communities and cultural settings. The study does not extensively explore these cultural variations, which could influence the interpretation of the plant's significance.
6. **Seasonal Variability:** The study procured seeds in November, and the seasonality of plant materials can impact their chemical composition. Seasonal variations, not explicitly addressed in the study, could influence the results and may warrant further investigation.
7. **Phytochemical Screening Specificity**: While the study reports the presence of various phytochemicals, it does not delve into the specific bioactive compounds responsible for the observed activities. Further analyses, such as chromatographic techniques, would provide more detailed insights into the chemical composition.
8. **Clinical Correlation**: The study lacks direct correlation with clinical outcomes or human trials. While it suggests potential health benefits based on phytochemical composition, clinical studies are essential to establish the efficacy and safety of Neocarya macrophylla seed oil in practical applications.

Acknowledging these limitations provides a foundation for future research refinement and enhances the contextual understanding of the study's scope and applicability.

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