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Physicochemical Properties and Nanomaterial Potential of Traditionally Purified Abrus precatorius (Gunja) Seed Oil

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Abstract

Abrus precatorius a herbaceous flowering plant belonging to the Fabaceae (bean) family is extensively utilized in traditional medicine across India and tropical and subtropical regions of Asia, including China, Indonesia, and parts of South Africa. This study focuses on extracting oil using purified (Gunja shodhana) *A. precatorius* seeds, *Eclipta prostrata* leaf extract (Karisalankanni keerai), and sesame oil. The formulated oil was analysed for its physical and physicochemical properties. The physical characterization of *Abrus* seed oil showed a density of 0.88 g/cm³, with a moisture content of 0.41% and a specific gravity of 0.8820. In addition, the ash content was recorded as 0.01%. The physicochemical assessment revealed a free fatty acid content of 2.96%, an iodine value of 58.3 mgI_2/g, and a peroxide value of 4.2 mEq/kg, the acid value was determined to be 5.90 mg KOH/g, while the refractive index measured 1.4620 at 40°C, the saponification value was found to be 221 mg KOH/g, and the total phenolic content was quantified at 1.5 mg GAE/g. These results were compared with values reported for other commercially available oils. The extracted oil was further examined for its total fatty acid profile, and the formulated oil comprises 99.43 g of total fat per 100 g, with Monounsaturated Fatty Acids (MUFA) constituting 42.05%, Polyunsaturated Fatty Acids (PUFA) contributed 40.42%, Saturated Fatty Acids (SFA) represented 16.96%, and Trans-Fatty Acids (TF) were detected only in negligible amounts (<0.05%). The shelf life of the oil was also evaluated to ensure its quality and stability. Furthermore, Carbon Nanoparticles (CNPs) were synthesized from *Abrus* seed oil through a cost-effective combustion method. SEM analysis indicated an average particle size of 50 µm with slight size variations, while EDX confirmed a predominantly carbon composition with trace amounts of oxygen and nitrogen.

KEYWORDS: *Abrus precatorius* seed oil, Gunja shodhana, *Eclipta prostrata* leaf, Commercial oils, Nanoparticles

Introduction

Plant-derived oils extracted from seeds, nuts, fruits, flowers, and other botanical sources are extensively utilized in cosmetic formulations due to their diverse functional properties. For

centuries,

these natural oils have played an important role in traditional beauty and skincare practices because of their emollient, nourishing, and protective effects. Today, they are widely incorporated into skincare, haircare, and cosmetic products to enhance product performance and improve skin and hair health. Rich in essential fatty acids, vitamins, antioxidants, and other bioactive constituents, plant oils help maintain skin hydration, reinforce the epidermal barrier, and protect against oxidative damage. The unique chemical composition of each oil determines its specific cosmetic applications, making them valuable ingredients in both personal care and pharmaceutical formulations. Several botanical oils, including avocado, almond, coconut, olive, cottonseed, peanut, soybean, and sesame oils, have also demonstrated natural ultraviolet (UV)-protective properties and have been investigated as base ingredients for sunscreen formulations (Kaur and Saraf, 2010).

According to the World Health Organization (WHO), 80% of people in developing countries depend on traditional medicines, primarily plant-based, for their healthcare needs (Tewari, 2000).

Abrus precatorius is a prominent medicinal plant in India, historically used in Ayurvedic and Indigenous medicine (Kuber *et al*., 2019). The roots, stems, leaves, and seeds of *A. precatorius* have demonstrated various pharmacological activities, including antibacterial, anti-infertility, antitumor, anti-inflammatory, and antimicrobial properties (Ross, 2005; Zore *et al*., 2007; Ghosh and Maiti, 2007; Adelowotan, 2008; Georgewill and Georgewill, 2009). This plant is enriched with a wide spectrum of bioactive molecules, including saponins, phenolic compounds, alkaloids, flavonoids, eugenol, steroids, terpenoids, quercetin, kaempferol, rutin, lupeol, and β-sitosterol. The foliage of *Abrus* also harbors distinctive phytochemicals such as the triterpenes abrusgenic acid, methyl abrusgenate, and liquiritigenin-7-monoglycosides. These phytoconstituents are attributed with multiple therapeutic applications, notably antimicrobial, antioxidant, and chemopreventive properties (Nisha *et al*., 2018). Furthermore, the seeds, distinguished by their bright red pigmentation, are traditionally utilized as a natural dye in the textile industry (Macfoy, 2004).

In Ayurveda, *Abrus* seeds are considered toxic, requiring a detoxification process known as *Sodhana*, which enhances the efficacy and potency of the seeds (Bobbarala and Vadlapudi, 2009). Seed paste is traditionally used topically to treat alopecia and skin conditions (Shingadiya *et al*., 2017).

Eclipta prostrata, from the Asteraceae family, is used to address alopecia, premature greying, hair growth, scalp itching, and a wide array of other conditions, including acidity, bronchitis, pneumonia, constipation, gingivitis, jaundice, liver issues, heart palpitations, and skin inflammation (Dixit and Pandey, 1984; Jain, 1991; Sharma *et al*., 2000; Khan and Khan, 2008; Jain and Das, 2016; Neamsuvan and Ruangrit, 2017).

Sesame seed oil is under exploration as a modulator of cellular expansion, decelerating proliferation and division, partly due to its antioxidative traits. Studies indicate that this oil counteracts reactive oxygen species within the skin and adjacent tissues. Additional investigations suggest its potential in clearing arterial obstructions. Rapidly infiltrating the skin, the oil traverses into the bloodstream via capillaries. Once in circulation,

its molecules support beneficial cholesterol (HDL) while aiding in the elimination of harmful cholesterol (LDL). Furthermore, sesame oil harbors two potent antioxidants sesamolin and sesamol credited with safeguarding cellular integrity and sustaining tissue vitality in the presence of oxidative agents. These compounds preserve lipids and significantly amplify vitamin E efficacy (Abdulsalam and Sheet, 2022).

According to the Ayurvedic Formulary of India (Ayurvedic Formulary of India (AFI), 2003), medicated oils are traditionally prepared using three key constituents: *drava* or *qwatha* (a liquid medium, which may consist of an aqueous decoction of single or multiple herbs, freshly extracted herbal juice, or milk), *kalka* (a finely milled herbal paste), and *sneha dravya* (a lipidic base, typically derived from vegetable oils). In most classical preparations, crude sesame oil functions as the principal *sneha dravya*, while castor oil or coconut oil is occasionally incorporated, either partially or entirely, as substitutes.

In Siddha medicine, therapeutic oils were formulated by blending seeds, herbs, and carrier bases to achieve a synergistic effect. The mixture of *A. precatorius* seeds, *Eclipta prostrata* leaves, and sesame oil was selected for its pharmacological harmony as well as its alignment with traditional healing practices. This study aimed to formulate a oil incorporating *A. precatorius* seeds, *Eclipta prostrata* leaf extract (Karisalankanni keerai), and sesame oil. The prepared oil was analyzed for its physical and physicochemical properties, along with total fatty acid content. The formulated oil was processed to obtain carbon soot. Furthermore, the size and elemental composition of the carbon soot were investigated using Scanning Electron Microscopy (SEM) and Energy-Dispersive X-ray (EDX) analysis. Additionally, the shelf life was assessed to ensure product quality and stability.

Methodology

Gunja shodhana (purification method)

The purification procedure was conducted in accordance with the Ayurvedic method known as *Gunja Shodhana*, as outlined in the Ayurvedic Pharmacopoeia of India (2008), which is traditionally employed to eliminate toxic constituents from *A. precatorius* seeds. It is one of the classically approved methods in Ayurveda. 250g of seeds were kept in muslin cloth, which was tied into a pottali. The pottali was placed into the steel vessel, and freshly collected milk was added to the vessel. The milk should be used to immerse the pottali. During this process, the milk should be maintained at 100°C for three hours. 2.5 litres of milk were utilised in this process. After boiling, the seeds were taken out of the pottali and washed 5 – 6 times with warm water. The skin of the seed was removed shade dried. The dried seeds were pulverised and stored in an airtight glass container.

Procedure for *Abrus* seed oil

As outlined in the Ayurvedic Formulary of India (AFI, 2003), purified *A. precatorius* seed powder, *Eclipta prostrata* extract, and sesame oil were incorporated in the preparation process. 50 g of *Eclipta prostrata* leaf powder was simmered in 500 ml of distilled water for 15 - 20 minutes before filtering with muslin cloth. The leaf extract was subsequently mixed with 250 g of purified *A. precatorius* seeds, followed by 125 ml of sesame oil, and simmered together for 30 minutes. After the oil is collected, stored in an airtight container for future use.

Analysis of Physical Properties

The fundamental physical characteristics, including density, moisture content, specific gravity, and ash content, were evaluated in the extracted *Abrus* seed oil. The analysis was conducted in accordance with the standardized protocols outlined in IS 548 (Indian Standard, 1964) and the FSSAI Manual of Methods (FSSAI, 2016).

Analysis of Physiochemical Properties

The physicochemical attributes, including free fatty acid content, iodine value, peroxide value, refractive index, acid value, saponification value, and total phenolic compound concentration, were assessed in the extracted *Abrus* seed oil. The analysis was carried out following the standardized methodologies prescribed in IS 548 (Indian Standard, 1964) and the FSSAI Manual of Methods (FSSAI, 2016).

Fatty Acid Profile Analysis

The fatty acid profile, including Monounsaturated Fatty Acids (MUFA), Polyunsaturated Fatty Acids (PUFA), Saturated Fatty Acids (SFA), and Trans-Fatty Acids (TF), was analysed in the extracted *Abrus* seed oil. The analysis was conducted following the AOAC and AOCS official methods (Association of Official Analytical Chemists, 2005; American Oil Chemists Society, 2005).

Evaluation of *Abrus* seed oil

The formulated oils underwent a comprehensive sensorial assessment. Observations were recorded over a 60-day period, focusing on color, physical state, fragrance, appearance, and, tackiness.

Preparation of *Abrus* seed oil soot

In the present investigation, carbon soot was synthesized using the flame synthesis method based on oil-wick combustion (Mohapatra *et al*., 2003).The formulated oil was poured into a traditional mud lamp fitted with a cotton wick, which was allowed to soak in the oil for 15 minutes to ensure optimal absorption. Afterward, the lamps were ignited and the seed oil was allowed to burn steadily. A silver plate was positioned above the flame to collect the soot. The accumulated soot was periodically scraped off using a blade and stored in plastic containers. Approximately 5 grams of soot were collected using this method, which required around 3 to 4 hours to complete, depending on the quantity of oil used in the lamp. The stored soot was subjected to SEM and EDX analyses for characterization.

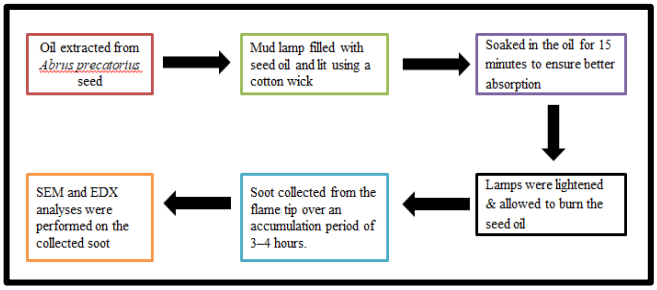

Figure 1: Preparation and collection of carbon soot

SEM and EDAX Analyses of oil Soot

The physical and chemical properties of the prepared oil soot were analyzed using Scanning Electron Microscopy (SEM) and Energy-Dispersive X-ray Spectroscopy (EDX). The surface morphology of the synthesized carbon nanoparticles was examined using a VEGA3 TESCAN SEM at a scale of 500 nm, with an applied acceleration voltage ranging from 10 to 15 kV. The SEM is capable of resolving features down to 1 nm in size (Raliya *et al*., 2013).

RESULT & DISCUSSION

The physical properties of the extracted *Abrus* seed oil were measured and are tabulated in Table 1. It has a density of 0.88 g/cm^3. This value suggests that *Abrus* seed oil is less dense than water (1 g/cm^3), which is typical for vegetable oils. A lower density indicates that it is a light oil, making it suitable for applications like cosmetics and pharmaceuticals (Bhavsar, 2017). The oil had a moisture content of 0.41%. The low moisture content implies that the oil is less prone to microbial growth and has a longer shelf life. It also indicates proper extraction and drying processes. The specific gravity of the oil was 0.8820. Being close to the density, this value confirms that the oil has characteristics similar to other edible and non-edible oils. It reflects the oil's purity and potential use in formulations like biofuels or cosmetics (Ichu and Nwakanma, 2019). The ash content measured was 0.01%. The minimal ash content suggests a low level of inorganic impurities, indicating high purity and suitability for edible or medicinal applications. Low ash is also favorable for biodiesel production, as it reduces engine deposits. When biodiesel made from this oil which has less ash content is used in the engine, a smaller amount of soot and carbon is generated through combustion and thus soot contamination of engine oil is lesser (Kurre *et al*., 2016).

Table 1: Physical Properties of the *Abrus* seed Oil

Physical properties		
S. No	**Parameter**	**Result**
1	Density	0.88 g/cm^3
2	Moisture content	0.41 %
3	Specific gravity	0.8820
4	Ash	0.01 %

Physiochemical Properties of *Abrus* seed Oil

The physicochemical properties of the extracted *Abrus* seed oil were analyzed and are displayed in Table 2. A free fatty acid content of 2.96% indicates the degree of hydrolysis of triglycerides. The obtained level is moderate which suggests that the oil is relatively fresh and has not undergone significant degradation (Di Pietro *et al*., 2020). The iodine value was found to be 58.3 mg I_2/g. Generally, iodine value measures the degree of unsaturation in the oil. An iodine value of 58.3 suggests the presence of mono- and polyunsaturated fatty acids but leans more towards a saturated profile compared to highly unsaturated oils (Unyime Ebong, 2019). The analysis revealed a peroxide value of 4.2 mEq/kg, an acid value of 5.90 mg KOH/g, a refractive index of 1.4620, a saponification value of 221 mg KOH/g, and a total phenolic content of 1.5 mgGAE/g.

Table 2: Physiochemical Properties of *Abrus* seed oil

Physiochemical properties		
S. No	**Parameter**	**Result**
1	Free fatty acid	2.96 %
2	Iodine value	58.3 mgI_2/g
3	Peroxide value	4.2 mEq/kg
4	Acid value	5.90 mg KOH/g
5	Refractive index	1.4620
6	Saponification value	221 mg KOH/g
7	Total phenolic compounds	1.5 mg GAE/g

Physiochemical properties of *Abrus* seed oil comparison with other oils

The physiochemical properties of *Abrus* seed oil were compared with those of coconut oil, almond oil, groundnut oil, sesame oil and sunflower oil, as shown in the Table 3. The free fatty acid concentration of *Abrus* seed oil (2.96%) exceeded the Codex Alimentarius Commission (1993) permissible threshold of 2.0%. This level was markedly higher than that of coconut oil (2.019%) (Mahmud *et al*., 2019), groundnut oil (1.79%) (Kupwade and Desai, 2019), sesame oil (0.92%) (Sabahelkhier *et al*., 2008), sunflower oil (0.81%) (Konuskan *et al*., 2019), and almond oil, which has the lowest amount (0.26%) (Sarkar *et al*., 2020). The elevated free fatty acid content indicated that *Abrus* seed oil was more susceptible to hydrolytic degradation and exhibited comparatively lower oxidative stability, potentially compromising its edibility and shelf life. Nevertheless, the values remained within the acceptable limits for cosmetic, medicinal, and industrial applications.

The Iodine Value of *Abrus* seed oil (58.3 mgI_2/g) reflected a moderate degree of unsaturation. This value was comparatively lower than that of sunflower oil (100-145 mgI_2/g**),** sesame oil (103-120 mgI_2/g), almond oil (90-109 mgI_2/g), and groundnut oil (85- 99 mgI_2/g) indicating fewer double bonds and, consequently, reduced susceptibility to oxidative rancidity. In contrast, it was markedly higher than that of coconut oil, signifying that *Abrus* seed oil contained a greater proportion of unsaturated fatty acids than coconut oil (7.5-10 mgI_2/g) but fewer than the other edible oils assessed. Thus, *Abrus* seed oil was classified as an intermediate type between highly unsaturated and highly saturated oils (FSSAI, 2022).

The Peroxide Value of *Abrus* seed oil (4.2 mEq/kg), within the acceptable range of 1 to 15 mEq/kg. Values above 15 mEq/kg may indicate oxidation and potential rancidity, which can affect the oil's flavour, aroma, and nutritional value (FSSAI, 2022). The results confirmed that the oil was stable and had not experienced significant oxidative deterioration. Its value was slightly higher than those of sun flower oil (4.19 mEq/kg) (Konuskan et al., 2019), coconut oil (3.989 mEq/kg) (Perera *et al*., 2020), almond oil (3.46 mEq/kg) (Berkkan *et al*., 2022), and sesame oil (2.0 mEq/kg) (Dim, 2013). But lower than that of groundnut oil (8.39 mEq/kg) (Konuskan *et al*., 2019), This indicated that *Abrus* seed oil exhibited moderate oxidative stability, rendering it less susceptible to rancidity than groundnut oil, yet more vulnerable compared to sunflower, coconut, almond, and sesame oils.

The acid value should not exceed 6.0, as higher values may indicate hydrolysis and potential rancidity, affecting the oils flavour, aroma, and nutritional values (FSSAI, 2022). High acid levels can lead to sourness in the oil (Lotfy *et al*., 2015).The *Abrus* seed oil obtained the Acid Value (5.90 mg KOH/g) (milligrams of potassium hydroxide per gram of oil), remained slightly below the recommended upper limit of 6.0 mg KOH/g, suggesting that the oil was acceptable but nearing the threshold for hydrolytic deterioration. In comparison with sesame oil (5.64 mg KOH/g) (Dim, 2013), groundnut oil (2.890 mg KOH/g) (Aluyor *et al*., 2009), almond oil (1.8 mg KOH/g), coconut oil (0.37 mg KOH/g) (Sharma and Jain, 2015), and sun flower oil (0.22 mg KOH/g) (Arleziana, 2013). The elevated acid value implied that *Abrus* seed oil was more vulnerable to oxidative rancidity and sensory deterioration. Nevertheless, since the value remained within the permissible threshold, the oil was considered appropriate for alternative applications, particularly in medicinal, cosmetic, and industrial domains.

The Refractive Index (1.4620) of *Abrus* seed oil indicated that its optical characteristics were closely comparable to those of almond oil (1.4620 - 1.4639) and groundnut oil (1.4620 - 1.4640), reflecting similarities in purity and fatty acid composition. Although marginally lower than the values reported for sesame oil (1.4646 - 1.4665), sunflower oil (1.4640 - 1.4691) and coconut oil (1.4481 - 1.4491), it remained within the standard range for both edible and non-edible plant oils, thereby affirming its consistency and suitability for comparative physicochemical assessment (FSSAI, 2022).

The Saponification Value of *Abrus* seed oil (221 mg KOH/g). This value reflects the average molecular weight of fatty acids present in the oil (Ektakhare and Gupta, 2019). Ideally, the saponification value ranges from 150–250 mg KOH/g. In Comparison with almond oil (186–195 mg KOH/g), groundnut oil (188–196 mg KOH/g), and sunflower oil (188–194 mg KOH/g), *Abrus* seed oil exhibited a higher saponification value, indicative of shorter fatty acid chains, whereas its value was lower than those of sesame oil (288–293 mg KOH/g) and coconut oil (250–280 mg KOH/g) (FSSAI, 2022). Short-chain fatty acids have a higher saponification value due to more carboxylic functional groups per unit mass compared to long-chain fatty acids (Sajjadi *et al*., 2016). Therefore, the saponification value of *Abrus* seed oil indicates that it contains short chain- fatty acid and has a relatively low molecular weight. This positioned *Abrus* seed oil in an intermediate category, reflecting a balanced composition that was suitable for applications in soap-making, cosmetics, and other industrial formulations requiring oils with short- to medium-chain fatty acids (Obeta *et al*., 2014).

The Total phenolic content of *Abrus* seed oil (1.5mg GAE/g) was observed to be moderate relative to other edible oils. Although it contained lower levels of phenolics than groundnut oil (3.09mg GAE/g) and coconut oil (1.8mg GAE/g), it exhibited considerably higher values than sunflower oil (0.49 mg GAE/g), sesame oil (0.33mg GAE/g) (Janu *et al*., 2013), and almond oil (0.137mg GAE/g) (Bouhadi *et al*., 2021). These findings indicated that *Abrus* seed oil served as a comparatively rich source of bioactive phenolic compounds, highlighting its potential antioxidant and nutraceutical significance.

Table 3: Physiochemical properties of *Abrus* seed Oil comparison with other oils

Types of oil	*Abrus* seed Oil	Coconut Oil	Almond Oil	Groundnut Oil	Sesame Oil	Sunflower Oil
Free Fatty Acid	**2.96 %**	2.019 % (Mahmud *et al*., 2019)	0.26 % (Sarkar *et al*., 2020)	1.79 % (Kupwade and Desai, 2019)	0.92 % (Sabahelkhier *et al*., 2008)	0.81 % (Konuskan *et al*., 2019)
Iodine value	**58.3** mgI2/g	7.5 – 10 $mgI_{2/g}$ (FSSAI, 2022)	90-109 $mgI_{2/g}$ (FSSAI, 2022)	85-99 $mgI_{2/g}$ (FSSAI, 2022)	103-120 $mgI_{2/g}$ (FSSAI, 2022)	100-145 $mgI_{2/g}$ (FSSAI, 2022)
Peroxide value	**4.2 mEq/kg**	3.989 mEq/kg (Perera *et al*., 2020)	3.46 mEq/kg (Berkkan *et al*., 2022)	8.39 mEq/kg (Konuskan *et al*., 2019)	2.0 mEq/kg (Dim, 2013)	4.19 mEq/kg (Konuskan *et al*., 2019),
Acid value	**5.90 %**	0.37% (Sharma and Jain, 2015)	1.8 % (Sharma and Jain, 2015)	2.890 % (Aluyor *et al*., 2009)	5.64% (Dim, 2013)	0.22 % (Arleziana, 2013)
Refractive index	**1.4620**	1.4481 - 1.4491 (FSSAI, 2022)	1.4620 - 1.4639 (FSSAI, 2022)	1.4620-1.4640 (FSSAI, 2022)	1.4646-1.4665 (FSSAI, 2022)	1.4640 - 1.4691 (FSSAI, 2022)
Saponification value	**221**	250-280 (FSSAI, 2022)	186 – 195 (FSSAI, 2022)	188 – 196 (FSSAI, 2022)	188 – 193 (FSSAI, 2022)	188 – 194 (FSSAI, 2022)
Total phenolic compounds	**1.5mg GAE/g**	1.8 mg GAE/g((Janu et al., 2013)	0.137 mg GAE/g (Bouhadi *et al*., 2021)	3.09 mg GAE/g (Janu *et al*., 2013)	0.33 mg GAE/g (Janu *et al*., 2013)	0.49mg GAE/g (Janu *et al*., 2013)

Fatty Acid Profile Analysis

The total fatty acid profile is presented in Table 4. In this analysis, the fatty acid profile was identified using a GC-FID instrument, involving the preparation and examination of fatty acids methyl esters. The total fat content in *Abrus* seed oil was found to be 99.43 g/100 g. The fatty acid analysis of the oil revealed that it was predominantly composed of Saturated Fatty Acids (SFA: 46.26 g/100 g) and Monounsaturated Fatty Acids (MUFA: 41.66 g/100 g), with a relatively lower proportion of Polyunsaturated Fatty Acids (PUFA: 9.12 g/100 g) and negligible Trans Fatty Acids (TFA: 0.07 g/100 g). Among the individual fatty acids, oleic acid (C18:1 cis-9, 41.60 g/100 g) was identified as the dominant MUFA, whereas stearic acid (C18:0, 6.28 g/100 g) and palmitic acid (C16:0, 9.66 g/100 g) constituted the

major SFAs. The PUFA fraction was chiefly represented by linoleic acid (C18:2 cis-9, 12, 9.12 g/100 g). This composition suggested that the oil possessed nutritional value, characterized by a favorable MUFA:SFA ratio and a moderate level of PUFA, comparable to oils with established health-promoting properties. The negligible TFA content enhanced its nutritional profile, while the balance between MUFAs and SFAs implied good oxidative stability, as well as potential cardioprotective and nutraceutical relevance.

Table 4: Total fatty acid analysis of *Abrus* seed Oil

Fatty Acid Methyl Esters (FAME)	**Result (g/100g)**
Methyl butyrate (C4:0)	<0.05
Methyl caproate (C6:0)	<0.05
Methyl caprylate (C8:0)	<0.05
Methyl decanoate (C10:0)	<0.05
Methyl undecanoate (C11:0)	<0.05
Methyl dodecanoate (C12:0)	0.23
Methyl tridecanoate (C13:0)	<0.05
Methyl myristate (C14:0)	0.20
Methyl myristoleate (C14:1[cis-9])	<0.05
Methyl pentadecanoate (C15:0)	<0.05
Methyl pentadecenoate (C15:1 [cis-10])	<0.05
Methyl palmitate (C16:0)	9.66
Methyl palmitoleate (C16:1[cis-9])	0.14
Methyl heptadecanoate (C17:0)	<0.05
Methyl heptadecenoate (C17:1 [cis-10])	<0.05
Methyl stearate (C18:0)	6.28
Methyl octadecenoate (C18:1 [trans-9])	<0.05
Methyl oleate (C18:1 [cis-9])	41.60
Methyl linoleaidate (C18:2 [trans-9,12])	<0.05
Methyl linoleate (C18:2 [cis-9,12])	40.12
Methyl arachidate (C20:0)	0.59
Methyl linolenate (C18:3 [cis-6,9,12])	0.16
Methyl eicosenoate (C20:1 [cis-11])	0.31
Methyl linolenate (C18:3 [cis-9,12,15])	<0.05
Methyl heneicosanoate (C21:0)	<0.05
Methyl eicosadienoate (C20:2 [cis-11,14])	0.14
Methyl behenate (C22:0 FAME)	<0.05
Methyl eicosatrienoate (C20:3 [cis-8,11,14])	<0.05
Methyl erucate (C22:1 [cis-13])	<0.05
Methyl eicosatrienoate (C20:3 [cis-11,14,17])	<0.05
Methyl arachidonate (C20:4 [cis-5,8,11,14])	<0.05
Methyl tricosanoate (C23:0)	<0.05
Methyl docosadienoate (C22:2 [cis-13,16])	<0.05
Methyl lignocerate (C24:0)	<0.05
Methyl cis 5,8,11,14,17-eicosapentaenoate (C20:5)	<0.05
Methyl nervonate (C24:1 [cis-15])	<0.05
Methyl docosahexaenoate (cis-4,7,10,13,16,19)	<0.05
Total Fat content in sample (g/100g)	**99.43**

Table 5 indicated that *Abrus* seed oil contains 99.43 g of total fat per 100 g. The oil was rich in unsaturated fatty acids, with Monounsaturated Fatty Acids (MUFA) 42.05 g/100 g and Polyunsaturated Fatty Acids (PUFA) 40.42 g/100 g together constituting the major fraction. In contrast, Saturated Fatty Acids (SFA) 16.96 g/100 g were present in comparatively lower amounts and Trans Fatty Acids (TFA) <0.05 g/100 g were negligible.

Table 5: Total amount of Fat content in *Abrus* seed oil

S. No	Parameters	Results
1	Monounsaturated Fat	42.05 %
2	Polyunsaturated Fat	40.42%
3	Saturated Fat	16.96%
4	Trans fat	<0.05%
Total Fat content in sample (g/100g)		**99.43**

Evaluation of *Abrus* seed oil results

The formulated oil was evaluated for its typical sensorial properties, and the results are presented in Table 6. The oil exhibited a green color, a liquid state with a greasy texture, a pleasant fragrance, and a smooth consistency.

Table 6: Evaluation parameters of *Abrus* seed oil

Parameters	Results
Color	Greenish color
Physical state	Liquid with greasy in nature
Odor	Pleasant
Texture	Smooth

Shelf Life Study

The shelf life study was conducted to evaluate and ensure product quality and customer safety. The extracted *Abrus* seed oil was stored in a glass bottle at room temperature, and its color, odor, appearance, and texture were analyzed. From Table 7 the shelf life study of the *Abrus* seed oil shows that there is no significant change in the product for a period of 60 days.

Table 7: Shelf life study of *Abrus* seed oil

Testing	15 days	30 days	45 days	60 days
Color	No Change	No Change	No Change	No Change
Odor	No Change	No Change	No Change	No Change
Appearance	No Change	No Change	No Change	No Change
Texture	No Change	No Change	No Change	No Change

SEM analysis for Carbon nanoparticles synthesized from *Abrus* seed oil

SEM micrograph with EDX analysis of carbon nanoparticles synthesized from *Abrus* seed oil. Figure.2 (A–G) illustrated the SEM micrographs of carbon nanoparticles (CNPs) synthesized from *Abrus* seed oil. The images revealed predominantly spherical morphology and elemental structures at scales of 500 nm, 1 µm, 2 µm, 5 µm, 10 µm, 20 µm, and 50 µm, captured under various magnifications of 46.0 kx, 22.7 kx, 10.0 kx, 5.01 kx, 2.41 kx, 1000×, and 573×, respectively. The particle sizes were found to range approximately from 1 to 50 µm.

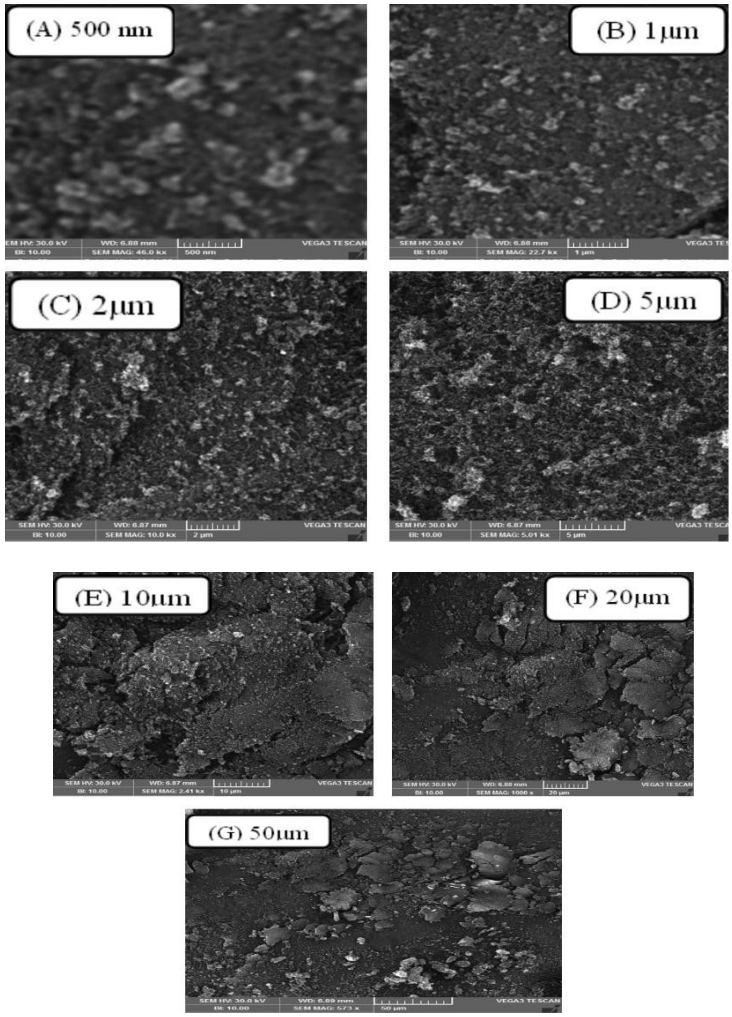

Figure 2: The SEM micrograph of carbon nanoparticles synthesized from *Abrus* seed oil

The greyscale micrograph (Figure.3) was captured at 4150× magnification and an accelerating voltage of 30.0 kV, revealing the surface morphology of the nanoparticles and confirming carbon as the major element.

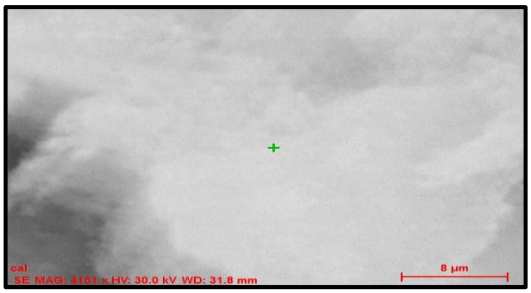

Figure 3: SEM analysis of carbon nanoparticles from *Abrus* seed oil, captured at 4150× magnification and 30.0 kV

EDX Interpretation of Carbon Nanoparticle from *Abrus* seed oil

In this process, an Energy Dispersive X-ray Spectroscopy (EDX) spectrum was employed to determine the elemental composition of the carbon soot. As shown in Figure 4, a pronounced peak observed around 0.2–0.3 keV, corresponded to the carbon (C Kα) peak, confirming carbon as the dominant element. The presence of an oxygen peak near 0.5 keV

indicated possible oxidation or surface functionalization, while the nitrogen peak around 0.4 keV likely stemmed from nitrogen doping or environmental nitrogen adsorption.

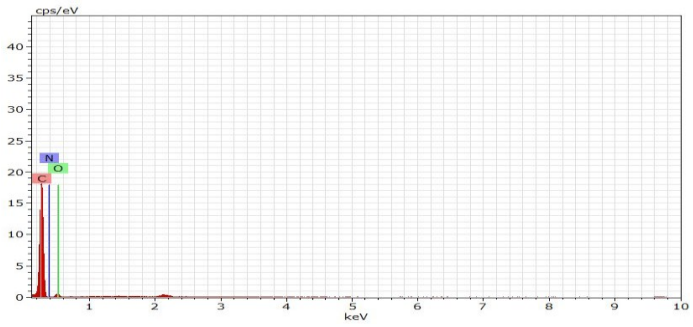

Figure 4: EDX spectrum with prominent peaks for C, N, and O

Table 8: Elemental Composition of Carbon Soot determined by EDX (Weight %)

El	AN	Series	unn. C (wt. %)	Norm. C (wt. %)	Atom. C (at. %)	(1 Sigma) (wt. %)
Carbon	6	K-series	83.23	83.23	86.39	10.34
Oxygen	8	K-series	11.92	11.92	9.28	2.67
Nitrogen	7	K-series	4.86	4.86	4.32	1.94
		Total	**100.00**	**100.00**	**100.00**	

In this interpretation, Table 8 shows the elements Carbon (C), Oxygen (O), and Nitrogen (N) were identified. Carbon was present in high intensity, confirming that the sample mainly consisted of carbon. Oxygen and nitrogen were present in smaller amounts, which could have originated from surface oxidation, atmospheric contamination, or functional groups in the carbon nanoparticles. The sample primarily consisted of carbon (exceeding 83%), accompanied by lesser proportions of oxygen (11.92%) and nitrogen (4.86%). The detected oxygen may have originated from oxidized surface functionalities, such as carboxyl or hydroxyl groups, or as residual oxygen introduced during synthesis. The nitrogen presence could be attributed to solvent remnants, exposure to ambient air, or deliberate nitrogen incorporation during fabrication.

Conclusion

In this study, *Abrus precatorius* seed oil was effectively extracted and characterized, demonstrating promising potential for diverse industrial and therapeutic applications. Comprehensive evaluations including physical, physicochemical, and total fatty acid profiling were performed on the formulated oil. The physical characterization of *Abrus* seed oil showed a density of 0.88 g/cm^3, with a moisture content of 0.41% and a specific gravity of 0.8820. In addition, the ash content was recorded as 0.01%. The physicochemical assessment revealed a free fatty acid content of 2.96%, an iodine value of 58.3 mgI_2/g, and a peroxide value of 4.2 mEq/kg, the acid value was determined to be 5.90 mg KOH/g, while the refractive index measured 1.4620 at 40°C, the saponification value was found to be 221 mg KOH/g, and the total phenolic content was quantified at 1.5 mg GAE/g. The total fatty acid profile and all analytical metrics fell within acceptable ranges, indicating the significant influence of the incorporated components on the final formulation. Additionally, sensorial assessment and shelf-life testing confirmed the product's quality, stability, and practical

usability. The carbon nanoparticles (CNPs) were synthesized from *Abrus* seed oil using a cost-effective and energy efficient combustion method. SEM analysis revealed that the synthesized CNPs had an average particle size of approximately 50 µm, with variations in individual particle dimensions. The EDX results confirmed that the nanoparticles were primarily carbon-based, with trace amounts of oxygen and nitrogen.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions

All authors contributed to the Conceptualization and designing of the study. **R. Kavitha:** Methodology, Data curation, and Writing- Original draft preparation, **J. Merrylin:** Investigation, Supervision, and Validation; **Lighty George:** Reviewing and Editing.