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# Characterization and Evaluation of physicochemical properties, phytochemicals and antimicrobial analysis of coconut oil

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## Abstract

*This study examines the physical and chemical properties, phytochemical makeup, and antibacterial activity of coconut oil, derived from the coconut kernel. The oil's acid value, saponification value, peroxide value, and iodine value were assessed to determine its quality and stability. The density and percentage of free fatty acid were also determined. A phytochemical analysis was conducted to identify bioactive substances like flavonoids and saponin, contributing to its potential for therapeutic use and health benefits. The antibacterial activity of coconut oil was assessed against various pathogenic microorganisms using standard disc diffusion and minimum inhibitory concentration methodologies. The findings demonstrate coconut oil's potential as a functional ingredient in various applications, highlighting its antibacterial characteristics, rich phytochemical profile, and physico-chemical stability. This comprehensive investigation supports the use of coconut oil for improving health and wellbeing.*

**Keywords**: Physicochemical Properties, Phytochemicals, Antimicrobial analysis, Coconut oil

## INTRODUCTION

Humans are blessed with plants, which are essential for maintaining good health. Numerous plants have been utilized for numerous things, such as food, clothing in the past, and medicinal purposes. Certain plants are utilized in medicine because it is thought that they are safer for treating a wide range of conditions. Secondary plant metabolites that have pharmacological properties have been studied recently as potential sources of pharmaceuticals. (Krishnaraju *et al.*,2005). According to the World Health Organization, about 75-80% of the world's population use herbal medicine, mainly in developing countries, for primary health care because of better cultural acceptability, better compatibility with the human body, less expensive, and fewer side-effects (Kamboj 2000; Yadav and Dixit, 2008). Plants are composed of very important bioactive constituents (phytochemicals) e.g. terpenoids, phenolic compounds, steroids, and alkaloids (Hill, 1952). Thus, phytochemicals with adequate antimicrobial effectiveness could be used for the treatment of bacterial infections. (Balandrin *et al.*, 1985). Plants contain abundant oil, known as Triacylglycerides (TAG), which are composed of three fatty acids with chain lengths ranging from C8 to C24. These oils are primarily used as food but are also increasingly used as a sustainable fuel and

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feedstock for industry. The composition of the fatty acids in the oil, such as chain length or functional groups, determines their value and applications. Lauric acid, a medium chain fatty acid (MCFA), is used as a surfactant in soap and detergents. Cooking oils typically have a larger proportion of mono-unsaturated FAs, making them more stable at high temperatures. Other oils, like salad oils, contain more polyunsaturated FAs.

According to the Royal Botanic Gardens, Cocos nucifera is the only species of the genus Cocos and a member of the Arecaceae (palm) family. The term "coconut" refers to the entire coconut palm, the seed, or the fruit; in botanical terms, it is a drupe rather than a nut. The name originates from the Portuguese and Spanish word coco, which means "head" or "skull" in the sixteenth century. The origin of the plant is still being debated after many decades (Grimwood *et al.,* 1975 Perera *et al.,* 2009). It has generally been accepted that the coconut originated in the Indian-Indonesia region and float-distributed itself around the world by riding ocean currents (Dowe 2002).

Maloof (2011), stated a significant portion of the oil present in coconuts has been used in conventional medicine and as a carrier oil in the pharmaceutical sector. Over 70% of saturated, mono-, and polyunsaturated fatty acids are found in coconut oil. The function of saturated fats in nutrition and health is significant. The predominant fatty acid in medium chain triglycerides (MCTs), which make up saturated fats, is lauric acid (C-12), which gives coconut oil its stable, solid white cream hue. There's also capric acid (C-10), caprylic acid (C-8), and caproic acid (C-6). Coconut oil is one of the most contested edible oils in terms of health benefits because of its fatty acids. The MCT's absorbed directly into the bloodstream without any barriers and thus save energy and also control cholesterol levels in the blood (Nevin and Rajamohan, 2007). Also, they may help control body weight and may bring a reduction in the risk of atherosclerosis when coconut oil is taken in moderation (Enig, 2004).

Loki and Rajamohan, 2003 Opined that Coconut oil is a good source of energy, concentrated with saturated fats. It also has traces of micronutrients. Coconut oil contains iron, which is a nutrient that helps with oxygen transportation, It has trace amounts of two vitamins: vitamin E, an antioxidant that protects all cells from harmful free radicals, and vitamin K, which aids in blood clotting. By rupturing their lipid membrane, the MCFAs and their derivatives—such as MGs—found in coconut oil are efficient in eliminating a variety of lipid-coated bacteria. For example, they may be useful in combating germs that cause urinary tract infections, food poisoning, dental cavities, and stomach ulcers. Intravenously administered oil-in-water emulsion compositions have been shielded from the growth of Candida albicans (C. albicans), Pseudomonas aeruginosa (P. aeruginosa), Escherichia coli (E. coli), and Staphylococcus aureus (S. aureus) by the use of monoglycerides, particularly monolaurin. The compositions may consist of whole intravenous nutritional composition or medications comprising lipophilic medicines, like propofol. (Daftary and others, 2008).

The resistance of bacteria, fungi, viruses, and parasites to various agents now in use has alarmingly increased. (Tanwar & associates, 2014). Antibiotic-resistant organisms have accelerated in emergence as a result of the extensive and careless use of antibacterials, posing a major threat to global public health. A renewed search for antimicrobial drugs that are effective against pathogenic bacteria resistant to existing antibacterial agents is necessary due to the resistance problem. Possible approaches to achieving this goal include expanding environmental sampling, using metagenomics to find bioactive compounds produced by as-yet-unknown and uncultured microorganisms, and creating small-molecule libraries tailored to target specific bacteria. Oil extracts of coconut have nutritional and medicinal values and

may be efficacious in combating some of these harmful microorganisms, hence the need to verify this. It is hoped that at the end of the research project, the oil extracts find a wider range of applications as antimicrobial agents that may be incorporated into food and cosmetics.

## METHODOLOGY

### Sample Collection and Preparation

The coconut was bought in Kwara State, North Central Nigeria, from Oja Oba Ilorin. The pericarp was carefully removed to isolate the kernel. After that, the kernels were shredded and air dried for a week.

### Materials

Regular laboratory apparatus available in the Department of Industrial Chemistry, University of Ilorin will be used. Examples include round bottom flask, beaker, rotary evaporator, water bath, etc

### Reagents

All reagents were of analytical grade. Solvents will be distilled before usage. Some of the reagents to be used are NaOH, $H_2SO_4$, $FeCl_3$, etc

### Oil Extraction

Oil was extracted for four to six hours at 50 to 65 degrees Celsius using a Soxhlet extractor with n-hexane as the solvent. The solvent was fully distilled to yield the entire amount of oil from the coconut samples. The oil beaker was submerged in a water bath for two to three hours to eliminate any remaining solvent. For additional analysis, the extracted oils were properly labeled and kept in a cool, dry location.

### Qualitative Analysis of Phytochemicals

#### Test for Flavonoids

A few drops of the oil extract were placed in a test tube and mixed with two milliliters of 10% sodium hydroxide. formation of a yellow tint that vanishes when two milliliters of weak hydrochloric acid are introduced. (Trease, and Evans 2002).

#### Test For Tannins

5 drops of 0.1% ferric chloride solution were added to a few of the oil samples, formation of a brownish-green or blue-black coloration indicated a positive result (Sofowara,1993)

#### Test For Saponins

A few drops of the oil extracts were added to 2ml distilled water. After that, it was shaken for five minutes in a test tube. A 0.1-centimeter layer of foam signifies a successful outcome. (Mbatchou and Kosoono 2012).

#### Test for Alkaloids

A few drops of each oil sample were combined with 2 milliliters of 10% hydrochloric acid. One milliliter of Hager's reagent (saturated picric acid solution) was added to the acidic medium. The production of a yellow precipitate indicated the presence of alkaloids.

**Test for Steroids**
10 ml of concentrated sulphuric acid was added by the side of the test tube to a few drops of each oil dissolved in 10 ml of chloroform. While the sulfuric acid layer turned yellow with green fluorescence, the upper layer turned red. This suggested that steroids were present. (Mbatchou and Kosoono 2012).

**Test for Terpenoids**
To create a layer, a few drops of the oils were combined with two milliliters of chloroform and one milliliter of carefully added strong sulfuric acid. A good outcome is indicated by distinct top and lower layers with a reddish-brown interphase. (Mbatchou and Kosoono 2012).

**Test for Glycosides**
A few drops of each oil sample were mixed with two milliliters of acetic acid. After that, the mixture was placed in a bath of cold water to chill. Add 2 milliliters of pure H2SO4. When the color changes from blue to bluish-green, glycosides are present. (Sofowara, 1993).

**Determination of Alkaloids Content**
A 250 mL beaker was filled with 5 g of the oil sample, 100 mL of 20% acetic acid in ethanol, and the lid was closed. The mixture was let to stand for two hours. After filtering, the extract was reduced to a quarter of its original volume by utilizing a water bath. The extract will be gradually mixed with concentrated ammonium hydroxide until the precipitation is complete. The whole solution is then allowed to settle and the precipitate will be collected by filtration and weighed. (Harborne, 1998).

$$Alkaloid\ (mg/g) = \frac{weight\ of\ residue}{weight\ of\ sample}$$

**Determination of Flavonoids Content**
25 mL of 80% aqueous methanol was combined with 2.5 g of the oil sample. Next, the entire mixture was passed through the Whatman filter paper. After being moved to a crucible, the filtrate was dried out over a water bath and weighed. (Harborne, 1993).

**Determination of Saponins Content**
A conical flask was filled with 5 g of the oil extract and 25 mL of 20% aqueous ethanol. The sample was heated to around 55 0C for an hour while being constantly stirred over a water bath. After transferring the concentrate into a 250 ml separating funnel, 5 mL of diethyl ether was added, and the mixture was violently agitated. The ether layer will be disposed of, and the aqueous layer will be recovered. After that, 2.5 mL of 5% aqueous sodium chloride was added, followed by 15 mL of n-butanol. Heat was applied to the residual solution using a water bath. Following evaporation, the sample was dried in an oven to a consistent weight.

$$Saponins\ (mg/g) = \frac{weight\ of\ residue}{weight\ of\ sample}$$

**Physicochemical analysis**

**Relative density determination**
We cleaned, dried, and weighed a bottle with a specified density (W1). It was weighed after being filled with distilled water (W2). After draining the water, the bottle was dried to its pre-selected weight, filled with the oil sample, and weighed (W3).

$$Relative\ Density = \frac{W3 - W1}{W2 - W1}$$

**Determination of Acid Value/Free Fatty Acid (FFA)**
The acid value is the milligrams (mg) of potassium hydroxide required to neutralize one gram of free acid in the sample. It is given as (mgKOH/g).

Procedure: In a conical flask holding 2g of the oil sample, 25ml of petroleum ether, 25ml of ethanol, and 4 drops of phenolphthalein indicator were combined. After that, the mixture was titrated with aqueous 0.1M KOH and thoroughly agitated to produce a pink color that lasted for 15 seconds. (Kyari *et al.,* 2008). Free Fatty Acid: This value is commonly computed as oleic acid and is also given in milligrams per gram (mgKOH/g).

$$\text{Acid Value}= \frac{56.5\ x\ V\ x\ N}{Weight\ of\ Oil}$$

Where; V= volume of standard alkali used
N= normality of standard alkali used
$FFA= \frac{Acid\ Value}{2}$

**Determination Saponification Value**
This is the amount of potassium hydroxide milligrams needed to neutralize the free fatty acids produced by fully hydrolyzing one gram of the sample. It's expressed as (Mg/g). To make new 0.2M alcoholic KOH, dissolve the KOH pellet in ethanol. After weighing out two grams of oil, it was added to a conical flask. I added 25 milliliters of the alcoholic KOH to it. To obtain the endpoint, 1 milliliter of phenolphthalein was added to the mixture and titrated against 0.5 milliliters of HCl after the sample was well covered and submerged in a steam water bath for 30 minutes, shaking it occasionally. All of the reagents were added for a blank titration, but no oil sample was used (AOAC 1980).

$$\text{Saponification value} = \frac{(B-S)\times 0.5\ \times 56.10}{Weight\ of\ sample}$$

Where: B = blank titre value, S = sample titre value; molecular weight of KOH was taken to be 56.1g/mol, Molarity of HCL.

**Iodine Value**
The preparation of Wij's solution involved dissolving 8.0g of iodine monochloride in 200cm3 of glacial acetic acid. A 1000cm3 standard flask was filled to the brim with glacial acetic acid after 9.0g of iodine crystals were dissolved in 300cm3 of carbon tetrachloride (CCl4). A dry 250cm3 conical flask containing 10g of oil sample was filled with 10cm3 of carbon tetrachloride and 20cm3 of Wij's solution. After that, the flask was sealed and allowed to sit at room temperature for half an hour in a dark cabinet. After that, 100cm3 of distilled water and 15ml of a 10% potassium iodide solution were added. This will then be titrated against 0.2M Sodium thiosulfate solution using starch solution as an indicator. A blank titration was also conducted under the same conditions without the sample (AOAC 1980).

$$\text{Iodine value} = \frac{(A-B)\times N\ \ of\ Na2S2O30.5\ \times 12.69}{Q}$$

Where; A = volume of 0.1 in Na2S2O3.5H2O solution used for the black titration.

B = Volume of 0. l m of Na2S2O3. 5H2O solution was used for the Sample titration.

Q= Weight in grams of the oil sample

12.69 = Conversion factor.

N = Normality

**Peroxide Value**
A precise 2.0g of the oil sample was put into a 250 cm3 flask along with 1g of potassium iodide (KI) powder and a 2:1 solvent mixture of trichloromethane and glacial acetic acid. For full dissolution, the solution will be submerged in water for a few minutes. After adding 20 cm3 of 50% potassium iodide, 0.1 M Na2S2O3 was used to titrate the sample. A standard starch solution served as the indication. Additionally, a blank experiment was run. (AOAC 1980)

$$\text{Peroxide value} = \frac{(R \times B)\ x\ Molarity\ Na2S2O3}{W}$$

Where, R and B stand for oil and blank samples in terms of titre values, respectively.

**Soap Preparation**

**Lye preparation**
The wood ash was gathered from Tanke Ilorin's Ayox Bakery and left to soak for a whole day. The Whatman filter paper was used to filter the ash solution that was produced. Next, evaporation was used to concentrate the filtrate.

**Saponification of the oils**

The cold process does not give instant saponification hence the oil samples were saponified using hot process. 2 ml of each oil sample were heated to boiling in a beaker and 10 ml of prewarmed lye solution was added to the boiling oil with constant stirring (Atolani et al., 2016).

**Soap characterization**
The pH, foaming ability, solubility, and hardness of each soap were measured and compared to the parameters of a commercial soap known as Luxas.

**Determination of pH**
All soaps were measured using a pH meter (Inolab, WTW, Germany, pH 7310). To create a uniform soap solution, 0.1g of each soap was weighed and dissolved in 10 ml of distilled water. After the pH meter's electrode was submerged in the soap solution, all of the readings were noted.

**Solubility determination**
Ten milliliters of distilled water were mixed with 0.1 g of each produced soap. The amount of time it took for the soaps to totally dissolve was noted.

**Hardness determination**
A standard hand-sewing needle (4.2 cm long and 0.5 mm in diameter) was used to pierce the soaps to test their hardness. Using a lever system, a 370g weight was placed into the top of the needle. After 30 seconds, the lever was raised and allowed to gradually penetrate the soap. (Ameh *et al.,* 2013).

**Foaming ability tests**
Ten milliliters of distilled water were mixed with 0.2 grams of each soap. To create foams, the liquids were violently shaken. The cylinders were shaken for two minutes, then left to stand for ten minutes, during which time the height of the foam was measured and noted. (Atolani *et al.,* 2016).

**Total fatty matter (TFM)**

150 ml of distilled water was heated continuously while 10 g of finished soap was weighed and dissolved in it. After boiling the solution, add 20 milliliters of 15% H2SO4 to get a clear solution. After adding 7g of bee wax and heating the mixture, the fatty acids on the surface hardened. The assembly was left to cool and solidify into a cake. After removing the cake, it was blotted dry and weighed using the following formula to determine the total amount of fat:

$$\% TFM = \frac{A-X}{W} \times 100$$

Where:
A = weight of wax + oil
X = weight of wax and
W = weight of soap.

**Total free caustic alkali**

Weighing 5 grams of finished soap, we dissolved it in 30 milliliters of ethanol. Ten milliliters of 20% BaCl2 and a few drops of phenolphthalein indicator were added. Following that, the resultant solution was titrated against 0.05 M H2SO4 (aq). (Onyango et al., 2014).

$$\text{Total free caustic alkali} = 0.31 \times \frac{V}{W}$$

Where:
V = Vol. of acid
W =Weight of soap

**Determination of Total Alkali**

Weighing out 10 grams of soap, 100 milliliters of neutralized alcohol were added. After adding 5 mL of 1 N H2SO4(aq) solution to the mixture, it was heated until the soap sample was completely dissolved. Using phenolphthalein indicator, the test solution was titrated against 1 N NaOH (AOCS, 1997) The following formula was used to get the total alkali:

$$\frac{V_A - V_B}{W} \times 3.1$$

Where: $V_A$ = Volume of acid, $V_B$ = Volume of base, W = Weight of soap.

**Sample preparation for GC/MS**

2 g of each oil will be treated with 0.2M methanolic HCl to undergo trans-esterification. Ten milliliters of pre-made methanolic hydroxide (HCl) will be placed in a round-bottom flask along with two grams of oil. After an hour of reflux, the mixture will be allowed to settle into layers in a separating funnel. The aqueous layer will be rewashed with hexane upon separation before being disposed of. To obtain the fatty acid methyl esters (FAMES), which will be dried over anhydrous magnesium sulfate and kept for GC-MS analysis, the organic phase will also be cleaned with water and then concentrated. The following formula will be used to calculate the trans-esterified oil's yield:

$$\text{Percentage Yield} = \frac{Weight\ of\ trans\text{-}esterified\ oil}{Weight\ of\ lipids}$$

**GC-MS Analysis**

An Agilent Technologies 7890A gas chromatograph GC-FID, fitted with a fused silica capillary column HP-5MS (30 m by 0.32, 0.5 µm films Thickness) on ultra-pure helium gas and connected to a mass selective detector (mass spectrometer), will be utilized to acquire the gas chromatogram. Agilent Technologies operated at an ionization voltage of 70 eV throughout an acquisition mass range, following the experimental parameters reported for GC-FID analysis. Mass spectrometry MS and qualitative analyses will be performed on an MS 5975. By comparing the MS spectra of the product to be obtained with information retrieved from the National Institute of Standards and Technology, the chemical compositions of the product will be recognized.

(NIST, 2008) database. The relative percentages of the constituent compounds will be percentages from the GC peak areas based on the total ion chromatogram (Atolani *et al.,*2015).

**Antimicrobial method of analysis**

In 1940, Agar disk-diffusion testing was developed to evaluate extracts and pure medications as potential antibacterial agents. The process involved preparing oil concentrations of 500 mg/ml and gradually diluting them to create serial concentrations of 250, 125, 62.5, 31.25, and 15.625 mg/ml. A complete organism was inoculated into a sterile nutrient broth for 18-24 hours at 37°C, and then diluted with a 1:100 (10-2) solution of the organism. The diluted solution was then placed into sterile Nutrient Agar and solidified for 45-60 minutes. The number of wells was determined based on the graded concentrations of the sample. The plates were left on the bench for two hours, then incubated at 37°C for 18-24 hours. Surface plate techniques were used for the fungus. A sterile Sabouraud Dextrose Agar was produced, placed into duplicate sterile plates, and applied to the agar's surface. Experimental graded extract concentrations were added to all wells, including controls. The plates were left on the bench for 120 minutes, then incubated at 26-28°C for 48 hours. The zone of inhibition was calculated using a ruler.

**RESULTS AND DISCUSSION**

**Yield of Extract and Percentage Yield**

The fixed oil extracted from *Cocos nucifera* (500 g) was weighed and the yield was calculated. Table 1.0 below displays the results:

**Table 1.0:** Yield of the extracts

| SEED | YIELD | YIELD (%) |
|---|---|---|
| *Cocos nucifera* | 108.93 | 21.79 |

The percentage yield of *cocos nucifera,* oils was found to be 21.79%. The percentage yield of cocos nucifera was similar to the percentage yield reported by Sani et al., (2013). Furthermore, it is rather low in comparison to the 46–50% percentage yield of palm kernel oil reported by O'Brien (2008). For industrial use, the percentage yield of seed oil obtained in this study was too low.

## Physicochemical Characteristics of the Oils

**Table 1.1:** physicochemical characteristics of oils

| Parameter | *Cocos nucifera* |
|---|---|
| **Physical state at room temperature** | Liquid |
| **Colour** | Light golden |
| **Odour** | Nutty |
| **pH** | 4.5 |
| **Acid value (mgKOH/g)** | 19.6±0.3 |
| **Saponification value (mgKOH/g)** | 192.6±5.8 |
| **Peroxide value ($H_2O_2$/kg)** | 3.8±0.02 |
| **Iodine value (Wijj's) g$I_2$/g** | 20.4±0.4 |
| **Density** | 1.04 |
| **% Free fatty Acid** | 9.82 |

Table 1.2 shows the pH of the oils of cocos nucifera was 4.5. The pH of the oil was between 4.5 and 5.6. The pH was slightly acidic while the colour of cocos nucifera is light golden. The acid value controls how quickly lipases and other agents, such as heat and light, break down the glycerides in oil. It is the milligrams of KOH needed to balance one gram of oil's free fatty acid content. An accurate indicator of the percentage of free fatty acids in a specific volume of oil is its acid value. It is an indicator of how unsaturated an oil is (Asuquo et al., 2010). The acid value of the cocos nucifera oil used in this study was 19.64. The quantity of free acids present per gram of the sample is known as the free fatty acid content. The smoke, flash, and fire point of an oil increase with the amount of fatty acid it contains. In Cocos nucifera, the free fatty acid content is 9.82. It is not good for crude oil to have a high percentage of free fatty acids since refining results in significant losses of neutral oil. (2013) Sani et al. High-quality oils have low levels of free fatty acids (AOAC, 1997). When compared to the 4.48 free fatty acid value reported by Bligh and Dyer (2007), the free fatty acid value of cocos nucifera oil was found to be high. With a high saponification value of 192±4.62 mg KOH/g, the oils derived from cocos nucifera may be deemed edible due to their lower molecular weight fatty acid content. Comparing the coconut oil to seed oils of Elaeisguineensis 246.60 mg KOH/g reported by Akububugwo and Ugbogu (2007), AdansoniadigitataLinn 230.01 mg KOH/g (Ibironke, 2010), and Citrus lanatus 189.35 mg KOH/g (Anhwange et al., 2010) revealed that the coconut oil was lower. An oil's ability to dry out or not is determined by its iodine value. An iodine value of more than 130 indicates that the oil is drying, whereas an iodine value between 90 and 130 indicates semi-drying oil. Oil is classified as non-drying if the iodine value is less than 90 (Guner et al., 2006). The iodine value measures the amount of unsaturation in oil, the higher the iodine value the higher the unsaturation the table above, shows that the iodine values of *cocos nucifera* oil to 20.4±0.4 gI2/g. The unsaturation level in oil is measured by the iodine value; the greater the iodine value, the higher the unsaturation The iodine levels of cocos nucifera oil are displayed in the above table at 20.4±0.4 gI2/g. When compared to (Sani et al., 2013), the iodine value was low. Peroxide values are used to quantify oxidative rancidity, which is the addition of oxygen along the double bonds in unsaturated fatty acids when specific chemical substances or enzymes are present. A higher rate of rancidity is correlated with higher peroxide readings. Higher peroxide values in oils are associated with rancidity, and it is well known that highly unsaturated oils absorb more oxygen. (Nzikou *et al.*, 2007). The peroxide value obtained for this research is *cocos nucifera Persea* (3.8±0.02) which indicates that the coconut seed oil has a high chance of becoming rancid.

**Phytochemical Screening of Oil Samples From *Cocos nucifera***

The findings of the qualitative and quantitative phytochemical screening of oil samples from Cocos nucifera are shown in the tables below. In the sample, seven phytochemicals were examined. According to the tables below, the (+) symbol denotes the presence of the phytochemical in the various oil samples, and the (-) sign denotes its absence.

**Table 1.2:** Qualitative evaluation of phytochemicals in oil samples from *Cocos nucifera*

| | *Cocos nucifera* |
|---|---|
| Tannins | _ |
| Saponins | + |
| Terpenoids | _ |
| Glycosides | _ |
| Alkaloids | _ |
| Flavonoids | + |
| Steroids | _ |

**Table 1.3:** Quantitative Evaluation of Phytochemicals in Oil Sample From *Cocos nucifera*

| | *Cocos nucifera* |
|---|---|
| Tanins | _ |
| Saponins | 0.4±0.03 |
| Alkaloids | _ |
| Flavonoids | 0.23±0.08 |

The oil of C. nucifera was found to contain flavonoids and saponins. Alkaloids, flavonoids, and saponins were also reported to be present by Sani et al. (2014). The saponins and flavonoid contents are 0.4±0.03 and 0.23±0.08 respectively. The absence of some phytochemicals for example glycosides may be due to lipid insolubility (Njoku *et al.,* 2010). The presence of flavonoids shows that coconut oil will be good for protection against cardiovascular diseases and also saves as biological antioxidants (Njoku *et al.,* 2010). The flavonoid content also affirms its antioxidant properties as reported by Ramesh *et al.,* (2005). Naturally, coconut oil has high stability due to the presence of these natural antioxidants (Lyon 1972)

**Antimicrobial Activities of Oil Samples from *Cocos nucifera***

The degree of microbial activity of the oils was examined using a variety of bacteria and fungi in this study. Broad-spectrum antibacterial activity is demonstrated against a variety of tested Gram-positive and Gram-negative bacteria and fungi. There have been reports of morbidity and mortality associated with these organisms in mucous membrane infections (Mahmoud, 2001). Antimicrobial properties of oil from cocos nucifera.

**Table 1.4:** Antimicrobial Activities of Oil Samples from *Cocos nucifera*

| | ***Concentration (mg/ml)*** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *500* | *250* | *125* | *62.5* | *31.25* | *16.625* | *Negative Control* | *Positive control* |
| ***Tested organism*** | ***Diameter Zone of Inhibition (mm)*** | | | | | | | |
| ***Bacteria*** | | | | | | | | |
| *Staphylococcus aureus* | 15 | 14 | 12 | - | - | - | - | 40±1 |
| *Bacillus subtilis* | 14 | 12 | 10 | - | - | - | - | 40±1 |
| *Escherichia coli* | 15±1 | 13±1 | 10 | - | - | - | - | 40±1 |
| *Pseudomonas aeruginosa* | 14 | 10 | - | - | - | - | - | 40±1 |
| *Salmonella typhi* | 15±1 | 13±1 | 10 | - | - | - | - | 40±1 |
| *Klebsiella pnemonae* | 15±1 | 13±1 | 10 | - | - | - | - | 40±1 |
| ***Fungi*** | | | | | | | | |
| *Phijoptius stoloniter* | 15±1 | 13±1 | 10 | - | - | - | - | 30±1 |
| *Penicillium notatam* | 15±1 | 14 | - | - | - | - | - | 30±1 |
| *Candida albicans* | 15±1 | 13±1 | - | - | - | - | - | 30±1 |
| *Aspergillium niger* | 15±1 | 13±1 | 10 | - | - | - | - | 30±1 |

As can be seen from table 1.4 above, the examined organisms demonstrated a significant level of antibacterial activity in the oil of cocos nucifera. All studied organisms showed an activity at oil concentrations of 250 and 500 mg/ml. 500 mg/ml concentration; Bacillus subtilis and Salmonella typhi showed reduced sensitivity. In comparison to the higher concentration, fewer activities were observed at 125 mg/ml. This oil recorded an inhibition on *Pseudomonas aeruginosa* and *Penicillium notatam* at concentrations 250 and 500mg/ml alone.

No activity was recorded at lower concentrations 125mg/ml inhibition level increases with increase in concentration.

**Table 1.5**: Fatty acids composition of oil samples from *Cocos nucifera,*

| S/N | Fatty Acids | Saturation | % Composition CC |
|---|---|---|---|
| 1 | Capric acid | C:10:0 | 3.73 |
| 2 | Palmitic acid | C:16:0 | 18.38 |
| 3 | Oleic acid | C:18:1 | 7.91 |
| 4 | Lauric acid | C:12:0 | 60.04 |
| 5 | Palmitoleic acid | C:16:1 | 4.02 |
| 6 | Petroselinic acid | C:18:1 | 2.14 |
| 7 | Linoleic acid | C:18:2 | _ |
| 8 | Stearic acid | C:18:0 | _ |
| 9 | Linolenic acid | C:18:3 | _ |
| 10 | Myristic acid | C:14 | 3.2 |
| 11 | Hypogeic acid | C:16:1 | 0.58 |
| 12 | Tridecylic acid | C:13 | _ |
| 13 | Valeric acid | C:5 | _ |
| | | Total saturate Total | =85.35% |
| | | unsaturated Total | = 14.65% |
| | | monounsaturated | =14.65% |
| | | Total polyunsaturated | = - |

Table 1.5 abov shows that Palmitic (C16:0) and Oleic (C18:1n9) acids was present in the oil, while palmitoleic acid (C16:1) was present in noticeable percentage in cocos nucifera oil; (4.20% ). As shown in table above, Lauric acid (12:0) was the most abundant fatty acid (60.04%) in *Cocos nucifera* oil followed by palmitic acid and oleic acid with 18.38% and 7.91% respectively. Also, fatty acids such as capric acid (3.73%), myristic acid (3.2%), petroselinic acid (2.14%) and hypogeic acid (0.58%) were present. *Cocos nucifera* oil contains 85.35% of saturated and 14.65% unsaturated fatty acids. Gregorio (2005) and Gopala *et al.,* (2010) also reported that lauric acid was the predominant fatty acid in cocos nucifera. Eqbla et al., (2011), reported the presence of oleic (7.211%), capric (5.071%), myristic (20.572%), and palmitic (9.16%) fatty acids. In the food and cosmetic industries, lauric acid, a medium chain fatty acid (MCFA), and its derivatives work well as antibacterial agents. Ahita and colleagues (2013). Research by Hristov et al. (2009) demonstrated that the combined use of coconut oil and free lauric acid has more antibacterial effects than either substance applied alone. Lauric acid is also essential for stopping the growth of microorganisms, including Gram-negative (E. coli) and Gram-positive (Staphylococcus aureus).

## CONCLUSION

Results obtained from the analyses carried out on the oils extracted from coconut oil have shown that the oils have antimicrobial properties, and contain some phytochemicals. The phytochemicals present were reported to be bioactive. Phytochemicals present in this plant include tannins, saponins, alkaloids, and flavonoids, Studies have shown that these phytochemicals have physiological and therapeutic qualities that can be used to prevent and treat illnesses and ailments. Studies done on the oil reveal that it has a certain quantity of fatty acids. Coconut oil's saturated and unsaturated fatty acids help strengthen bones, boost the immune system, and nourish the liver. The study's findings verify that coconut oil contains a sizable amount of oil. The pharmaceutical and cosmetic sectors may use the oils extensively.

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