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Phytochemical analyses of extracts of the *Peltophorum pterocarpum* root bark and their anti-tyrosinase activities

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ABSTRACT

Background: Hyperpigmentation and other melanin-related disorders have driven interest in natural tyrosinase inhibitors. *Peltophorum pterocarpum*, a medicinal plant traditionally used for various ailments, presents potential for dermatological applications. However, scientific studies validating its anti-tyrosinase activity remain limited. **Objective:** This study aimed to investigate the phytochemical constituents of the chloroform extract of *Peltophorum pterocarpum* root bark and evaluate its anti-tyrosinase potential, thereby supporting its ethnopharmacological relevance. **Materials and Methods:** A total of 800 g of *Peltophorum pterocarpum* root bark was collected, defatted with n-hexane, and extracted using methanol. The methanol extract was partitioned with chloroform and water. The chloroform extract was subjected to phytochemical screening and analyzed using Gas Chromatography-Mass Spectrometry (GC-MS). The anti-tyrosinase activity was evaluated in vitro using the dopachrome method, with L-DOPA as the substrate and kojic acid as a standard reference inhibitor. **Results:** Preliminary phytochemical analysis revealed the presence of flavonoids, alkaloids, tannins, cardiac glycosides, and saponins in both chloroform and aqueous extracts. GC-MS profiling of the chloroform extract identified thirty-three (33) bioactive compounds, comprising 98.88% of the total extract. Major constituents included n-hexadecanoic acid (17.13%), 2-methoxy-4-vinylphenol (11.20%), phytol (5.65%), and various methyl esters of fatty acids. The chloroform extract exhibited significant anti-tyrosinase activity with an IC_{50} value of 2.35 ± 1.07 µg/mL, which was closely comparable to kojic acid (IC_{50} = 2.84 ± 0.38 µg/mL) and more potent than the aqueous extract (IC_{50} = 3.52 ± 1.19 µg/mL). **Conclusion:** The chloroform extract of *Peltophorum pterocarpum* root bark contains a rich profile of phytochemicals with strong tyrosinase inhibitory activity. These findings support its potential application in managing hyperpigmentation and related skin conditions. The results also provide a scientific basis for the traditional use of this plant in dermatological therapy and natural cosmetic formulation.

Keywords: *P. pterocarpum* (PP), Tyrosinase, Hyperpigmentation, Ethnopharmacological, Anti-tyrosinase.

INTRODUCTION

The usage of natural compounds derived from herbal plants has gained more attention in recent years due to their comparatively low side effects in modern medical and cosmetic products. Medicinal plants are known to be the main source of drug therapy in traditional medicine. It is an alternative to Western medicine and is strongly linked to religious beliefs and practices of indigenous cultures [1]. According to estimates from the World Health Organization (WHO), 80% of people worldwide use complementary and alternative medicine (CAM), sometimes known as traditional medicine, which covers all types of therapy that are unique to diverse cultures. Modern biomedicine and traditional medicine are frequently contrasted. In Nigeria and other regions of West Africa, herbal treatments and spiritual healing are very common [2]. Reported uses for traditional medicine (TM) include cancer [3], diabetes [4], HIV [5], and hypertension [6], among others. Parents often treat their children with traditional medicine, with documented applications for epilepsy, asthma, and sickle cell illness [7]. India is blessed with thousands of Ayurvedic and home formulas to cure numerous ailments, including anxiety, depression, arthritis, high blood pressure, hormone imbalances, insomnia, migraines, skin problems, and other disorders [8].

The therapeutic property of a plant depends upon the physiologically active biochemical molecules termed secondary metabolites. Plants have an almost endless ability to generate secondary metabolites present in the plant parts like leaves, fruits, buds, stem, flowers, bark, roots, etc. [9]. Additionally, most Asian and African cultures are following the contemporary trend of wanting white skin and healthiness in an attempt to appear younger than their true age. Melanin, a natural pigment created by the tyrosinase enzyme catalyst, is what gives human skin its color.

Tyrosinase, (also known as polyphenol oxidase) is a copper-containing oxidation enzyme, which is responsible for the formation of melanin. This enzyme is broadly distributed in microorganisms, animals

and plants, and plays a vital part in unwanted browning of fruits and vegetables, antibiotic resistance, skin pigment synthesis, sclerotization of cuticle, neurodegeneration, etc. Therefore, it has been recognized as a therapeutic target for the development of insecticides, skin-whitening therapies, antimicrobial products, anti-browning products, and other therapeutic substances. Many synthetic tyrosinase inhibitors have been widely reported in recent years, with substantial potential for usage in the food, agricultural, cosmetic, and pharmaceutical industries [10]. Natural tyrosinase inhibitors identified in herbal plants show promise as therapeutic treatments for skincare and cosmetics [11]. Tyrosinase is a copper-containing enzyme successfully utilized as an inhibitor for the treatment of melanogenesis [12]. Since tyrosinases reduce melanogenesis, they have been explored as cosmetic agents. Most commercially available skin-lightening solutions are based on tyrosinase inhibitors, and some potential tyrosinase inhibitors have been employed for pharmacological, cosmeceutical, or agricultural applications [13,14].

Peltophorum pterocarpum (*P. pterocarpum)*, referred to as the copper-pod, yellow flame tree, yellow-flamboyant, yellow poinciana, or golden flamboyant, is a tropical plant of the *Fabaceae* family. Native to tropical Africa and Southeast Asia, it is commonly cultivated across tropical and subtropical regions of the world as an ornamental tree due to its vivid yellow blossoms and adaptability. In addition to its aesthetic value, *P. pterocarpum* has long been utilized in traditional medicine for the treatment of numerous diseases, including skin disorders, infections, and inflammatory disorder [15]. Bioassay tests have demonstrated that *P. pterocarpum* exhibits considerable antioxidant, anti-inflammatory, antibacterial, and wound healing activity, adding scientific backing to its traditional therapeutic usage [16–19].

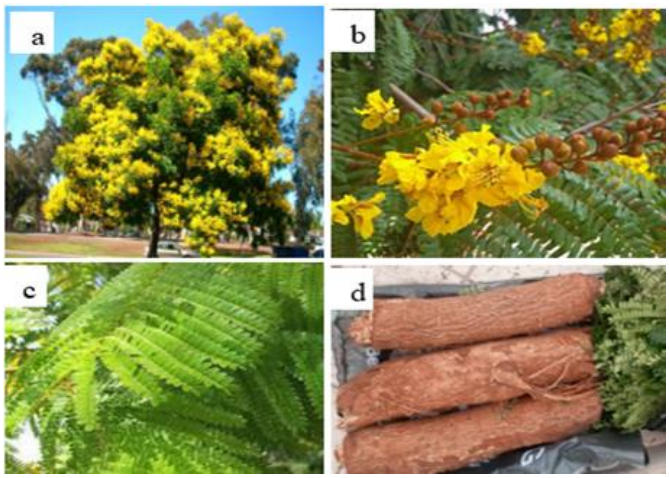


Plate 1: (a) The whole tree **(b)** Flower and bud **(c)** Leaves **(d)** The root bark of *P. pterocarpum*

According to Jaiwal *et al* [20], *P. pterocarpum* is distributed in the tropical region of the world. Different parts of this tree are used to cure several disorders like stomatitis, insomnia, skin issues, constipation, ringworm and its flower extract is recognized to be a good sleep inducer and utilized in insomnia treatment [21–24].

MATERIALS AND METHODS

Collection of the Plant

The fresh root bark of *P. pterocarpum* was collected from Ega-Abada Forest, Kogi State, Nigeria, on 10th June, 2024. GPR; Latitude 7.8023° N, and 6.7333° E" and was taken to the Herbarium unit of the Department of Botany, Federal University Lokoja, for identification and authentication by the Taxonomist (Mr. Akanni Gbenga Theophilus), on 19th July, 2024. A voucher specimen of the plant was kept in the department's herbarium for future reference.

Preparation of Plant Extracts

The root bark of *P. pterocarpum* was washed thoroughly under running tap water to remove surface contaminants. It was then chopped into small pieces and air-dried at room temperature for three weeks to reduce moisture content. The dried root bark was pulverized using a wooden mortar and pestle to obtain a coarse powder. Eight hundred (800 g) of the pulverized sample was poured into an aspirator glass bottle (10L), defatted with n-hexane by cold maceration, it was allowed to extract for five (5) days at room temperature with occasional shaking. After five days the extract was filtered using No. 1 Whatman filter paper. The defatted root bark was then extracted with 80% methanol at room temperature and evaporated to dryness. The aqueous methanol extract was dissolved in water and partitioned with chloroform to obtain chloroform and aqueous extracts. The phytochemical composition of the chloroform extract was analyzed using GCMS and its anti-tyrosinase activity was also investigated.

Preliminary Phytochemical Analysis

Phytochemical analysis of the root bark of *P. pterocarpum* aqueous and chloroform extracts, were carried out for the detection of the presence of secondary metabolites such as flavonoids, alkaloids, cardiac glycosides, terpenoids, tannins, steroids, carbohydrates, saponins, phlobatannins, phytosterols and resins by adopting standard procedures [25][26–31].

Gas Chromatography-Mass Spectrometry Analysis

GC-MS is a distinctive analytical technique employed for the identification and quantification of analytes that are volatile, thermally labile, and capable of enduring the rigorous partitioning conditions of the gas chromatograph [32]. This technique displays a representative spectral output of all identifiable substances from the empirical sample. The gas chromatography apparatus features an injection port through which the process commences by introducing the sample into the port. Subsequently, evaporation and sequential separation of the components occur, culminating in the equipment's identification of the constituents within the respective sample. A distinct spectral peak is generated for each component, which is electronically recorded on a paper chart.

The chloroform root bark extract of *P. pterocarpum* was evaluated for the various compounds therein, using gas chromatography-mass spectrometry (GC-MS). The analysis was conducted utilizing an Agilent Technologies 7890A GC system paired with a 5975C Inert Mass Selective Detector (MSD) equipped with a triple-axis detector and an auto-injector (10 µL syringe). Chromatographic separation was performed on an Agilent HP-5MS capillary column (30 m × 250 µm × 0.25 µm) covered with 5% phenyl methyl siloxane. The injection volume was 1.0 µL, performed in split mode with a split ratio of 1:50 at an injection temperature of 280°C. High-purity helium was used as the carrier gas. The column temperature program began at 50°C, held for 2 minutes, then ramped to 100°C at a rate of 20°C/min, and further rose to 250°C at the same rate, where it was held for 5 minutes. The overall run time was 19 minutes. The ion source temperature was set to 250°C, the interface temperature to 300°C, and the pressure to 16.2 psia. The mass spectrometer operated in the range of 50–500 m/z.

The GC-MS system was operated using MS Solution software provided by the instrument vendor, and data gathering was performed appropriately. Compound identification was based on a comparison of mass spectra with those in the NIST Mass Spectral Library (NIST II). This extensive investigation enabled the identification of bioactive elements in *P. pterocarpum*, offering vital information for possible pharmaceutical applications.

Anti-tyrosinase Assay:

The anti-tyrosinase activity of the extracts was evaluated using L-dopa as a substrate and kojic acid as a standard according to the

modified method [33]. 0.3 mL of tyrosinase enzyme (50 mg/mL) was pre-incubated with various doses of the standard inhibitor kojic acid and the extract (0.5 mL) in 50 mM phosphate buffer, pH 6.8, for 5 minutes at 37°C. L-Dopa (25 mM, 0.30 mL) was added to the reaction mixture and incubated at 37°C for 10 min. The enzyme reaction was tested for the production of DOPA-chromium by measuring the absorbance at 475 nm. The percent inhibition of tyrosinase activity was estimated using the percent inhibition equation.

$$\% \text{ inhibition} = \frac{\text{A475 nm control} - \text{A475 nm sample}}{\text{A475 nm control}} x\ 100$$

The A 475 nm control is the absorbance of the control solution without kojic acid (or extract) and A 475 nm sample is the absorbance of the solution with kojic acid (or extract). The degree of inhibition was expressed as a percentage of the concentration required to achieve 50% inhibition (IC_{50}).

Statistical Analysis

The entire qualitative test was performed in triplicate. The anti-tyrosinase assay results were analyzed with GraphPad Prism (version 10.2.0). Results were reported as mean ± standard deviation (SD) from triplicate experiments. Nonlinear regression was utilized to calculate IC_{50} values by comparing percentage inhibition to concentration. A paired Student's t-test was used to compare two groups, but for multiple group comparisons, a One-way ANOVA (analysis of variance) followed by Dunnett's post hoc test was utilized. The significance level was chosen at $p < 0.05$.

RESULTS

Results of Phytochemical Analysis of Chloroform and Aqueous Extracts

The therapeutic efficacy of medicinal plants is attributed to specific chemical compounds that exert a distinct physiological effect on the human body [34]. In this study, qualitative phytochemical screening of the aqueous and chloroform extracts of the root bark of *P. pterocarpum* revealed a variety of biologically active chemicals. The chloroform extract indicated the presence of flavonoids, cardiac glycosides, tannins, saponins, alkaloids, carbohydrates, and glycosides, while the aqueous extract included terpenoids, phlobatannins, and resins. Steroids and phytosterols are absent in both extracts (Table 1).

Given their well-known antioxidant, anti-inflammatory, and antibacterial properties, flavonoids and tannins are prominently present in both extracts. Strong free radical scavengers, flavonoids reduce oxidative stress and change signaling pathways linked to the progression of cancer [35,36]. Tannins, notably phlobatannins discovered in the aqueous extract, also demonstrate antibacterial and anti-cancer properties by destroying microbial cell walls and interfering with tumor growth signals [34].

Saponins are renowned for their anti-inflammatory, immune-stimulating, and cytotoxic characteristics [37]. They improve vascular permeability, regulate the immunological response, and have showed potential in preventing tumor development by apoptosis induction [38]. The identification of alkaloids provides another dimension of pharmacological interest. Alkaloids offer a wide spectrum of bioactivities including analgesic, antibacterial, and anticancer properties, frequently functioning by interacting with nucleic acids or blocking important enzymes in infections [39]. The presence of cardiac glycosides in the chloroform extract suggests possible cardiovascular and anticancer advantages. While traditionally employed in the treatment of heart failure, cardiac glycosides have recently received attention for their capacity to cause apoptosis in cancer cells by blockage of the Na^+/K^+-ATPase pump.

Terpenoids and resins, identified in the aqueous extract, are lipophilic chemicals linked with broad-spectrum pharmacological effects. Terpenoids demonstrate powerful antioxidant, antibacterial, and anti-inflammatory properties by regulating redox-sensitive transcription factors. Resins, frequently rich in terpenoids possess antibacterial and wound-healing qualities and contribute to the plant's defense against diseases. From Table 1, the chloroform extract displayed a more diversified collection of secondary metabolites, which correlates with its increased reported pharmacological activity. This validates previous findings that non-polar solvents such as chloroform often extract more bioactive chemicals, including alkaloids, flavonoids, and cardiac glycosides, which have better therapeutic benefits. [40]. The variety of phytochemicals in the root bark of *P. pterocarpum* shows its potential for further development into pharmacological compounds with antioxidant, antibacterial, anti-inflammatory, and cytotoxic uses [41].

GC-MS Analysis of the Plant Extract:

The analytical GC-MS technique was utilized for the identification and quantification of the constituents contained in the plant sample. The analysis indicated the presence of a total thirty-three (33) compounds from the chloroform extract of the root bark. The chemical formulas, retention times, peak areas and class of the compounds are provided in Table 2. The peaks of the compounds are shown in Figure 1.

Among the numerous compounds detected, the major components were identified as n-hexadecanoic acid (17.13%), 2-Methoxy-4-vinylphe-nol (11.20%), Eugenol (8.87%), Hexacosane (8.05%), Pentadecanoic acid, 14-methyl-, methyl ester (8.56%), Neophytadiene (6.11%), 9-Octadecenoic acid (Z)-, methyl ester (6.38%), Phytol (5.65%), 9-Octadecenoic acid (E)- (4.21%), and Oleic acid (3.29%).

The major compounds identified in this study have some important biological potential that could be useful for making new drugs in the future. This study found a lot of bioactive chemicals, however n-hexadecanoic acid was the most common. Among the bioactive chemicals found in this research, n-hexadecanoic acid, the most prevalent compound, has been reported to possess antimicrobial, antioxidant [42] and larvicidal activities [43]. 2-methoxy-4-vinylphenol, a phytoconstituent with antioxidant, antimicrobial, anti-inflammatory properties in *Cassia angustifolia* [44]. The compound, eugenol, has several biological properties like antioxidant, antimicrobial[45] anti-proliferative and anti-inflammatory activities [46]. Docosa-2,6,10, 14,18-pentaen-22-al, this compound also have anti-oxidant [47]. Hexacosane had previously been reported to possess antimicrobial activity [48].

Comparative Tyrosinase Inhibitory Activity of Aqueous and Chloroform Extracts of *P. pterocarpum* Root Bark

The tyrosinase inhibition assay of the *P. pterocarpum* root bark extracts (aqueous and chloroform extracts) exhibited considerable activity in a dose-dependent manner as shown in Table 4, the chloroform extract exhibited a greater inhibition across all concentrations when compared to the aqueous extract, with the greatest inhibition at 500 µg/mL being 87.15 ± 0.07%, which is close to the standard kojic acid (88.45 ± 0.74%). The aqueous extract demonstrated a maximal inhibition of 81.89 ± 1.41% at the same concentration (Figure 2a).

Importantly, the IC_{50} values indicate the efficacy of these extracts. The chloroform extract had an IC_{50} of 2.35 ± 1.07 µg/mL, which is comparable to that of kojic acid (2.84 ± 0.38 µg/mL), but the aqueous extract had a slightly higher IC_{50} of 3.52 ± 1.19 µg/mL, showing a lower inhibitory efficiency compared to the chloroform extract and kojic acid (Figure 2b). The enhanced tyrosinase inhibition in the chloroform extract can be attributed to the presence of phytochemicals such as flavonoids, tannins, alkaloids, and cardiac glycosides (as previously observed in the qualitative phytochemical screening),

which are known to possess significant enzyme inhibitory and antioxidant properties [49,50]. Tyrosinase inhibitors from plant sources, particularly those rich in phenolics and alkaloids, have been thoroughly researched for their depigmenting and antioxidant properties [51]. Furthermore, the significant association of the chloroform extract with kojic acid highlights the potential of *P. pterocarpum* as a natural alternative for cosmetic and therapeutic applications targeting hyperpigmentation and oxidative skin problems. These findings are in consonance with previous researches that have highlighted the usefulness of solvents (such as chloroform or ethyl acetate) in extracting more active secondary metabolites with enzyme inhibitory effects[52,53].

Table 1: Qualitative phytochemical composition of *P. pterocarpum* root bark of aqueous and chloroform Extract

S. No.	Phytochemicals constitutions	Test/ Reagents	Aqueous extract	Chloroform extract
1	Flavonoids	Shinoda's test	-ve	+ve
2	Terpenoids	Noller's Test	+ve	+ve
3	Cardiac glycosides	Keller-Killani test	-ve	+ve
4	Tannins	Braymer's test	-ve	+ve
5	Steroids	Acetic acid + chloroform + Conc. H_2SO_4	-ve	-ve
6	Saponins	Foam test	-ve	+ve
7	Phlobatanins	HCl test	+ve	+ve
8	Phytosterols	Salkowski's test	-ve	-ve
9	Alkaloids	Wagner's test, Dragendorff's test	-ve	+ve
10	Carbohydrates	Molisch's test	-ve	+ve
11	Glycosides	Molisch's test	-ve	+ve
12	Resin	Acetic anhydride test	+ve	+ve

Table 2: GC-MS analysis of the chloroform extract of the root bark of plant *P. pterocarpum*

Sample No.	Retention Time	Name of the Compounds	Molecular Formula	Molecular Weight	Class of compound	Peak Area (%)
PH-1	4.86	Benzoic acid, methyl ester	$C_8H_8O_2$	136.15	Ester	1.61
PH-2	5.59	Benzoic acid	$C_7H_6O_2$	122.12	Acid	0.38
PH-3	6.06	Methyl valerate	$C_6H_{12}O_2$	116.16	Fatty acid ester	1.46
PH-4	8.35	Isopulegol	$C_{10}H_{18}O$	154.25	Alcohol	0.34
PH-5	9.10	Hexacosane	$C_{26}H_{54}$	366.7	Alkane	8.05
PH-6	9.27	Docosa-2,6,10,14,18-pentaen-22-al, 2,6,10,15,18-pentamethyl-, all-trans	$C_{27}H_{44}O$	384.6	Terpenoids	0.53
PH-7	9.36	Procaine	$C_{13}H_{20}N_2O_2$	236.31	unknown	2.48
PH-8	9.55	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	150.17	Phenol	11.20
PH-9	9.60	Eugenol	$C_{10}H_{12}O_2$	164.20	Terpenoids	8.87
PH-10	10.48	Dodecanoic acid	$C_{12}H_{24}O_2$	200.32	Fatty acid	1.13
PH-11	11.06	Myo-Inositol, 4-C-methyl	$C_7H_{14}O_6$	194.18	Sugar alcohol	0.60
PH-12	12.04	Tetradecanoic acid	$C_{14}H_{28}O_2$	228.37	Saturated fatty acid	0.37
PH-13	12.21	Cyclohexanemethanol, 5-t-butyl-2..	$C_{11}H_{22}O$	170.29	Alcohol	0.41
PH-14	12.75	Neophytadiene	$C_{20}H_{38}$	278.52	Terpene	6.11
PH-15	12.79	Carbonic acid, octadecyl prop-1-en-2-yl ester	$C_{22}H_{42}O_3$	354.57	Fatty acid	0.63
PH-16	12.96	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	296.53	Terpenoid alcohol	0.62
PH-17	13.12	3-Eicosyne	$C_{20}H_{38}$	278.52	Alkyne	0.86
PH-18	13.50	Pentadecanoic acid, 14-methyl, methyl ester	$C_{17}H_{34}O_2$	270.45	Alkyne	8.56
PH-19	13.59	Methyl cyclohexanepropionate	$C_{10}H_{18}O_2$	170.25	Ester	2.26
PH-20	13.79	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256.42	Saturated fatty acid	17.13
PH-21	14.07	Methyl valerate	$C_6H_{12}O_2$	116.16	Fatty acid ester	2.36
PH-22	14.86	9,12-Octadecadienoic acid (Z,Z)-...	$C_{18}H_{32}O_2$	280.45	Fatty acid	2.06
PH-23	14.92	9-Octadecenoic acid (Z)-, methyl ester	$C_{19}H_{36}O_2$	296.49	Fatty acid ester	6.38
PH-24	14.99	Phytol	$C_{20}H_{40}O$	296.53	Alcohol	5.65

PH-25	15.11	Heptadecanoic acid, 16-methyl-, methyl ester	$C_{19}H_{38}O_2$	298.50	Fatty acid ester	1.54
PH-26	15.15	Linoelaidic acid	$C_{18}H_{32}O_2$	280.45	Fatty acid	1.40
PH-27	15.20	9-Octadecenoic acid, (E)-	$C_{18}H_{34}O_2$	282.46	Fatty acid	4.21
PH-28	15.24	Oleic Acid	$C_{18}H_{34}O_2$	282.46	Fatty acid	3.29
PH-29	15.37	Octadecanoic acid	$C_{18}H_{36}O_2$	284.48	Saturated fatty acid	1.29
PH-30	15.55	4,2,7-Ethanylylidenecyclopenta[b]pyran-9-one, 2,3,4,4a,7,7a-hexahydro-7a-methyl	$C_{10}H_{10}O_2$	162.19	Terpenoid	0.38
PH-31	16.54	12-Hydroxydodecanoic acid	$C_{12}H_{24}O_3$	216.32	Fatty acid	0.38
PH-32	16.87	Methyltrans-9-(2-butylcyclopentyl)nonanoate	$C_{19}H_{36}O_2$	296.49	Fatty acid ester	0.34
PH-33	19.96	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{19}H_{38}O_4$	330.50	Fatty acid ester	1.06

Table 3: Structure of the major components identified from the chloroform extract of the root bark of *P. pterocarpum*

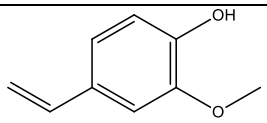
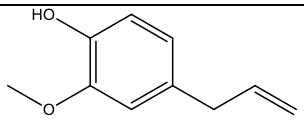
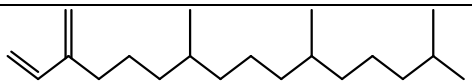
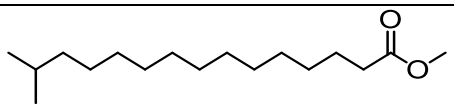
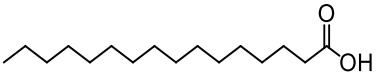
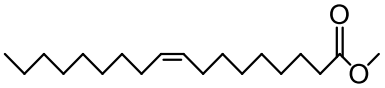
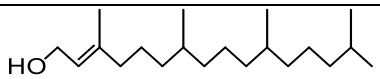
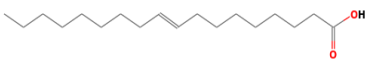
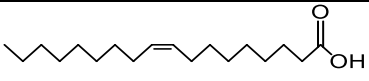
Name & Sample no. of the compounds	Chemical Structure
1-Pentanamine, N-methyl-N-(1-methylethyl) (PH-5)	
2-Methoxy-4-vinylphenol (PH-8)	
Eugenol (PH-9)	
Neophytadiene (PH-14)	
Pentadecanoic acid, 14-methyl-, methyl ester (PH-18)	
n-Hexadecanoic acid (PH-20)	
9-Octadecenoic acid (Z)-, methyl ester (PH-23)	
Phytol (PH-24)	
9-Octadecenoic acid (E)- (PH-27)	
Oleic acid (PH-28)	

Table 4: Tyrosinase inhibition and IC_{50} analysis of the aqueous and chloroform extract and the standard

Percentage (%) Inhibition			
Concentration (µg/mL)	**Aqueous extract**	**Chloroform extract**	**Kojic Acid**
100	64.66±0.32	69.32±0.07	64.38±0.69
200	67.52±0.46	71.70±0.85	68.93±0.23
300	71.39±0.85	75.89±1.02	72.82±0.69
400	78.79±1.27	85.68±1.80	86.23±0.46
500	81.89±1.41	87.15±0.07	88.45±0.74
IC_{50}	**3.52±1.19**	**2.35±1.07**	**2.84±0.38**

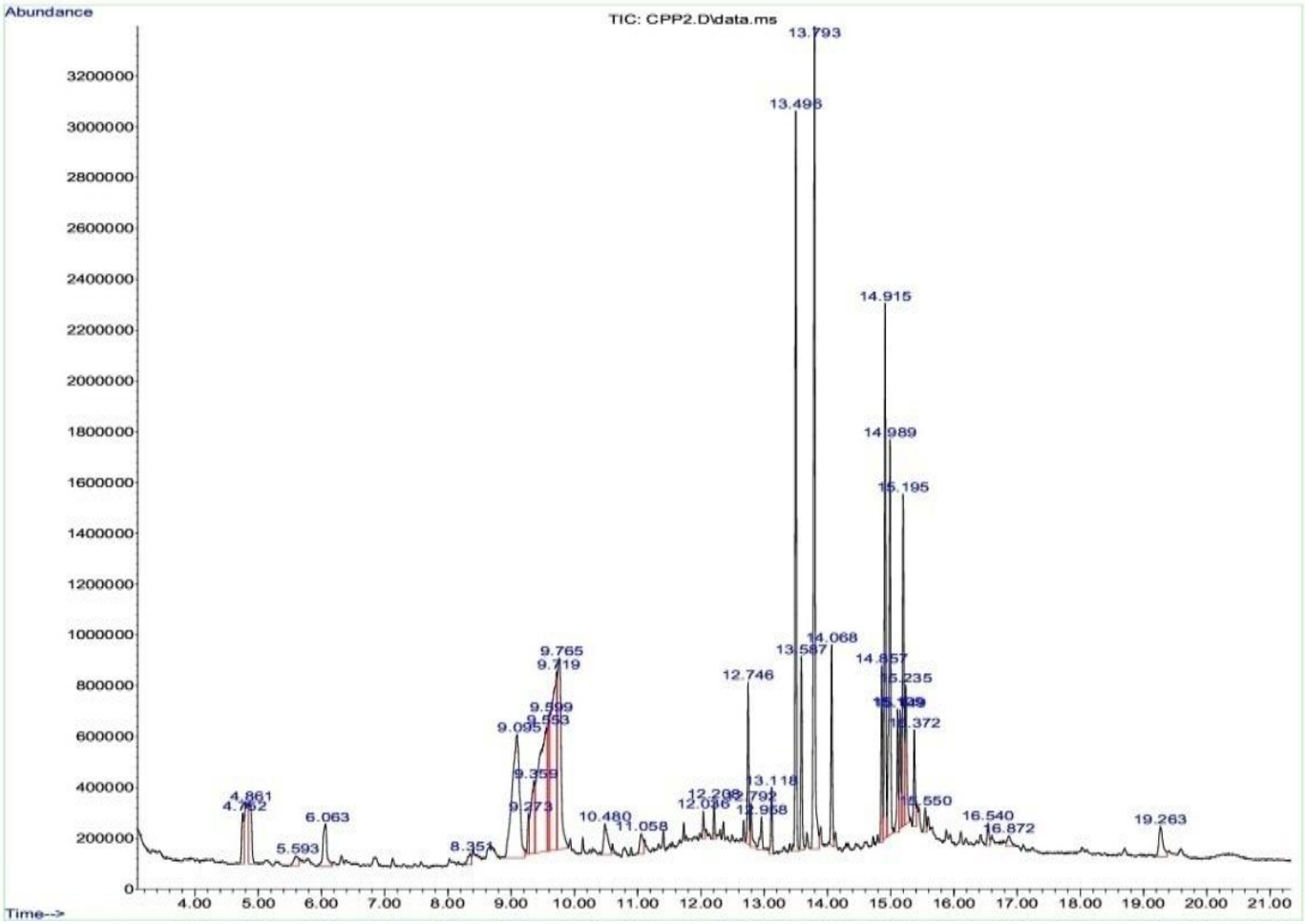


Figure 1: Total Ion Chromatogram (TIC) of the chloroform extract (GC-MS)

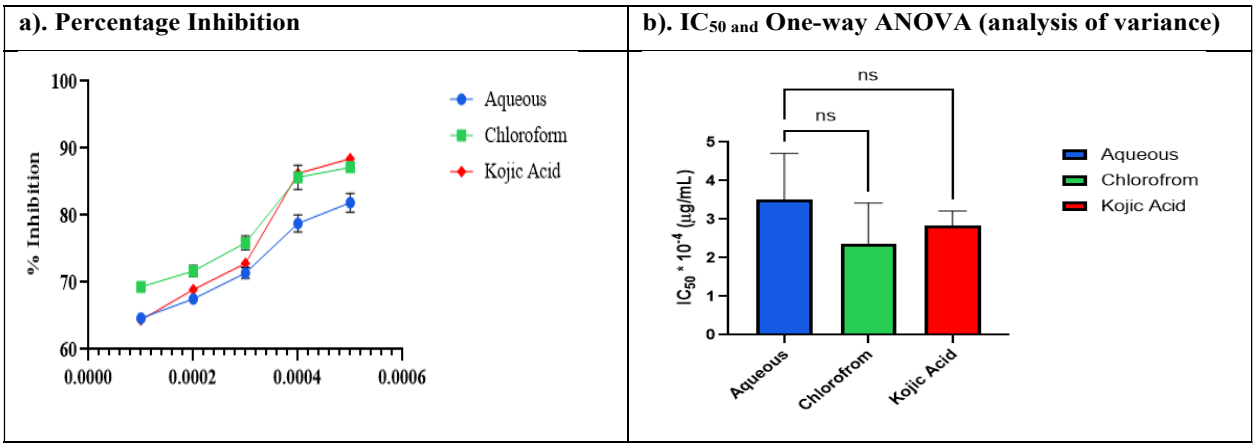


Figure 2: Anti-tyrosinase activities of aqueous and chloroform at different concentration. **(a)** Anti-tyrosinase percentage inhibition of aqueous, chloroform at different concentration of aqueous and chloroform root bark extract of *P. pterocarpum*; and Kojic acid (standard). **(b)** IC_{50} and One-way ANOVA of Anti-tyrosinase percentage inhibition of root bark extract *P. pterocarpum*; and kojic acid (standard).

CONCLUSION

The outcomes of this investigation underline the pharmacological potential of the chloroform extract of *P. pterocarpum* root bark, which revealed a rich profile of bioactive phytochemicals and substantial anti-tyrosinase activiity. The GC-MS analysis confirmed the presence of substantial compounds with known antibacterial, anti-inflammatory, antioxidant, and enzyme-inhibitory activities. Notably, the chloroform extract displayed a tyrosinase inhibitory effect that was comparable to that of kojic acid, a well-established commercial skin-lightening product. This shows that the root bark of *P. pterocarpum* may serve as a promising source of natural tyrosinase inhibitors for the development of alternative treatments for hyperpigmentation and oxidative skin diseases.

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Conflict of interest

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