Chemical and Biological Review on Various Classes of Secondary Metabolites and Biological Activities of Arecaceae (2021-2006)

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Abstract

Arecaceae is called palm trees. It is a flowering plant family including 181 genera and about 2600 species. The scientific researchers need to summarize phytochemical and biological studies on many genera of this family to help and orient them to carry out extensive studies on the uninvestigated plants. By reviewing the currently available literature (2021-2006), many classes of secondary metabolites of this family were determined, viz., flavonoids (59 compounds), phenolic acids and their derivatives (22 compounds), fatty derivatives (11 compounds), sterols (19 compounds) and other classes. Moreover, plants belonging to this family have been shown many biological activities such as anti-hyperlipidemic, anti-diabetic, anti-oxidant, anti-parasitic, anti-inflammatory, renal protective, cardioprotective, cytoxic, anti-microbial (antibacterial, antifungal and antiviral), anti-pyretic, anti-antimicrobial, anti-mutagenic, hepatoprotective, antihypertensive, analgesic, anti-platelet, anti-acetylcholinesterase and anti-Alzheimer. Also, the most chemically investigated genus is Phoenix. While, Aiphanes aculeate, Syagrus romanoffiana, Areca catechu, Hyophorbe indica, Brahea armata, Attalea funifera, Wodyetia bifurcate, and Dypsis leptocheilos need more phytochemical attention. Regarding the biological investigation, Cocos and Phoenix was the most investigated genera were the most investigated species. While, Areca, Bactris, Borassus, Brahea, Calamus, Caryota, Dypsis, Euterpe, Elaeis, Hyophorbe, Hyphaenae, Livistona, Lodoicea, Mauritia, Mauritiella, Orbignya, Rhaps, Raphia, Ravenea, Syagrus and Wodyetia genera require more pharmacological attention from the researchers.

Keywords
Arecaceae, Cocos, Phoenix, Phytochemistry, Flavonoids, Biological activity

1. Introduction

Arecaceae is a family of dominant perennial trees commonly called palm trees. This is a flowering plant family of monocots order Arecales. It includes around 181 genera with 2600 species, which are distributed in tropical, subtropical, and warm climates [1,2]. Arecaceae has been reported to contain flavonoids [3], terpenoids, steroids, fatty acids, and tannins [4]. It was classified taxonomically as a kingdom: Plantae, class: Magnoliopsida, Order: Arecales [5]. It is characterized by tall unbranched stems, or rarely by dichotomous branching stems of the same diameter from base to top. At the top of the stem, leaves are spirally arranged as palmately or pinnately compounds. Like all monocots, palms cannot form any secondary growth, so, no further increase in the width of the stem [6]. This review potentiates the scientific researchers to carry out more studies on uninvestigated plants of this family to isolate and develop new natural products with high relative safety and investigate their biological activities and possible mechanisms of action.

2. Methodology

From 2021 to 2006, we conducted a systematic search of the previous literature (117 peer-reviewed articles) in databases such as PubMed, Google Scholar, ACS Publications, SciFinder, DNP, The Plant List, Global Biodiversity Information Facility, and Scopus for reported compounds, chemistry, biological, and pharmacological properties of the Arecaceae family.

3. Results and discussion

3.1 Phytochemistry

Most of the characterized metabolites are flavonoidal derivatives (59 compounds, representing 36.42%), while other classes, such as lignan derivatives (8 compounds, representing 4.94%), stilbenoid derivatives (8 compounds, representing 4.94%), steroidal derivatives (19 compounds, representing 11.73%), triterpenoidal derivatives (5 compounds, representing 3.09%), simple phenolic glycosides (2 compounds, representing 1.23%), phenolic acids, and their derivatives (22 compounds, representing 13.58%), fatty derivatives (11 compounds, representing 6.79%), sugars (5 compounds, representing 3.09%), ceramides derivatives (4 compounds, representing 2.47%), glyceryl derivatives (9 compounds, representing 5.55%) and miscellaneous compounds (10 compounds, representing 6.17%). These data are displayed in Table 1 and the chemical structures are demonstrated in Figures 1 and 2.

Leaves and fruits were the main parts used in 23 genera and 37 species. Moreover, other parts were used as Areca catechu L. (leaves, stems and seeds), and Cocos nucifera L. (roots, leaves and fruits). The main secondary metabolites in this review (2021-2006) are flavonoids (59). They are classified into (44 flavones, 8 flavanones, 6 flavanols and 1 chalcone). The most phytochemically investigated genus is Phoenix, while, Aiphanes aculeate Wild, Syagrus romanoffiana Cham., Areca catechu L., Hyophorbe indica Gaertn., Brahea armata S.Watson, Attalea...
funifera Mart., Wodyetia bifurcate A.K.Irvine and Dypsis leptocheilos Hodel need more phytochemical attention.

2.2 Biological activities

Regarding the biological investigations, Cocos and Phoenix was the most investigated genera. Whereas, Areca, Bactris, Borassus, Brahea, Calamus, Caryota, Dypsis, Euterpe, Elaeis, Hyophorbe, Hyphaene, Livistona, Lodoicea, Mauritia, Mauritiella, Orbignya, Rhapis, Raphia, Ravenea, Syagrus and Wodyetia genera require further biological attention from the researchers. In 23 genera and 33 species, fruits and leaves are the main biologically investigated parts. While, other parts (aerial parts, barks, flowers, seeds and roots) need more attention from the researchers. The biological activities are illustrated in Tables 2.

Table 1: A list of previously reported compounds of family Arecaceae (2021-2006).

| No. | Name                                      | Mol. weight | Mol. formula | Plant                        | Organ      | Extract | Ref. |
|-----|-------------------------------------------|-------------|--------------|------------------------------|------------|---------|------|
| 1   | Apigenin                                  | 270.2       | C_{15}H_{10}O_{5} | Livistona decipiens Becc.   | Leaves     | Ethanol | [7]  |
| 2   | Acacetin                                  | 284.3       | C_{16}H_{12}O_{5} | Caryota urens Linné         | Base       | Methanol| [3]  |
| 3   | Kaempferol                                | 286.2       | C_{15}H_{10}O_{6} | Caryota mitis Lour. Wodyetia bifurcata A.K.Irvine | Leaves     | Ethanol | [8]  |
| 4   | Luteolin                                  | 286.2       | C_{15}H_{10}O_{6} | Livistona decipiens Becc.   | Leaves     | Ethanol | [7]  |
| 5   | Chrysoeriol                               | 300.3       | C_{15}H_{10}O_{6} | Hyphaene thebaica L.        | Epicarps   | Acetone | [10] |
| 6   | Tricetin                                  | 302.2       | C_{15}H_{10}O_{7} | Attalea funifera Mart.      | Beepollen  | Ethanol | [11] |
| 7   | Quercetin                                 | 302.2       | C_{15}H_{10}O_{7} | Livistona decipiens Becc.   | Leaves     | Ethanol | [7]  |
| 8   | Apigenin 7-O-α-D-apiofuranoside           | 402.4       | C_{20}H_{18}O_{5} | Phoenix dactylifera L.      | Seeds      | Methanol| [13] |
| 9   | Diosmetin 7-O-β-D-apiofuranoside          | 432.4       | C_{21}H_{20}O_{10} | Phoenix dactylifera L.      | Epicarps   | Acetone | [14] |
| 10  | Genistein 8-C-glucopyranoside             | 432.4       | C_{21}H_{20}O_{10} | Phoenix dactylifera L.      | Seeds      | Methanol| [13] |
| 11  | Apigenin 7-O-β-D-glucopyranoside (syn.: Cosmosin) | 432.4 | C_{21}H_{20}O_{10} | Phoenix paludosa Roxb.      | Leaves     | Methanol| [15] |
| 12  | Apigenin 6-C-β-D-glucopyranoside (syn.: Isovitexin) | 432.4 | C_{21}H_{20}O_{10} | Dypsis leptocheilos Hodel Hyphaene thebaica L. Dypsis leptocheilos Hodel | Leaves     | Methanol| [16] |
| 13  | Apigenin 8-C-β-D-glucopyranoside (syn.: Vitexin) | 432.4 | C_{21}H_{20}O_{10} | Dypsis leptocheilos Hodel Hyphaene thebaica L. Dypsis leptocheilos Hodel | Epicarps   | Acetone | [10] |
| 14  | Kaempferin (syn.: Kaempferol-3-rhamnoside) | 432.4 | C_{21}H_{20}O_{10} | Serenoa repens W.Bartram Serenoa repens W.Bartram | Fruits     | Ethanol | [17] |
| 15  | Avicularin                                | 434.3       | C_{20}H_{18}O_{11} | Serenoa repens W.Bartram    | Fruits     | Ethanol | [17] |
| 16  | Astragalin (syn.: Kaempferol 3-glucoside) | 448.4       | C_{21}H_{20}O_{11} | Serenoa repens W.Bartram    | Fruits     | Ethanol | [17] |
| 17  | Luteolin 7-O-β-D-glucoside                | 448.4       | C_{21}H_{20}O_{11} | Hyphaene thebaica L.        | Leaves     | Ethanol | [18] |
| 18  | Luteolin 6-C-β-D-glucopyranoside (syn.: Isoorientin) | 448.4 | C_{21}H_{20}O_{11} | Dypsis leptocheilos Hodel Livistona decipiens Becc. | Leaves     | Ethanol | [7]  |
| No. | Name                                                                 | Mol. weight | Mol. formula | Plant                                      | Organ       | Extract | Ref. |
|-----|----------------------------------------------------------------------|-------------|--------------|--------------------------------------------|-------------|---------|------|
| 19  | Luteolin 8-C-β-D-glucopyranoside (syn: Orientin)                     | 448.4       | C_{21}H_{20}O_{11} | Dypsis leptochelos Hodel Livistona decipiens Becc. | Leaves      | Methanol | [16] |
| 20  | Quercitrin                                                           | 448.4       | C_{21}H_{20}O_{11} | Hyphaene thebaica L.                       | Leaves      | Ethanol  | [7]  |
| 21  | Isoquercitrin                                                        | 464.4       | C_{21}H_{20}O_{12} | Hyphaene thebaica L.                       | Edible parts| EthOAc   | [19] |
| 22  | 6-C-Glucopyranosyl-3',4',5,7,8-pentahydroxylflavone; 3'-methyl ether (syn.: 8-Hydroxyisoscparin) | 478.1       | C_{22}H_{20}O_{12} | Washingtonia filifera Lindl. | Aerial parts| Methanol | [20] |
| 23  | Isorhamnetin 3-O-glucoside                                          | 478.4       | C_{22}H_{20}O_{12} | Phoenix dactylifera L.                     | Pollen grains| Methanol | [21] |
| 24  | Tricin 7-O-glucoside                                                | 492.4       | C_{22}H_{20}O_{12} | Livistona decipiens Becc.                 | Leaves      | Ethanol  | [7]  |
| 25  | Tricin 5-0-β-D-glucoside                                            | 508.4       | C_{22}H_{20}O_{13} | Hyphaene thebaica L.                       | Leaves      | Ethanol  | [18] |
| 26  | Luteolin 7-O-glucoside 2'-sulfate                                   | 543.4       | C_{22}H_{20}O_{15}S | Washingtonia filifera Lindl. | Aerial parts| Methanol | [20] |
| 27  | Luteolin 7-O-β-D-glucoside 4'-sulfate                               | 543.4       | C_{22}H_{20}O_{15}S | Washingtonia filifera Lindl. | Aerial parts| Methanol | [20] |
| 28  | Quiquelignan C                                                      | 554.5       | C_{20}H_{19}O_{11} | Calamus quiquesetinervius Burret           | Stems       | Ethanol  | [22] |
| 29  | 4',5,7-Trihydroxy-3'-methoxyflavone; 7-O-[β-L-arabinofuranosyl-(1→2)β-D-apiofuranoside] | 564.5       | C_{22}H_{20}O_{14} | Phoenix dactylifera L                     | Fruit picarps| Acetone  | [14] |
| 30  | Schaftoside                                                         | 564.5       | C_{22}H_{20}O_{14} | Caryota mitis Lour. Livistona decipiens Becc. | Leaves      | Ethanol  | [8]  |
| 31  | Apigenin 7-O-α-D-apiofuranosyl-(1→2)-β-D-glucopyranoside            | 580.5       | C_{22}H_{20}O_{15} | Phoenix dactylifera L                     | Seeds       | Methanol | [13] |
| 32  | Acacetin 7-O-β-D-neohesperopyranoside                               | 592.5       | C_{22}H_{20}O_{14} | Phoenix dactylifera L                     | Seeds       | Methanol | [13] |
| 33  | Luteolin 7-O-β-D-neohesperopyranoside                               | 594.5       | C_{22}H_{20}O_{15} | Phoenix dactylifera L                     | Seeds       | Methanol | [13] |
| 34  | Nicotiflorin                                                        | 594.5       | C_{27}H_{20}O_{15} | Hyphaene thebaica L.                      | Leaves      | Ethanol  | [18] |
| 35  | Luteolin 7-O-β-D-neohesperopyranoside 3-O-methylether               | 608.6       | C_{22}H_{20}O_{15} | Phoenix dactylifera L                     | Seeds       | Methanol | [13] |
| 36  | Neodiosmin                                                          | 608.5       | C_{22}H_{20}O_{15} | Phoenix dactylifera L                     | Fruits      | Ethanol  | [23] |
| 37  | Rutin                                                               | 610.5       | C_{22}H_{20}O_{16} | Caryota mitis Lour.                       | Leaves      | Ethanol  | [8]  |
| 38  | Isorhamnetin 3-O-rutinoside                                         | 624.5       | C_{26}H_{20}O_{16} | Phoenix canariensis Chabaud              | Pollen grains| Ethanol  | [24] |
| 39  | Isorhamnetin 3-O-neohesperidoside                                   | 624.5       | C_{26}H_{20}O_{16} | Attalea junifera Mart.                    | Bee pollens | Ethanol  | [11] |
| 40  | Vicinine II                                                         | 626.5       | C_{27}H_{20}O_{17} | Caryota mitis Lour.                       | Leaves      | Ethanol  | [8]  |
| 41  | Rhamnazin 3-O-rutinoside                                            | 638.6       | C_{29}H_{20}O_{16} | Hyphaene thebaica L.                      | Leaves      | Ethanol  | [18] |
| 42  | Kaempferol 3-sulfate-4'-O-α-rhamnosyl(1→6)-β-D-glucoside            | 674.5       | C_{27}H_{20}O_{18}S| Caryota mitis Lour.                       | Leaves      | Ethanol  | [8]  |
| 43  | Quercetin 3-sulfate-4'-O-α-rhamnosyl (1→6)-β-D-glucoside            | 690.5       | C_{27}H_{20}O_{18}S| Caryota mitis Lour.                       | Leaves      | Ethanol  | [8]  |
| 44  | Manghaslin                                                          | 756.7       | C_{33}H_{20}O_{20} | Serenoa repens W.Bartram                  | Fruits      | Ethanol  | [17] |
| No. | Name                  | Mol. weight | Mol. formula | Plant                  | Organ     | Extract   | Ref. |
|-----|-----------------------|-------------|--------------|------------------------|-----------|-----------|------|
| 1B) Flavon derivatives |
| 1B-i) Flavanone derivatives |
| 45  | Naringenin            | 272.3       | C₁₅H₁₂O₅    | Washingtonia robusta   | Leaves    | Ethanol   | [12] |
| 46  | Hesperetin            | 302.3       | C₁₆H₁₄O₆    | Hyphaene thebaica L.   | Edible    | EtOAc     | [19] |
| 47  | Rhusflavone           | 542.5       | C₃₀H₂₂O₁₀   | Attalea fanifera Mart. | Bee       | Ethanol   | [11] |
| 48  | Quiquelignan A         | 556.6       | C₂₀H₂₅O₁₁   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 49  | Naringin              | 580.5       | C₂₇H₃₂O₁₄   | Phoenix dactylifera L.  | Pollen    | Methanol  | [21] |
| 50  | Chrysosoriel 7-O-β-D- galactopyranosyl(1→2)-α-L-arabinofuranoside | 596.5 | C₂₇H₃₂O₁₅ | Hyphaene thebaica L.   | Epicarps  | Acetone   | [10] |
| 51  | Luteolin 7-O-{6’-O-α-L-rhamnopyranosyl]-β-D-galactopyranoside | 596.5 | C₂₇H₃₂O₁₅ | Hyphaene thebaica L.   | Epicarps  | Acetone   | [10] |
| 52  | Eriocitrin            | 596.5       | C₂₇H₃₂O₁₅   | Hyphaene thebaica L.   | Edible    | EtOAc     | [19] |
| 1B-ii) Flavanol derivatives |
| 53  | Catechin               | 290.3       | C₁₅H₁₂O₆    | Brahea armata S.Watson  | Fruits    | Ethanol   | [25] |
| 54  | Epicatechin            | 290.2       | C₁₅H₁₂O₆    | Brahea armata S.Watson  | Fruits    | Ethanol   | [25] |
| 55  | Procyanidin B1         | 578.5       | C₃₀H₂₆O₁₂   | Hyophorbe indica Gaern. | Leaves    | Ethanol   | [26] |
| 56  | Arecaocin A1           | 866.8       | C₃₅H₃₈O₁₈  | Areca catechu L.        | Seeds     | Methanol  | [27] |
| 57  | Arecaocin B1           | 866.8       | C₃₅H₃₈O₁₈  | Areca catechu L.        | Seeds     | Methanol  | [27] |
| 58  | Arecaocin A2           | 1154.3      | C₃₀H₂₆O₂₄   | Areca catechu L.        | Seeds     | Methanol  | [27] |
| 1C) Chalcone               |
| 59  | 4’6’-Dimethoxy-β,4,2,4-tri hydroxy chalcone [syn.: (Z)-3-Hydroxy-1-(2-hydroxy-4,6-dimethoxyphenyl)-3-(4-hydroxyphenyl)prop-2-en-1-one] | 316.0 | C₁₇H₁₆O₅ | Brahea armata S.Watson  | Fruits    | Ethanol   | [25] |
| 2) Lignan derivatives      |
| 60  | Quiquelignan C         | 554.5       | C₂₀H₃₀O₁₁   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 61  | Quiquelignan A         | 556.6       | C₂₀H₃₂O₁₁   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 62  | Quiquelignan G         | 646.6       | C₂₅H₃₄O₁₂   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 63  | Quiquelignan H         | 646.6       | C₂₅H₃₄O₁₂   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 64  | Quiquelignan D         | 674.6       | C₂₅H₃₄O₁₃   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 65  | Quiquelignan B         | 676.7       | C₂₅H₃₄O₁₃   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 66  | Quiquelignan F         | 676.7       | C₂₅H₃₄O₁₃   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 67  | Quiquelignan E         | 708.7       | C₂₅H₃₄O₁₃   | Calamus quiquesetinervius Burret | Stems | Ethanol | [22] |
| 3) Stilbenoid derivatives |
| 68  | Piceatannin           | 244.2       | C₁₄H₁₂O₄    | Phoenix dactylifera L.  | Seeds     | Methanol  | [28] |
| 69  | Isorhapontigenin      | 258.3       | C₁₅H₁₄O₄    | Phoenix dactylifera L.  | Seeds     | Methanol  | [28] |
| 70  | 1-(3,5-Dihydroxyphenyl)-2-(3,4,5-trihydroxyphenyl)ethylene; (Z)-form, 4-methyl ether. (syn: (Z)3,5,3,5-Tetrahydroxy-4-methoxystilbene) | 274.3 | C₁₅H₁₄O₅ | Phoenix dactylifera L.  | Seeds     | Methanol | [30,31] |
| No. | Name                                      | Mol. weight | Mol. formula | Plant               | Organ     | Extract | Ref. |
|-----|-------------------------------------------|-------------|--------------|---------------------|-----------|---------|------|
| 71  | 1-(3,5-Dihydroxyphenyl)-2-(3,4,5-trihydroxyphenyl) ethylene; (E)-form, 4-methyl ether (syn.: (E) 3,5,3',5'-Tetrahydroxy-4-methoxy stilbene) | 274.3       | C13H10O5     | Phoenix dactylifera L. | Stems    | Methanol | [30;31] |
| 72  | Aiphanol                                  | 452.5       | C25H32O8     | Alphaenes aculeata Wild. | Seeds    | Methanol | [28] |
| 73  | Aiphanol; 5-hydroxy                      | 468.5       | C25H32O8     | Syagrus romanzoffiana Cham. | Seeds    | Ethanol  | [32] |
| 74  | Cassigaroil G                            | 484.5       | C26H32O4     | Cocos nucifera L.     | Endocarps | EtOAc    | [29] |
| 75  | Maackin A                                | 486.5       | C26H32O4     | Cocos nucifera L.     | Endocarps | EtOAc    | [29] |

4) Steroidal derivatives

| No. | Name                                      | Mol. weight | Mol. formula | Plant               | Organ     | Extract | Ref. |
|-----|-------------------------------------------|-------------|--------------|---------------------|-----------|---------|------|
| 76  | Estrone                                   | 270.4       | C19H22O2     | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 77  | Estradiol                                 | 272.4       | C19H22O2     | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 78  | Cholesterol                               | 386.7       | C27H44O      | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 79  | Ergost-4-en-3-one                         | 398.7       | C26H42O      | Phoenix paludosa Roxb. | Leaves    | Methanol | [15] |
| 80  | Ergost-4-en-3,6-dione                     | 412.6       | C26H42O      | Phoenix paludosa Roxb. | Leaves    | Methanol | [15] |
| 81  | \(\beta\)-Sitosterol                      | 414.7       | C26H42O      | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 82  | 5a-Campestan-3,6-dione                    | 414.7       | C26H42O      | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 83  | Stigmasta-4,22-diene-3,6-dione            | 424.7       | C26H42O      | Phoenix paludosa Roxb. | Leaves    | Methanol | [15] |
| 84  | 5a-Stigmast-22-en-3,6-dione               | 426.7       | C26H42O      | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 85  | Clionasterol acetate                      | 456.7       | C31H42O      | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 86  | \(\beta\)-Sitosterol acetate              | 456.7       | C31H42O      | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 87  | 24,24,27-Trimethylcycloart-25-3-en-ol; 3\(\beta\)-form, 3-ketone (syn.: Isoskimmiwallinone) | 466.4       | C31H42O      | Cocos nucifera L. | Poll. grains | Methanol | [21] |
| 88  | 25-Ethyl-24-methylenecycloarten-3-ol; 3\(\beta\)-form, 3-ketone (syn.: Skimmiwallinone) | 466.4       | C31H42O      | Cocos nucifera L. | Poll. grains | Methanol | [21] |
| 89  | 24,24,27-Trimethylcycloart-25-3-en-ol; 3\(\beta\)-form, Ac (syn.: Isoskimmiwallinol acetate) | 510.4       | C31H42O      | Cocos nucifera L. | Poll. grains | Methanol | [21] |
| 90  | 25-Ethyl-24-methylenecycloarten-3-ol; 3\(\beta\)-form, Ac (syn.: Skimmiwallinol acetate) | 510.4       | C31H42O      | Cocos nucifera L. | Poll. grains | Methanol | [21] |
| 91  | \(\beta\)-Sitosterol 3-O-\(\beta\)-D-glucoside | 576.8       | C31H42O      | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 92  | \(\beta\)-Sitosteryl caproate              | 568.9       | C31H42O      | Phoenix dactylifera L. | Poll. grains | Methanol | [21] |
| 93  | Dioscin                                   | 869.0       | C26H24O16    | Phoenix canariensis Chabaud | Poll. grains | Methanol | [24] |
| 94  | Methylprotodioscin                        | 1063.2      | C32H42O22    | Phoenix canariensis Chabaud | Poll. grains | Methanol | [24] |

5) Triterpenoidal derivatives

5A) Oleanane skeleton

| No. | Name                                      | Mol. weight | Mol. formula | Plant               | Organ     | Extract | Ref. |
|-----|-------------------------------------------|-------------|--------------|---------------------|-----------|---------|------|
| 95  | Oleanolic acid                            | 456.7       | C20H32O4     | Phoenix dactylifera L. | Leaves    | n-Butanol | [35] |

5B) Lupane skeleton

| No. | Name                                      | Mol. weight | Mol. formula | Plant               | Organ     | Extract | Ref. |
|-----|-------------------------------------------|-------------|--------------|---------------------|-----------|---------|------|
| 96  | Lupeol                                    | 426.7       | C30H32O5     | Phoenix paludosa Roxb. | Leaves    | Methanol | [15] |
| 97  | Epilupeol                                 | 426.7       | C30H32O5     | Phoenix paludosa Roxb. | Leaves    | Methanol | [15] |
| 98  | Betulinic acid                            | 456.7       | C30H42O3     | Ravenna rivularis Jum. & H.Perrier | Leaves    | Methanol | [36] |
| 99  | Lupeol acetate                            | 468.8       | C32H32O2     | Ravenna rivularis Jum. & H.Perrier | Leaves    | Methanol | [36] |
### 6) Simple phenolic glycosides

| No. | Name                                           | Mol. weight | Mol. formula | Plant                          | Organ         | Extract  | Ref.   |
|-----|------------------------------------------------|-------------|--------------|--------------------------------|---------------|----------|--------|
| 100 | 6'-O-(4-Hydroxybenzoyl)-β-glucose              | 300.3       | C_{14}H_{16}O_{8} | *Phoenix dactylifera* L.      | Poll. grains | Methanol | [21]   |
|     |                                                |             |              | *Serenoa repens* W.Bartram    | Fruits        |          |        |
| 101 | 6'-O-(3,4-Dihydroxybenzoyl)-β-glucose          | 316.3       | C_{14}H_{16}O_{8} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |

### 7) Phenolic acids and their derivatives

| No. | Name                                           | Mol. weight | Mol. formula | Plant                          | Organ         | Extract  | Ref.   |
|-----|------------------------------------------------|-------------|--------------|--------------------------------|---------------|----------|--------|
| 102 | 3-Hydroxybenzoic acid                          | 138.1       | C_{9}H_{8}O_{3} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |
| 103 | 4-Hydroxybenzoic acid                          | 138.1       | C_{9}H_{8}O_{3} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |
| 104 | Cinnamic acid                                   | 148.2       | C_{9}H_{8}O_{2} | *Hyphaene thebaica* L.        | Edible parts  | EtOAc    | [19]   |
| 105 | Hydroxychavicol (syn.: 4-Allylbenzene-1,2-diol) | 150.1       | C_{9}H_{10}O_{2} | *Areca catechu* L.            | Fruits        | Methanol | [37]   |
| 106 | 4-Vinylnuaciacol (syn.: 2-Methoxy-4-vinylphenol) | 150.1       | C_{9}H_{10}O_{2} | *Cocos nucifera* L.           | Coir          | Acetone  | [38]   |
| 107 | 3-Methoxybenzoic acid (syn.: m-Anisic)          | 152.2       | C_{9}H_{8}O_{3} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |
| 108 | 4-Methoxybenzoic acid (syn.: p-Anisic)          | 152.2       | C_{9}H_{8}O_{3} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |
| 109 | Pyrocatechuic acid                              | 154.1       | C_{9}H_{8}O_{4} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |
| 110 | Protocatechuic acid                             | 154.1       | C_{9}H_{8}O_{4} | *Cocos nucifera* L.           | Endocarps     | EtOAc    | [29]   |
| 111 | O-Coumaric acid                                 | 164.2       | C_{9}H_{8}O_{3} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |
| 112 | p-Coumaric acid                                 | 164.2       | C_{9}H_{8}O_{3} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |
| 113 | Isovanillic acid                                | 168.2       | C_{9}H_{8}O_{4} | *Serenoa repens* W.Bartram    | Fruits        | Ethanol  | [17]   |
| 114 | Gallic acid                                     | 170.1       | C_{9}H_{8}O_{5} | *Hyphaene thebaica* L.        | Leaves        | Ethanol  | [18]   |
|     |                                                |             |              |                                |              |          |        |
|     |                                                |             |              |                                |              |          |        |

### 8) Fatty derivatives compounds

#### 8A) Fatty acids

| No. | Name                                           | Mol. weight | Mol. formula | Plant                          | Organ         | Extract  | Ref.   |
|-----|------------------------------------------------|-------------|--------------|--------------------------------|---------------|----------|--------|
| 124 | Palmitic acid (syn.: Hexadecanoic acid)         | 256.4       | C_{16}H_{32}O_{2} | *Livistona australis* R.Br. Copernicia cerifera Mill. | Fruits        | Pet. ether | [40]   |
|     |                                                |             |              | *Phoenix paludosa* Roxb. Livistona chinensis Jacq. |               |          |        |
| 125 | Docosanoic acid (syn.: Behenic acid)            | 340.6       | C_{22}H_{44}O_{2} | *Phoenix dactylifera* L.      | Poll. grains  | Methanol  | [21]   |

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| No. | Name                                              | Mol. weight | Mol. formula | Plant                      | Organ          | Extract        | Ref. |
|-----|---------------------------------------------------|-------------|--------------|----------------------------|----------------|----------------|------|
| 126 | Tetracosanoic acid (syn.: Lignoceric acid)        | 368.6       | C₂₂H₄₈O₂     | Phoenix dactylifera L.     | Poll. grains   | Methanol [21]  |      |
| 127 | Hexacosanoic acid (syn.: Cerotic acid)            | 396.7       | C₂₆H₅₂O₂     | Phoenix dactylifera L.     | Poll. grains   | Methanol [21]  |      |
| 128 | Octacosanoic acid (syn.: Montanic acid)           | 424.7       | C₂₆H₅₆O₂     | Livistona australis R.Br.  | Fruits         | Pet. ether [40]|      |
|     |                                                   |             |              | Copernicia cerifera Mill. |                | n-Hexane [41]  |      |

### 8B) Fatty alcohol

| No. | Name          | Mol. weight | Mol. formula | Plant                      | Organ          | Extract        | Ref. |
|-----|---------------|-------------|--------------|----------------------------|----------------|----------------|------|
| 129 | Dotriacontanol| 466.9       | C₃₂H₆₀O₆    | Livistona australis R.Br.  | Fruits         | Pet. ether [40]|      |
|     |               |             |              | Copernicia cerifera Mill. |                | n-Hexane [41]  |      |

### 8C) Hydroxylated fatty acids

| No. | Name                                              | Mol. weight | Mol. formula | Plant                      | Organ          | Extract        | Ref. |
|-----|---------------------------------------------------|-------------|--------------|----------------------------|----------------|----------------|------|
| 130 | 16-Hydroxyhexadecanoic acid (syn.: Juniperic acid)| 272.4       | C₁₆H₃₂O₃     | Livistona australis R.Br.  | Fruits         | Pet. ether [40]|      |
|     |                                                   |             |              | Copernicia cerifera Mill. |                | n-Hexane [41]  |      |
| 131 | 18-Hydroxyoctadecanoic acid                       | 300.5       | C₁₈H₃₆O₃     | Livistona australis R.Br.  | Fruits         | Pet. ether [40]|      |
|     |                                                   |             |              | Copernicia cerifera Mill. |                | n-Hexane [41]  |      |
| 132 | 26-Hydroxyhexacosoanic acid                       | 412.7       | C₂₆H₅₂O₃     | Livistona australis R.Br.  | Fruits         | Pet. ether [40]|      |
|     |                                                   |             |              | Copernicia cerifera Mill. |                | n-Hexane [41]  |      |
| 133 | 28-Hydroxyoctacosanoic acid                       | 440.7       | C₂₈H₅₆O₃     | Livistona australis R.Br.  | Fruits         | Pet. ether [40]|      |
|     |                                                   |             |              | Copernicia cerifera Mill. |                | n-Hexane [41]  |      |
| 134 | Heptacosane                                        | 380.7       | C₂₇H₅₈O₆     | Livistona australis R.Br.  | Fruits         | Pet. ether [40]|      |
|     |                                                   |             |              | Copernicia cerifera Mill. |                | n-Hexane [41]  |      |

### 9) Sugars

| No. | Name                                              | Mol. weight | Mol. formula | Plant          | Extract   | Ref. |
|-----|---------------------------------------------------|-------------|--------------|----------------|-----------|------|
| 135 | Mannose                                           | 180.2       | C₆H₁₂O₆      | Phoenix paludosa | Methanol  | [15] |
|     |                                                   |             |              | Roxb.          |           |      |
| 136 | Maltose                                           | 342.3       | C₁₂H₂₄O₁₁    | Phoenix dactylifera L. | Ethanol | [23] |
| 137 | Sucrose                                           | 342.3       | C₁₂H₂₄O₁₁    | Phoenix dactylifera L. | Ethanol | [23] |
| 138 | β-D-Glucopyranosyl-(1→2)-β-D-fructofuranosyl-(6→α-D-glucopyranoside | 504.5       | C₁₅H₂₄O₁₆   | Phoenix dactylifera L. | Ethanol | [23] |
| 139 | Maltotriose (syn.: Pullulan)                      | 504.4       | C₁₅H₂₄O₁₆   | Phoenix dactylifera L. | Ethanol | [23] |

### 10) Ceramide derivatives

| No. | Name                                           | Mol. weight | Mol. formula | Plant          | Organ | Extract   | Ref. |
|-----|------------------------------------------------|-------------|--------------|----------------|-------|-----------|------|
| 140 | (25,35,4R)-2-[(2R)-2-Hydroxytetracosanoylamino]-1,3,4-octadecanetriol | 684.1       | C₂₅H₅₈NO₅  | Livistona chinensis Jacq. | Roots | Ethanol  | [42] |
| 141 | (25,35,4R,9Z)-2-[(2R)-2-Hydroxytricosanoylamino]-9-octadecene-1,3,4-triol | 668.1       | C₂₅H₅₈NO₅  | Livistona chinensis Jacq. | Roots | Ethanol  | [42] |
| 142 | 1-O-β-D-Glucopyranosyl-(25,35,4R,9Z)-2-[(2R)-2-hydroxydocosanoylamino]-9-octadecene-1,3,4-triol | 816.2       | C₂₆H₆₀NO₁₀ | Livistona chinensis Jacq. | Roots | Ethanol  | [42] |
| 143 | 1-O-β-D-Glucopyranosyl-(25,35,4R,9Z)-2-[(2R)-2-hydroxydocosanoylamino]-1,3,4-octadecanetriol | 846.3       | C₂₆H₆₀NO₁₀ | Livistona chinensis Jacq. | Roots | Ethanol  | [42] |

### 11) Glyceryl derivatives

#### 11A) Monoacylglycerols

| No. | Name                                           | Mol. weight | Mol. formula | Plant          | Organ | Extract   | Ref. |
|-----|------------------------------------------------|-------------|--------------|----------------|-------|-----------|------|
| 144 | 1-Hexadecanoyl-sn-glycerol                     | 330.5       | C₁₆H₃₆O₄ | Livistona chinensis Jacq. | Roots | Ethanol  | [42] |
| 145 | 1-Octadec-(9Z)-enoyl-sn-glycerol               | 356.5       | C₁₈H₄₀O₄ | Livistona chinensis Jacq. | Roots | Ethanol  | [42] |
| 146 | 1-[Nonadeca-(9Z,12Z)-dienoyl]-sn-glycerol      | 368.4       | C₂₂H₄₀O₄ | Livistona chinensis Jacq. | Roots | Ethanol  | [42] |

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Table 2: Biological activities of family Arecaceae (2021-2006).

| No. | Name | Mol. weight | Mol. formula | Plant | Organ | Extract | Ref. |
|-----|------|-------------|--------------|-------|-------|---------|------|
| 147 | 1-(Z6-Hydroxyhexacosanoyl)-sn-glycerol | 486.8 | C_{28}H_{56}O_{5} | Livistona chinensis Jacc. | Roots | Ethanol | [42] |
| 148 | 1-Octacosanoyl-sn-glycerol | 498.8 | C_{31}H_{62}O_{4} | Livistona chinensis Jacc. | Roots | Ethanol | [42] |
| 149 | 1-(34-Hydroxytetracontanoyl)-sn-glycerol | 598.9 | C_{37}H_{74}O_{3} | Livistona chinensis Jacc. | Roots | Ethanol | [42] |
| 150 | 1-[12-Hydroxypentatriaconta-(13E,15Z)-diencyl]-sn-glycerol | 608.9 | C_{39}H_{78}O_{3} | Livistona chinensis Jacc. | Roots | Ethanol | [42] |

11B) Diacylglycerols

| No. | Name | Mol. weight | Mol. formula | Plant | Organ | Extract | Ref. |
|-----|------|-------------|--------------|-------|-------|---------|------|
| 151 | 1-(Heptadeca-6Z,9Z-dienoyl)-3-(octadeca-6Z,9Z,12Z-trienoyl)-sn-glycerol | 600.3 | C_{31}H_{60}O_{3} | Livistona chinensis Jacc. | Roots | Ethanol | [42] |
| 152 | 1-Octadecanoyl-2-nonadecanoyl-3-O-(6-aminoo-6-deoxy)-β-D-glucopyranosyl-sn-glycerol | 800.2 | C_{46}H_{80}NO_{3} | Livistona chinensis Jacc. | Roots | Ethanol | [42] |

12) Miscellaneous compounds

| No. | Name | Mol. weight | Mol. formula | Plant | Organ | Extract | Ref. |
|-----|------|-------------|--------------|-------|-------|---------|------|
| 153 | 4-Hydroxybenzaldehyde | 122.1 | C_{6}H_{6}O_{2} | Serenoa repens W.Bartram | Fruits | Ethanol | [17] |
| 154 | Vanillyl alcohol | 154.2 | C_{9}H_{10}O_{3} | Phoenix dactylifera L. | Leaves | n-Butanol | [35] |
| 155 | 3-Hydroxy-2-(4-hydroxyphenyl)-6-methyl-4H-pyran-4-one | 220.2 | C_{13}H_{12}O_{4} | Livistona australis R.Br. | Leaves | Methanol | [43] |
| 156 | 7-Hydroxy-3,4'-dimethoxy-2'-arylbenzofuran | 270.2 | C_{16}H_{14}O_{4} | Livistona chinensis Jacc. | Fruits | Ethanol | [39] |
| 157 | 2-(3'-Hydroxy-5'-methoxyphenyl)-3-hydroxymethyl-7-methoxy-2,3-dihydrobenzofuran-5-carboxylic acid | 346.3 | C_{16}H_{16}O_{7} | Livistona chinensis Jacc. | Fruits | Ethanol | [39;44] |
| 158 | Protocatecholic acid | 370.7 | C_{16}H_{16}O_{3}Si_{3} | Serenoa repens W.Bartram | Fruits | Ethanol | [17] |
| 159 | Rhypocephalin | 376.4 | C_{23}H_{23}O_{6} | Phoenix paludosa Roxb. | Leaves | Methanol | [15] |
| 160 | 5-Hydroxyaiphanol | 468.5 | C_{23}H_{23}O_{9} | Syagrus romanzoffiana Cham. | Seeds | Ethanol | [32] |
| 161 | Scirpusin A | 470.5 | C_{28}H_{41}O_{7} | Cocos nucifera L. | Endocarps | EtOAc | [29] |
| 162 | Jezonofol | 482.4 | C_{28}H_{41}O_{8} | Cocos nucifera L. | Endocarps | EtOAc | [29] |

Table 2: Biological activities of family Arecaceae (2021-2006).

1) Antioxidant activity

- **Cocos nucifera L./ Roots**: Aqueous and methanolic extracts. Both extracts were evaluated using four methods (inhibition of LPO, FRAP, DPPH and ABTS assays). The extracts demonstrated antioxidant capacity, LPO percentage of inhibition (55.99 ± 1.3 and 42.61 ± 2.36 μg/mL), FRAP (87.71 ± 1.42 and 70.26 ± 1.98), DPPH IC_{50} (1.4 ± 0.08 and 1.4 ± 0.05 μg/mL), ABTS IC_{50} (4.79 ± 0.06 and 8.00 ± 0.08 μg/mL) for methanolic and aqueous extracts, respectively.

- **Mauritia flexuosa L. f. and Mauritiella armata Mart./ Leaves, roots and petioles**: Hydroethanolic extracts. Antioxidant activity was performed by spectrophotometric method. They possessed antioxidant activities.

- **Cocos nucifera L./ Outer shell fiber**: Aqueous extract. In DPPH, the possibility of lowering power was assessed. As compared to BHT, the results demonstrated promising DPPH scavenging (51.87% at 100 μg/mL) and lowering power activity (0.165 at 100 μg/mL) of the silver nanoparticles in a concentration-dependent manner.
| Plant name/ part used | Extract or fraction or compound | Method/ Result                                                                                   | Ref. |
|----------------------|---------------------------------|--------------------------------------------------------------------------------------------------|------|
| Bactris guineensis L./Fruits | Methanolic extract              | The extract IC$_{50}$ for DPPH was 3.3 ± 0.2 μg/mL and for generated intracellular reactive oxygen species was 153 ± 13 μg/mL, as determined by chemical and biological techniques. | [48] |
| Dypsis leptocheilos Hodel/Leaves | EtOAc fraction and aqueous methanolic extract (80%) | The antioxidant activity of EtOAc fraction and aqueous methanolic extract (80%) was determined using the DPPH assay, with SC$_{50}$ = 12.8 ± 0.56 μg/mL and SC$_{50}$ = 17.0 ± 0.77 μg/mL, respectively, when compared to ascorbic acid (SC$_{50}$ = 14.2 ± 0.355 μg/mL) | [16] |
| Caryota urens Linné (Fruits, leaves and barks) | Hydroethanolic extract (70%) | The antioxidant activity was evaluated using in vitro phosphomolybdenum reduction. The high antioxidant activity of leaf hydroethanolic extract (21.25 ± 4.51 mg/g similar to that of ascorbic acid indicates antioxidant activity. | [49] |
| Borassus flabellifer L./Fruits | Aqueous extract | An antioxidant assay was carried out using DPPH. The antioxidant activity of the extract was measured in a time interval of 5 min each until 30 min. Thus the percentage of radical scavenging of DPPH was (56.69, 62.20, 62.99, 64.57, 66.14, 66.93 and 67.72%), respectively. | [50] |
| Mauritia flexuosa L.f./Fruits | Chloroform (FCB), EtOAc (FAB) and ethanolic (FEB) fractions | The antioxidant capacity of the fractions was determined by the sequestration of the free radical ABTS and iron chelating activity. The FCB showed the most activity in ABTS, followed by FEB and FAB. There were no significant differences in iron chelating activity, with a maximum percentage of 78.2% for FCB, 72.9% for FAB and 80.9% for FEB. | [51] |
| Cocos nucifera L./Fruits | Shell methanolic extract | Total antioxidant activity ranged from 92.32% to 94.20%, when tested utilizing DPPH radical scavenging assay. | [52] |
| Caryota urens Linné/Leaves | Crude ethanolic extract (CLEE), chloroform fraction (CLF), EtOAc fraction (LEAF) and methanolic fraction (LMF). | Determined by total antioxidant activity, the DPPH radical scavenging assay and hydroxyl radical scavenging assay. The CEE of the C. urens leaves showed the highest total antioxidant activity compared to CLF, LEAF and LMF. In DPPH scavenging assay and the hydroxyl radical scavenging assay, CEE showed the highest scavenging activity (42.36% and 53.36%) having IC$_{50}$ of 472.14 and 374.81 μg/mL respectively with respect to other fractions. | [53] |
| Caryota urens Linné/ Starch extracted from “Kithul flour” | Methanolic extract | Different in vitro assays, such as ABTS, FRAP antioxidant power, oxygen radical absorbance capacity and ferrous ion chelating assay, were used to assess the results. C. urens flour has free radical scavenging activity (raw 0.02 ± 0.01 and boiled 0.04 ± 0.01 mg Trolox equivalent (TE)/g flour), electron-donating reducing power (raw 0.10 ± 0.03 and boiled 0.36 ± 0.11 mg TE/g flour), oxygen radical absorbance capacity (raw 2.29 ± 0.71 and boiled 192.3 ± 57.71 mg TE/g flour) and metal ion chelating capacity (raw 0.03 ± 0.01 and boiled 0.14 ± 0.04 mg EDTA equivalents/g flour) exhibiting its antioxidant potential. | [54] |
| Hyophorbe verschaffeltii H.Wendl./Leaves | Methanolic extract | The levels of serum liver enzymes Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) were determined in vivo using the CCL$_{4}$-induced hepatic damage approach. When compared to the CCL$_{4}$-treated group, the treatment with extract of Hyophorbe verschaffeltii leaves resulted in significant reduction in high serum AST and ALT levels of 64.15% and 40.53%, respectively, at dose levels of 200 mg/kg, b.wt. When compared to the CCL$_{4}$-treated group, the silymarin (25 mg/kg) treated group showed a 36.48% and 32.89% reduction in blood AST and ALT levels, respectively. | [55] |
| Rhapis excels Thunb./Leaves | EtOAc and butanol fractions | EtOAc and butanol fractions showed exceptional antioxidant activity when tested in DPPH scavenging activity (86.2% and 75.6%, respectively), when compared with the standard compound (Trolox, 98.2%). The EC$_{50}$ values of both were 30 ± 1.06 and 32 ± 1.26 μg/mL, respectively. | [56] |
| Plant name/ part used                  | Extract or fraction or compound                                                                 | Method/ Result                                                                                                                                                                                                 | Ref. |
|--------------------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| *Cocos nucifera* L./ Endocarp        | Ethanolic (cold and hot percolation), dry-distilled and aqueous extracts                       | Ethanolic (cold and hot percolation), dry-distilled and aqueous extracts of endocarp had significant antioxidant activity (4.18, 3.31, 20.83 and 1.02 μg/mL, respectively) comparable to that of standard ascorbic acid, when tested in DPPH radical scavenging, nitric oxide radical scavenging and alkaline dimethyl sulfoxide methods. | [57] |
| *Hyphaene thebaica* L./ Fruits      | Methanol/ultrasonic (MU), methanol/water bath (MW), ethanol/ultrasonic (EU) and ethanol/water bath (EW) extracts | The antioxidant potential of the extracts was investigated using DPPH. IC₅₀ values of MU, MW, EU and EW extracts were 107.6, 126.7, 172.7 and 196.3 μg/mL, respectively.                                                              | [58] |
| *Livistona australis* R.Br./ Fruits  | The lipophilic fraction                                                                        | Glutathione levels in the blood of CCl₄-treated rats were lowered by the lipophilic fraction (39.9%), when compared to the vehicle-treated group in CCl₄-induced oxidative stress in rats.                                      | [40] |
| *Borassus flabellifer* (Linn.)/ Fruits | Aqueous extract                                                                                | The extract was tested for antioxidant activity in vitro using DPPH and ABTS assays. Antioxidant properties DPPH and ABTS free radical scavenging methods were utilised on various concentrations of effective antilulcer concentration (100, 200, 300, 500, 600, 700, 800, 900 and 1000 μg/mL), from which the aqueous extract demonstrated antioxidant activity in a concentration-dependent manner. | [59] |
| *Calamus erectus* Roxb./ Fruits      | Methanolic extract (ME)                                                                        | DPPH, reducing power, metal chelating, nitric oxide, superoxide, hydroxyl radical scavenging capability and anti-lipid peroxidation assays were used to evaluate the antioxidant activity of ME. The IC₅₀ values of MEs of endocarp and mesocarp for DPPH radical scavenging are 0.10 and 0.12 mg/mL fresh weight tissue, respectively. The antioxidant assays of both MEs were improved, when the concentration was increased. | [60] |
| *Dypsis lutescens* (H.Wendl.) Beentje & J.Dransf./ Fruits | Aqueous and methanolic extracts                                                                | DPPH free radical scavenging assay and reducing power assay were used to determine the antioxidant activity. For both analyses, ascorbic acid was employed as a positive control. In DPPH scavenging assay, the highest radical scavenging activity was observed for methanolic extract (IC₅₀=18 μg/mL), when compared to aqueous extract (IC₅₀=25 μg/mL). The two extracts displayed reducing power activity and it was concentration dependent. | [61] |
| *Livistona australis* R.Br./ Leaves  | Methanolic extract and tricin 7-O-β-glucopyranoside-2'-sulphate sodium salt                    | In vivo the antioxidant activity was assessed by measuring blood GSH levels. The glycoside and the methanolic extract significantly recovered the diabetic rats' decreased GSH levels (the percent of change was 3.1% and 18.4%, respectively, compared to 37.46% for the untreated diabetic rats group). | [62] |
| *Cocos nucifera* L./ Fruits (green and yellow) | Water and Pet. ether extracts                                                                | By using the DPPH assay, high scavenger activity was found in the water extracts (0.19 and 0.24 μg/μL) and moderate activity was observed in the Pet. ether extracts (>1.0 and >1.0 μg/μL) for green and yellow fruits, respectively. | [63] |
| *Euterpe precatoria* Mart./ Roots and leaf stalks | Ethanol roots extract (ERE), n-butanol extract from ERE (n-BuOHE), leaf stalks ethanol extract (LSEE), residue obtained from the soluble fraction of LSEE with methanol/chloroform 1:1 (LSEE-1) and flavonoids (quercetin, catechin, epicatechin, rutin and astilbin) | In a spectrophotometric bioassay, β-carotene in TLC plates and DPPH radical scavenging were investigated. All extracts and pure compounds had strong radical scavenging activity at 100.0 μg/mL. The reference substance was BHT and the catechin, epicatechin, n-BuOHE and LSEE-1 extracts had the highest activity at 1.0 μg/mL. The sequence of IC₅₀ values for scavenging activity is LSEE-1 (3.33 ± 4.11) > quercetin (3.73 ± 1.31) > catechin = epicatechin (5.15 ± 2.42) > n-BuOHE (8.83 ± 5.55) > rutin (12.44 ±1.99) > BHT = astilbin (16.56 ± 2.66) > LSEE (24.74 ± 11.72) > ERE (43.54 ± 5.60). BHT was only more active than astilbin, the less active flavonoid. | [64] |
E significantly inhibited the ulcerative kg, i.p. The third group (positive odium (DSS)
gh dose group values were not compared
ompared

| Plant name/ part used | Extract or fraction | Method/ Result | Ref. |
|----------------------|--------------------|----------------|-----|
| *Phoenix dactylifera* L./ Fruits | Aqueous extract (PFAE) | The PFAE was tested in a dose-dependent suppression of superoxide and hydroxyl radicals. In the riboflavin photoreduction method, the amount of fresh extract required to scavenge 50% of superoxide radicals was equivalent to 0.8 mg/mL of date fruit. In the deoxyribose degradation procedure, 2.2 mg/mL of PFAE was required to achieve 50% hydroxyl-radical-scavenging activity. Superoxide and hydroxyl radicals were suppressed at concentrations of 1.5 and 4.0 mg/mL, respectively. In a dose-dependent way, PFAE was also demonstrated to reduce lipid peroxidation and protein oxidation. In a Fe³⁺/ascorbate system, 1.9 mg/mL of PFAE was required to reduce lipid peroxides by 50%. At a 2.0 mg/mL concentration of PFAE, there was a complete inhibition of TBARS generation in the early stages of the incubation period that increased throughout the later stages of the incubation period in a time course inhibition study of lipid peroxide. PFAE (2.3 mg/mL) suppressed carbonyl production determined by the DNPH reaction by 50% in the high Fe³⁺/ ascorbate induction setup. Furthermore, PFAE (4.0 mg/mL) fully suppressed the development of lipid peroxide and protein carbonyl. | [65] |
| *Dypsis lutescens* H.Wendl./ Leaves | Ethanolic extract | There were five groups of six rats each. The duration of experiment 8 days. The first group (the normal control group) was given 5 mL/kg, p.o. of distilled water. The second group D-galactosamine (D-GalN-group as the model group) was injected with 200 mg/kg, i.p. The third group (positive treatment group) was given silymarin at a dose of 100 mg/kg, p.o. The extract (250 and 500 mg/kg) was supplied orally in the fourth and fifth groups (the D-GalN group + low dose of *D. lutescens* extract). On the eighth day (final day), the third, fourth and fifth groups received a single dose of D-GalN group (200 mg/kg i.p.) after 1 h of extract delivery. When compared to the control group, D-GalN group significantly raised GOT, GPT, ALP, total protein, total bilirubin, NO, MDA, hyaluronic acid and MMP1 enzyme levels, while decreasing PON1 levels. Similar to silymarin, *D. lutescens* efficiently corrected these modifications in dosage dependence. | [66] |
| *Phoenix loureiroi* Kunth/ Fruits | Methanolic extract (PFME) | Indomethacin (s.c.), acetic acid (i.c.) and dextran sulphate sodium (DSS) induced models of inflammatory bowel disease (IBD) were examined in Wistar albino rats. Consumption of PFME on a regular basis may help to avoid IBD and lends credence to the fruit’s folkloric use in the treatment of digestive illnesses The PFME significantly inhibited the ulcerative inflammatory damage score in the indomethacin (15.50 to 11.26), acetic acid (20.33 to 12.00) and DSS (5.00 to 3.50) induced groups compared to standards treated groups at doses 50, 100 and 200 mg/kg. | [67] |
| *Phoenix dactylifera* L./ Leaves | Chloroform extract (PLCE) | Pylorus ligation in Wistar rats was utilized to test two dosages of PLCE: 200 and 400 mg/kg. PLCE showed a significant inhibition of mean ulcer score and ulcer index, as well as a marked decrease in gastric content, free and total acidity levels and an increase in pH in a dose-dependent manner, it possessed gastroprotective activity. The ulcer inhibition values were 26.36% and 25.54% for extract doses 200 and 400 mg/kg, respectively when compared to the control group which was 51.63%. | [68] |
| *Areca catechu* L./ Nuts | Ethanolic extract | Ethanol-induced gastric mucosal injury in rats revealed that A. catechu nut ethanolic extract increased ulcer production, as evidenced by significant increases in ulcer area and histologically by comparatively increased ulcer areas (1094.17 ± 59.45, 1253.33 ± 40.65 mm²) for doses 250 and 500 mg/kg, respectively, compared to an ulcer control group (856.67 ± 9.89 mm²). | [69] |
| *Phoenix dactylifera* L./ Fruits | Methanolic extract | In two doses (300 and 600 mg/kg), *P. dactylifera* demonstrated hepatoprotective activity against thioacetamide-induced liver damage in male albino Wistar rats at a dose (200 mg/kg s.c.). Normal group, the values for ALT, AST, ALP, bilirubin and albumin were 36.40 ± 4.28 U/L, 43.20 ± 4.31 U/L, 62.55 ± 5.8 U/L, 8.12 ± 0.52 mol/L and 49.84 ± 4.42 g/L, respectively. The low dose group had respective values that were significantly different from it, whereas the high dose group values were not significantly different from the normal group values. | [70] |
| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|----------------------|---------------------------------|----------------|------|
| Phoenix dactylifera L./ Fruits | Aqueous date extract (ADE) | Oral administration of the ADE to male Wistar rats intoxicated with dichloroacetic acid at 0.5 and 2 g/L as drinking water for two months showed a significant protective effect by lowering hepatic marker enzymes (AST, ALT, LDH and GGT) and conjugated bilirubin levels, as well as improving the histological architecture of the rat liver. | [71] |
| Elaeis guineensis Jacq./ Leaves | Methanolic extract | Mice given the E. guineensis leaf methanolic extract (200 mg/kg) showed a substantial reduction in ALT, AST and bilirubin levels, which were all raised in the paracetamol-treated group. | [72] |
| Areca catechu L./ Seeds | Aqueous extract (ASAE) | The percent protection of ASAE (67-85%) at 2000 mg/kg was substantially higher than that of ASAE at 500 and 1000 mg/kg (18-33%) and silymarin (50-75%) when they were tested against liver injury caused by carbon tetrachloride (CCl₄) in rats. | [73] |
| Elaeis guineensis Jacq./ Red palm oil | The supernatant fluid of African red palm oil (ARPO) | ARPO at dose (1.5 mL/kg) was tested in acute hepatic injuries caused by 800 mg/kg of acetaminophen (APAP). The results suggest that when given up to 2 h after APAP induction, ARPO reduces the consequences of APAP-induced hepatotoxicity, but does not have preventive efficacy. | [74] |

4) Anti-diabetic activity

| Phoenix sylvestris (L.) Roxb./ Leaves | Methanolic and hydro-methanolic extracts | The in-vitro anti-diabetic activity was evaluated by α-amylase and α-glucosidase inhibitory assays. This study revealed different ranges of inhibition of both enzymes; hydro-methanolic extract (26.45-78.48% α-amylase and 29.14-72.30% α-glucosidase) and methanolic extract (26.45-78.48% α-amylase and 38.28-76.07% α-glucosidase) and had comparable anti-hyperglycemic activity in comparison to control (34.73-92.18% α-amylase and 42.24-86.44% α-glucosidase). | [75] |
| Phoenix dactylifera L./ Seeds | Methanolic extract | Alloxan-induced diabetic rats (150 mg/kg, i.p.) were studied. Diabetic rats were given this extract. They showed significant reductions in LDL, cholesterol and blood glucose levels, when compared to the control group. Diabetic rats given the extract at doses (150, 300 and 600 mg/kg) exhibited improvement in glucose tolerance, as well as lowering in the levels of creatinine (0.95±0.1, 0.92±0.5 and 0.86±0.4 mg/dl), urea (52.33±0.1, 45.9±1.4 and 36.54±1.3 mg/dl) and alkaline phosphatase (212.39±3.2, 191.11±1.9 and 182.91±2.3 mg/dl), respectively in their blood. | [76] |
| Phoenix roebelenii O’Brien/ Leaves | Ethanol, methanolic, water, acetone and Pet. ether extracts | In-vitro, anti-diabetic activity was evaluated by inhibitory activity of two enzymes (α-amylase and α-glucosidase). Also, glucose diffusion inhibition assay was investigated. The study tested five extracts at two doses 200 and 400 μg/mL. Among them, ethanolic and methanolic extracts have demonstrated the highest inhibitory activity at 400 μg/mL. The ethanolic extract displayed the highest inhibitory action for both α-amylase (75.5 ± 0.06%) and α-glucosidase (77.5 ± 1.07%) in a concentration-dependent manner. While, the activity of the methanolic extract was extremely similar 70.4 ± 0.62% for α-amylase and 75.5 ± 0.09% for α-glucosidase. For acarbose, the maximum inhibition was 80.7 ± 0.74% for α-amylase and 80.2 ± 0.23% for α-glucosidase at the same dose of the extracts. Regarding glucose diffusion inhibition assay. Also, maximum glucose inhibition was shown by ethanolic extract (69.77 ± 1.00%) at 400 μg/mL. Moreover, the methanolic extract also displayed a significant inhibition (64.87 ± 0.9%) after 180 min at the same dose. Whereas, the acetone and Pet. ether extracts illustrated moderate inhibition at both 200 and 400 μg/mL. Finally, the aqueous extract demonstrated poor inhibition. | [77] |
| Caryota urens Linné/ Starch extracted from “Kithul flour” | Methanolic extract | Inhibition assays for α-amylase and α-glucosidase enzymes were used to assess the results. Up to 5 mg/mL of concentrated C. Urens flour, the percentage inhibition of α-amylase enzyme was 8.42 ± 0.97%, while for boiled flour was 10.77 ± 2.64%. Neither raw nor boiling C. Urens flour showed significant α-glucosidase enzyme inhibitory activity. | [54] |
| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|----------------------|---------------------------------|----------------|-----|
| Calamus erectus Roxb./ Fruits (mesocarp and endocarp) | Methanolic extract | In-vitro antidiabetic activity was evaluated by α-glucosidase and α-amylase inhibition. The methanolic extract of distinct fruit portions (endocarp and mesocarp) demonstrated concentration dependent α-glucosidase (IC50 = 1.69 and 2.00 mg/mL) and α-amylase (IC50 = 2.74 and 3.30 mg/mL) inhibitory activity, respectively. | [60] |
| Raphia gentiliana De Wild./ Fruits | Aqueous extract (RFAE) | In vivo anti-diabetic assay in mice and humans was evaluated. Fasting (18 h) hyperglycemic induced The Naval Medical Research Institute mice were given a dose of 0.2 g/kg, p.o. of RFAE, which resulted in a considerable reduction in blood sugar levels. After 1 and 2 h RFAE, there was a decrease of 27% and 56%, respectively. The observed glycemic index and load for human subjects were -3.1% and -1.36%, respectively. | [78] |
| Cocos nucifera L. | Hydro-methanolic extract | Anti-diabetic activity was evaluated in streptozotocin-induced diabetic rats at a dose (50 mg/kg, b.wt. i.p.). The anti-hyperglycemic efficacy (% of protection) of the C. nucifera hydro-methanolic extract at a dose of 250 mg/kg and 500 mg/kg b.wt. p.o. 21.51 and 30.96, respectively were found to be comparable to glibenclamide at a dose of 0.5 mg/kg p.o. which was 45.34%. | [79] |
| Cocos nucifera L./ Coconut kernel | Coconut kernel protein (CKCP) | Alloxan-induced diabetes (150 mg/kg body weight, i.p) was studied. CKCP has a significant amount of arginine, according to the findings. In diabetic rats, CKCP feeding reduced the rise in glucose and insulin levels. When compared to control diabetic rats, the levels of glycogen in the liver and the activity of carbohydrate metabolizing enzymes in the serum of treated diabetic rats were restored to normal levels. | [80] |
| Lodoicea sechellarum (J.F.Gmel.) Pers. (Sea coconut)/ Fruits | Powdered sea coconut (LFPSC) | In normal and diabetic volunteers, the effects of oral administration of LFPSC on blood glucose and lipid profile were examined. Oral therapy with 2, 3 and 4 g of LFPSC and repaglinide (1 mg) significantly reduced blood glucose in normal (166.2 ± 5.6, 159.0 ± 4.5, 141.2 ± 4.7 and 165.8 ± 4.7) and diabetic patients (212.3 ± 10.2, 220.0 ± 8.3, 218.7 ± 6.6 and 194.5 ± 6.8), respectively. | [81] |
| 5) Renal protective activity |
| Cocos nucifera L. | Coconut water extract | Ethylene glycol in drinking water (0.75%) can induce urolithiasis in male Wistar rats. Treatment with 10% coconut water decreased crystal formation in renal tissue and reduced the quantity of crystals in urine in a Wistar rat model. Furthermore, the extract shielded the kidneys against deterioration in renal function and the formation of oxidative stress. | [82] |
| Phoenix dactylifera L./ Fruits | Flesh and pits aqueous extracts | The animals were given either date flesh aqueous extract combined with food (50% w/w) or pits aqueous extract mixed in drinking water (2:1 w/v), with GM (80 mg/kg/day intramuscularly for 6 days) administered during the final 6 days of treatment. Other groups of rats were administered GM at the same time as the date flesh extract or the date pits extract at the same doses. GM treatment dramatically increased plasma creatinine and urea concentrations and caused renal proximal tubule necrosis. They were efficient in lowering the elevations in plasma creatinine and urea caused by GM nephrotoxicity, as well as ameliorating proximal tubular damage. | [83] |
| 6) Cardioprotective activity |
| Cocos nucifera L. | Dietary coconut sprout | Myocardial infarction was caused by isoproterenol in rats at a dose of 20 mg/100 g, b.wt. The levels of cardiac markers (CK-MB and troponin-T) in the serum of the group given coconut sprout (50, 100, or 200 mg/100 g, b.wt., p.o.) for 45 days showed a decrease. The activities of these cardiac marker enzymes in serum were lowest in rats fed 100 mg/100 g, b.wt. sprout (533.2 ± 51.2 and 0.7 ± 0.1, respectively), indicating superior cardioprotection among the coconut sprout doses investigated. | [84] |
| Plant name/ part used                  | Extract or fraction or compound                        | Method/ Result                                                                 | Ref. |
|---------------------------------------|--------------------------------------------------------|-------------------------------------------------------------------------------|------|
| Cocos nucifera L.                     | Tender coconut water (TCW)                              | Isoproterenol-induced myocardial infarction in rats at a dose of 20 mg/100 g, b.w.t. Rats fed TCW had a considerably greater survival rate than control rats after isoproterenol-induced myocardial infarction. The TCW fed group had a survival rate of 91%, whereas the control group had a survival rate of 66%. | [85] |
| Livistona australis R.Br. Fruit pulp  | The lipophilic fraction and Oleic acid                  | Thirty adult male rats were distributed into three groups of six randomly. The animals were fed a high-fat diet for two months that included a basal diet supplement with 1% cholesterol, 0.2% cholic acid and 10% fat. The anti-hyperlipidemic effect of a Pet. ether extract of L. australis fruit pulp was examined *in vitro*. For 8 weeks, hypercholesterolaemic rats were given 100 mg/kg, b.wt. of palm oil once a day. The reduction in serum cholesterol and triglycerides were 50% and 43.6%, respectively, while the reduction in LDL-C was 71.2% with a significant increase in HDL-C by 101%. | [40] |
| Phoenix sylvestris (L.) Roxb./Leaves   | Methanolic extract (PLME) and hydro-methanolic extract (PLHME) | Evaluated by fructose-induced hypertension method (10% w/v in drinking water) in male Wistar rat. The antihypertensive activity of PLME (35.59-89.65%) and PLHME (33.36-78.47%) in vitro was equivalent to the control (45.62-91.69%), indicating that the plant extracts displayed antihypertensive capabilities. | [75] |
| Cocos nucifera L./Endocarp             | Ethanolic extract (CEEE)                                | CEEE significantly lowered mean systolic blood pressure (from 185.3 ± 4.7 to 145.6 ± 6.1 mm Hg) in the deoxycorticosterone acetate salt-induced hypertension model at a dose of 25 mg/kg, b.wt. | [57] |
| Areca catechu L./ Betel nut            | Aqueous-methanolic extract (70%) Catechin              | A Lumi-aggregometer was used to assess the concentration of platelets in human platelet-rich plasma. Arachidonic acid, adenosine diphosphate (ADP), platelet-activating factor, adrenaline and Ca(2+)-ionophore suppressed platelet aggregation. A. catechu was the most effective inhibitor of aggregation caused by ADP and Ca(2+)-ionophore. The antiplatelet activity was measured in human platelet-rich plasma by using a Lumi-aggregometer. Catechin was significantly less potent than A. catechu, indicating a presence of additional compound(s) with antiplatelet activity. | [86] |
| Phoenix dactylifera L. (Date palm)/Fruits | Ethanol extract                                        | The MTT colorimetric assay was used to assess the viability of the extract PEGylated nanoemulsion against MCF-7 and Hep-G2 cells. The PEGylated nanoemulsion of the extract showed considerable suppression of cancer cell viability, with IC50 values of 18.6 ± 2.4 and 13.5 ± 1.8 µg/mL for MCF-7 and Hep-G2 cell lines, respectively. | [87] |
| Cocos nucifera L./Outer shell fibers   | Aqueous extract                                        | The cytotoxicity of the synthesised silver nanoparticles of the extract was tested on Hep-G2 cells. It had a significant cytotoxicity potential against Hep-G2 cells, with an effective concentration IC50 of 15.28 µg/mL. | [47] |
| Syagrus coronate (Mart.) Becc.         | Fixed oil extract                                      | It was evaluated using the tetrazolium reduction assay in three cell lines: HEK-293 kidney embryonic cells, J774.A1 macrophages and the tumor line Sarcoma-180. The highest concentrations of the oil showed low levels of cytotoxicity. | [88] |
| Phoenix dactylifera L./Fruits          | Aqueous extract                                        | The most effective concentration was 100 mg/mL, as determined by the MTT assay, after 24 h of treatment with date palm fruit extracts, MCF-7 cell viability decreased sharply and dose-dependently with IC50 values of 12 ± 0.02 mg/mL. | [89] |
| Dypsis leptocheilos Hodel/Leaves       | EtOAc fraction and aqueous-methanolic extract (80%)    | MTT cell viability assay was used to assess cytotoxicity. The EtOAc fraction had a stronger cytotoxic activity on MCF-7 cells, with an IC50 of 12.3 ± 1.82 µg/mL, when compared to vinblastine sulfate. | [16] |
| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|-----------------------|---------------------------------|----------------|------|
| *Bactris guineensis* L./ Fruits | The phenolic compounds | For colon and liver adenocarcinomas, MTT cytotoxic experiments show IC₅₀ values ranging from 16.6 to 24.9 μg/mL, with strong selectivity for cancer cells compared to non-tumor cells. A 20 to 50% early apoptotic effect was demonstrated in cancer cells lines by staining (Annexin/PI). | [48] |
| *Caryota mitis* Lour. and *Caryota arense* Linné/ Leaves | Pet. ether, chloroform, EtOAc and ethanol (70%) extracts | NQO1 enzyme was selected as a marker for tracing the cancer chemopreventive effect of *C. mitis* and *C. arense* successive leaf extracts via mechanism-based kinetic colorimetric assay using DCPIP assay. Pet. ether leaf extract of *C. arense* showed the most potent induction of NQO1 enzyme activity (4.79 times to vehicle control) via DCPIP assay and a significant difference was observed at a concentration of 25 μg/mL via NQO1 western blot analysis. | [90] |
| *Hyophorbe verschaffeltii* H.Wendl./ Leaves | Methanolic extract (70%) | The maximum activity was measured against MCF-7 cells using the MTT cell viability assay, with viability of 7.33% for a concentration of 1000 μg/mL of the extract. It is required to achieve 50% inhibition is 323.6 μg/mL. | [91] |
| *Ravenea rivularis* Jum. & H.Perrier/ Leaves | Methanolic extract | Using the MTT cell viability assay, the methanol extract showed a strong cytotoxic effect against MCF-7 cells, with an IC₅₀ value of 70.85 μg/mL, while it displayed no significant cytotoxic effect on Hep-G2, with an increase in cell proliferation as sample concentration was increased. | [36] |
| *Borassus flabellifer* L./ Fresh palm sugar | Ethanolic extracts of young fruits, ripe seed coat and cotyledon | All extracts of *B. flabellifer* were tested in vitro for cytotoxicity against human dermal fibroblast neonatal (HDFn) cell lines and Caco-2 cell lines by Resazaurin microplate assay. All extracts were inactive against HDFn cell lines and Caco-2 cell lines, with the exception of palm sugar at 10% v/v in distilled water, which showed 67.31% HDFn cell line survival. | [92] |
| *Wodyetia bifurcata* A.K.Irvine/ Aerial parts | n-Butanol extract | Cytotoxicity measured against Hep-G2 cells using MTT cell viability assay. n-Butanol extract had weak cytotoxicity activity against Hep-G2 cells, IC₅₀ = 568.5 μg/mL. | [9] |
| *Livistona australis* R.Br./ Leaves | Methanolic extract and tricin 7-O-β-glucopyranosyl-2′-sulphate sodium salt | MTT cell viability assay was used to assess cytotoxicity. Three human cancer cell lines were examined in vitro for cytotoxic activity: colon carcinoma HCT-116, breast carcinoma MCF-7 and liver carcinoma Hep-G2. Tricin 7-O-β-glucopyranosyl-2′-sulphate sodium salt revealed the highest antiproliferative activity with IC₅₀ values of 13.5, 15.2 and 16.5 μg/mL against Hep-G2, MCF-7 and HCT-116, respectively, while the extract exhibited less activity against Hep-G2 and MCF-7 cell lines with IC₅₀ values of 21.9 and 22 μg/mL, respectively and the weakest activity against colon carcinoma HCT-116 with IC₅₀ values of 45.8 μg/mL. | [62] |
| *Livistona chinensis* Jacq./ Roots | 1-O-β-D-Glucopyranosy1-(2S,3S,4R,9Z)-2-[(2R)-2-hydroxydocosanoylaminio]-9-octadecene-1,3,4-triol 1-octadecanoyl-2-nonadecanoyl-3-O-(6-amino-6-deoxy)-β-D-glucopyranosyl-sn-glycerol | The cytotoxicity assay was performed according to the MTT method in 96-well microplates. It showed significantly antiproliferative effects against the human tumor cell lines (K562, HL-60, Hep-G2 and CNE-1) with the IC₅₀ of 10-65 μM. | [42] |
| *Borassus aethiopum* Mart./ Male inflorescences | DCM-methanol extract (50:50) | Cell proliferation was determined by MTT assay. The human colon cancer HT29 cells were used. Incubation of HT29 cells with DME showed significant inhibition of proliferation from the first h with a 100 μg/mL compared to the control group. This inhibition was observed from 2 h of incubation with 1 μg/mL. This inhibition was dose-dependent. | [93] |
| *Phoenix dactylifera* L. (Date palm)/ Fruits | Aqueous extract (FAE) | Investigated by hydrogen peroxide H₂O₂ induced cytotoxicity in Hep-G2, A172, U937 and PC12 cell lines The 1.47 mM H₂O₂ induced damage was greatly prevented by the 10% FAE, notably in the A172 cells. Furthermore, 10% FAE blocked 29.4 μM H₂O₂ induced damage. Simultaneously, in the presence of 10% FAE, U937 cell proliferation was considerably increased compared to control cells. Cells treated with 2.94 mM H₂O₂ showed many apoptotic features, whereas cells exposed to H₂O₂ and FAE concurrently demonstrated total suppression of apoptotic features. | [94] |
### Euterpe precatoria Mart./Roots

| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|-----------------------|---------------------------------|----------------|-----|
| Euterpe precatoria Mart./Roots | Ethanol standard extract (ESE), n-butanol extract from ESE (n-BuOH), leaf stalk ethanol extract (LSE), LSE soluble fraction obtained by treatment with methanol/chloroform 1:1 (LSE-2) and flavonoids (quercetin, catechin, epicatechin, rutin and astilbin) | Extracts were evaluated by the brine shrimp (*Artemia salina*) larvicide bioassay. LSE-2 [LC₅₀ = 271.0 (111.73-658.11)], LSE [LC₅₀ = 523.0 (84.85-977.59)], n-butanol [LC₅₀ = 481.0 (154.58-898.75)] and ESE [LC₅₀ = 1010.0 (342.05-1186.65)] were lower than that of lapachol [LC₅₀ = 68.0 (57.10-79.05)] used as control. | [64] |

### Orbignya speciose Mart./Epicarp and mesocarp

| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|-----------------------|---------------------------------|----------------|-----|
| Orbignya speciose Mart./Epicarp and mesocarp | Ethanolic extract | A viability assay was performed to evaluate the permeability of the cells to the trypan blue dye. Investigated against several cell lines, including the leukaemic cell lines HL60 and K562 (and its multidrug-resistant counterpart K562-Lucena 1), MCF-7, the mouse fibroblast cell line 3T3-L1 and fresh human lymphocytes yielded ID₅₀ values of (9.3 ± 0.8, 33.9 ± 4.3, 55.0 ± 6.1, 48.8 ± 5.7, 127.0 ± 14.3, 141.2 ± 15.4), respectively. | [95] |

### Cocos nucifera L./Husk fibers

| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|-----------------------|---------------------------------|----------------|-----|
| Cocos nucifera L./Husk fibers | Molecular weight fractions of husk fiber aqueous extracts | Lucena 1, a multidrug-resistant (MDR) and vincristine-resistant derivative of K562 was tested on human erythroleukemia cell line K562. The results demonstrated that both variations have nearly identical antitumoral activity against the K562 leukaemia cell line (60.1 ± 8.5 and 47.5 ± 11.9%, respectively, for the usual A and common types). The crude extracts were separated with Amicon membranes into fractions with molecular weights ranging from 1-3 kDa (fraction A) to 3-10 kDa (fraction B) and more than 10 kDa (fraction C). MTT was used to assess cytotoxicity after cells were treated with 500 µg/mL of these fractions. The cytotoxicity of fractions with molecular weights ranging from 1 to 10 kDa was increased. C. nucifera extracts were also found to be effective against Lucena 1, a drug-resistant leukaemia cell line. Their cytotoxicity against this cell line was around 50% (51.9 3.2 and 56.3 2.9, respectively, for types typical A and common). Lucena 1 cells’ viability and anti-MDR activity were reduced by 50% as compared to K562 cells. | [96] |

### Brahea armata/Fruits

| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|-----------------------|---------------------------------|----------------|-----|
| Brahea armata/Fruits | Fractions of the aqueous ethanolic extract | The inhibitory activity of the different extracts on 5α-reductase type II (prostate cancer) was determined using a cell line (HEK293-5aII), that expressed the human recombinant enzyme. The most active extract was kernel ethanolic extract-2 which showed 59% inhibition at a concentration of 1 mg/mL. | [25] |

#### 10B) In vivo

| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|-----------------------|---------------------------------|----------------|-----|
| Euterpe oleracea Mart./Fruit's oil | Oil | Male Wistar rats were treated with oil by gavage at doses of 30, 100 and 300 mg/kg, for 14 days, within a 24 h interval. Showed that animals exposed to oil presented alterations in the liver cells, where the integrity of the liver tissue was increasingly lost as oil doses increased. | [97] |

| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|-----------------------|---------------------------------|----------------|-----|
| Orbignya phalerata Mart./Mesocarp flour | Aqueous extract | Investigated the effect of babassu mesocarp flour aqueous extract (BM) on C3H/HePas mice peritoneal cellular migration and macrophage activation by measuring the nitric oxide (NO), hydrogen peroxide (H₂O₂) and tumor necrosis factor (TNF) release, spreading activity and major histocompatibility complex (MHC) class II expression. Demonstrate that BM injected once ip in mice at 10 and 20 mg/kg increased the cellular influx to the peritoneal cavity, the MHC class II expression and the spreading ability and also induced the production of NO (15 ± 4 and 20 ± 5), TNF (8 and 16) and H₂O₂ (40 ± 5 and 50 ± 10). | [98] |
| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|----------------------|----------------------------------|----------------|-----|
| **11) Anti-mutagenic activity** | | | |
| *Phoenix dactylifera* L./ Fruits | Aqueous extract | On *Salmonella* tester strains TA-98 and TA-100 with metabolic activation, date fruit extract produced a dose-dependent inhibition of benzo(a)pyrene-induced mutagenicity. Extract from 3.6 mg/plate and 4.3 mg/plate was found to be required for 50% inhibition of his revertant formation in TA-98 and TA-100, respectively. demonstrate that date fruit has a high level of anti-mutagenic action. | [65] |
| **12) Neuropharmacological activity** | | | |
| *Phoenix sylvestris* (L.) Roxb./ Fruits | Methanolic extract (MEPS) | Sleeping time test using sodium thiopental. MEPS dosages of 50, 150, 300 and 450 mg/kg resulted in a significant decrease in sleep start (174.31 ± 4.49, 156.6 ± 2.31, 103.83 ± 5.74 and 92.15 ± 5.02) and an increase in sleep duration (40.01 ± 1.11, 50.67 ± 1.30, 71.30 ± 1.81 and 88.73 ± 4.48 min), respectively. | [99] |
| *Calamus rotang* L./ Seeds | Methanolic extract | In hole cross and open field tests, maximum suppression of locomotor activity was 81.42% and 86.61%, respectively, with the larger dose (500 mg/kg) of extract, whereas inhibition rates for the conventional drug diazepam (1 mg/kg) were 87.14% and 91.86%. | [100] |
| *Phoenix dactylifera* L./ Fruits | Methanolic extract | Elevated plus-maze test. The subgroups treated with *P. dactylifera* extract at doses of 100 and 300 mg/kg, as well as diazepam at a dose of 1.0 mg/kg i.p., showed a substantial decrease in time spent in the open arm (83.27 ± 11.60 and 92.05 ± 7.55), as well as a significant rise in time spent in enclosed arms (155.70 ± 17.35 and 150.68 ± 17.43), although the extract at 30 mg/kg was found ineffective. | [101] |
| **13) Anti-convulsant activity** | | | |
| *Cocos nucifera* L./ Roots | Ethanolic extract (REE) | In pentyleneetetrazole-induced seizure models, 60.7% of the mice given 25 mg/kg, ip, REE developed seizures and died 30 min later no animals developed seizures or died in the group that got REE at 80 mg/kg, i.p, even after 24 h. | [102] |
| **14) Anti-acetylcholinesterase (AChE) activity** | | | |
| *Areca catechu* L./ Betel nut | Aqueous-methanolic extract (70%) | The anti-AChE activity was measured spectrophotometrically *in vitro*. The extract showed significant AChE inhibitory activity with almost complete inhibition percentage of the enzyme (90.1 ± 0.4). | [86] |
| **15) Anti-alzheimer activity** | | | |
| *Caryota urens* Linné | Ethanolic extract | Evaluated in Alzheimer's induced mice using various memory retention experiments such as Y maze and Morris water maze (MWM). The selected doses of *C. urens*, 200 mg/kg and 400 mg/kg had a substantial effect on memory and learning processes, however, the larger dose 400 mg/kg had a better effect (39.65%) and escape latency of MWM (19.17 ± 1.57) than the lower dose of 200 mg/kg (36.71%) and escape latency of MWM (19.17 ± 1.57). | [103] |
| **16) Anti-pyretic activity** | | | |
| *Phoenix loureiroi* Kunth/ Leaves | Ethanolic extract | The ethanolic extract confirmed its beginning of action at doses of 200 mg/kg in 2 h (38.42 ± 0.04) and EEPLL 400 (38.42 ± 0.11) and 600 mg/kg (38.23 ± 0.09) in 60 min when tested using the yeast induced hyperpyrexia method at dose 10 mL/kg of 20% aqueous suspension of Brewer’s yeast below the neck’s nap s.c. | [104] |
| *Caryota mitis* Lour./ Leaves | Ethanolic extract, n-hexane, chloroform, EtOAc, ethanol and aqueous fractions | *n*-Hexane and aqueous fractions at dose 400 mg/kg showed considerable antipyretic effect against yeast-induced hyperthermia (10 mL/kg of 20% w/v of aqueous suspension of yeast) when tested in rats. The effect peaked at 3rd h (37.14 ± 0.178 and 37.17 ± 0.186, respectively ) and lasted until the 5th h. | [105] |
| *Borassus flabellifer* L./ Male Flowers | Ethanolic extract (BFEE) | Using yeast-induced pyrexia. BFEE at doses of 150 and 300 mg/kg, b.wt. significantly reversed hyperthermia at both doses after 60 min (36.72 ± 0.10 and 36.37 ± 0.10), respectively. | [106] |
| Plant name/ part used       | Extract or fraction or compound | Method/ Result                                                                                                                                                                                                 | Ref.     |
|-----------------------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| **17) Anti-inflammatory activity**                                                                                                                                                                                                                                                  |
| **17A) In vitro**                                                                                               |                                                                                                                                             |          |
| *Cocos nucifera* L./ Roots | Aqueous and methanolic extracts | *In vitro* testing the ability of aqueous and methanolic extracts to inhibit key inflammation enzymes such as 15-lipoxygenase, phospholipase A2 and cyclooxygenases 1 and 2. *C. nucifera* root extracts inhibited the activity of 15-LOX (IC_{50} = 24.57 ± 1.16 and IC_{50} = 8.31 ± 0.73), sPLA2 (not determined (nd) and 24.68 ± 0.08), COX-1 (nd and 27.21 ± 1.66) and COX-2 (nd and 39.41 ± 1.36), respectively. | [45]     |
| *Ravenea rivularis* Jum. & H.Perrier/ Leaves                | Methanolic extract              | *In vitro* by Nitric oxide technique, methanolic extract at dose 125 μg/mL showed anti-inflammatory effect (66% inhibition) in comparison with dexamethasone at dose 50 ng/mL (65% inhibition). | [36]     |
| *Areca catechu* L./ Seeds                                   | Aqueous extract                 | Determining *in vitro* anti-inflammatory activity against 5-lipoxygenase. Aqueous extract exhibited 5-LOX inhibitory action, with IC_{50} 25.07. The positive reference, NDGA (IC_{50} = 59.50 ± 1.04 μg/mL), had a value that was two-fold lower. | [73]     |
| **17B) In vivo**                                                                                                 |                                                                                                                                             |          |
| *Phoenix loureiroi* Kunth/ Leaves                           | Ethanolic extract (DLEE)        | Carrageenan-induced rat paw edema method was used. The ethanolic extract showed maximum inhibition of 32.24%, 38.16% and 45.4% at doses of 200, 400 and 600 mg/kg, p.o., respectively, after 3 h of medication administration, whereas the therapeutic drug ibuprofen (10 mg/kg, p.o.) illustrated 46.72% inhibition. | [104]    |
| *Dypsis lutescens* H.Wendl./ Leaves                         | Ethanolic extract               | In five groups of six rats, two doses (250 and 500 mg/kg, p.o.) of DLEE were tested. Anti-inflammatory mediators were tested and found to have the ability to inhibit pro-inflammatory enzymes as following hyaluronic acid (37.78 ± 1.26 and 29.79 ± 1.27) and matrix metalloproteinase (814.51 ± 20.25 and 629.18 ± 18.64) for low and high dose, respectively. | [66]     |
| *Caryota mitis* Lour./ Leaves                                | Ethanolic extract, n-hexane, chloroform, EtOAc, n-butanol and aqueous fractions                                                          | Carrageenin-induced rat hind paw edema was studied. The anti-inflammatory action of the various extracts begins within the first h, increases in strength in the 2\textsuperscript{nd} and 3\textsuperscript{rd} h and lasts until the 5\textsuperscript{th} h. The aqueous fraction had the highest percentage of anti-inflammatory activity (42.67%), while the n-butanol fraction had the lowest (17.09%) at 2\textsuperscript{nd} h. | [105]    |
| *Hyophorbe verschaffeltii* H.Wendl./ Leaves                 | Methanolic extract              | The methanolic extract (500 mg/kg) exhibited long-term anti-inflammatory activity than diclofenac sodium (100 mg/kg) as it showed continuous and significant inhibition of edema by 48.54% and 44.2% at 8\textsuperscript{th} and 12\textsuperscript{th} h, respectively when tested *in vivo* using carrageenan-induced rat hind paw edema model 0.1 mL, 1% carrageenan suspension injected sub-planter into the rat's hind paw. | [91]     |
| *Calamus rotang* L./ Seeds                                  | Methanolic extract              | In carrageenan-induced paw edema the sub-planter administration of 0.1 mL of 1% carrageenan, it showed a significant reduction in paw edema at doses of 250 and 500 mg/kg after 30 min (10.11% and 12.68%, respectively) and after 240 min (11.24% and 16.27%, respectively), when compared to indomethacin at dose 10 mg/kg [17.46% (after 30 min) and 20.34% (after 240 min)]. | [100]    |
| *Cocos nucifera* var. *typica* L./ Husk fiber               | Aqueous crude extract           | Inflammation models (formalin-induced licking and subcutaneous air pouch) were tested using *C. nucifera* aqueous crude extract (10, 50 and 100 mg/kg) and the standard medicines morphine (1 mg/kg) and acetylsalicylic acid (100 mg/kg). Firstly, formalin-induced licking model, the extract treatment induced dose-dependent inhibition, indicating an anti-inflammatory effect. Secondly, the subcutaneous air pouch, pre-treatment with 10 mg/kg of the extract was not able to significantly decrease the number of leukocytes. Nevertheless, pre-treatment with the other doses of extract (50 or 100 mg/kg) significantly inhibited the cell migration. The extract also suppressed the inflammatory process by reducing protein extravasation, cell migration and TNF-α production with 100 mg/kg extract. | [57]     |
| Plant name/ part used       | Extract or fraction or compound | Method/ Result                                                                                                                                                                                                 | Ref. |
|-----------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| *Acrocomia aculeate* Jacq.  | Pulp oil                        | *A. aculeata* oil exhibited anti-inflammatory properties, which resulted in a significant reduction in carrageenan-induced hind paw edema (67% versus 7% after 2 h). Furthermore, oral administration of *A. aculeata* oil at 300 and 700 mg/kg dosages effectively prevented leukocyte migration to the pleural cavity produced by carrageenan in rats. Inhibition levels were 91 ± 3% and 81 ± 16%, respectively. | [107]|
| *Borassus flabellifer* L./ Male Flowers | Ethanolic extract               | Acute inflammation model, such as carrageenan induced paw edema in mice with 0.1 mL of 1% carrageenan (in 1% CMC) solution into the sub-plantar region of the right hind paw. In comparison to control, the extract at dosages of 150 and 300 mg/kg, b.wt., as well as diclofenac sodium 100 mg/kg, b.wt. (standard), exhibited maximum anti-inflammatory activity at 6h (1.498 ± 0.007032 and 1.288 ± 0.007923), respectively. | [106]|
| *Phoenix loureiroi* Kunth/ Leaves | Ethanolic extract (PLEE)         | Writhing test by single i.p. injection of 10 mL/kg of 0.6% acetic acid in mice was used. The percentage inhibition of writhes was 33.34%, 57.04% and 66.62% were obtained at doses of 200, 400 and 600 mg/kg, p.o., of PLEE, respectively, whereas the percentage inhibition of writhes for standard drug aspirin (69.02%) was obtained at a dose of 100 mg/kg, p.o. | [104]|
| *Caryota mitis* Lour./ Leaves | Ethanolic extract, n-hexane, chloroform, EtOAc, n-butanol and aqueous fractions | Induction of inflammation by the acetic acid (10 mL/kg of 0.7% v/v) induced writhing in mice. All the tested samples at a dose of 400 mg/kg showed varying significant analgesic activity. The total ethanolic extract and EtOAc fraction showed a higher percentage of inhibition than the other samples (96.1% and 92.85%), respectively. | [105]|
| *Phoenix sylvestris* (L.) Roxb./ Fruits | Methanolic extract (PSFME)       | In a hot plate test, oral administration of PSFME resulted in a substantial increase in latency period to thermal stimuli at dosages of 300 and 450 mg/kg at 120 min (6.60 ± 0.28 and 8.88 ± 0.55), respectively. | [99] |
| *Calamus rotang* L./ Seeds   | Methanolic extract (CSME)        | Acetic acid-induced writhing (0.7% v/v i.p.) and formalin-induced pain procedures (20 µL 5% into the dorsal surface of the right hind paw) were used to assess the analgesic activity. At a dose of 500 mg/kg, it inhibited acetic acid-induced pain by 51.27%, while indomethacin (10 mg/kg) inhibited acetic acid-induced pain by 58.86%. CSME (500 mg/kg) caused 68.47% inhibition in a formalin-induced test, while indomethacin produced 70.72% inhibition. | [100]|
| *Cocos nucifera* L./ Crude husk-fiber | Ethanolic extract               | Analgesic activity was evaluated by acetic acid (10 mL/kg of 2% v/v, i.p.)-induced abdominal writhing, test in mice. The ethanolic extract at doses (50, 100 and 150 mg/kg) significantly inhibited writhing by 24%, 34% and 52.4%, respectively, when compared with a control group. | [57] |
| *Areca catechu* L./ Leaves and stems | Methanolic extract              | Induction of inflammation by acetic acid-induced gastric pain writhing model in Swiss albino mice at a dose of 10 mL/kg (1% acetic acid v/v). The leaf extract demonstrated higher antinociceptive activity (55.8%, 57.7%, 86.5% and 88.5%) than the stem extract (30.8%, 36.6%, 40.9% and 59.6%) for doses (50, 100, 200 and 400 mg/kg, b.wt.), respectively. | [108]|
| *Borassus flabellifer* L./ Male Flowers | Ethanolic extract               | Using of acetic acid (10 mL/kg of 6% v/v, i.p.) caused writhing in mice. At doses of 150 and 300 mg/kg, b.wt. of ethanolic extract a significant reduction in the number of writhes induced by acetic acid (30.67 ± 2.84 and 19.33 ± 1.56), respectively. | [106]|

### 19) Antimicrobial activity

| Plant name/ part used       | Extract or fraction or compound | Method/ Result                                                                                                                                                                                                 | Ref. |
|-----------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| *Dypsis leptochelios* Hodel/ Leaves | EtOAc fraction (EAF) and aqueous methanolic extract (80%, AME) | The agar diffusion method was used to assess antimicrobial activity. It revealed significant activity against Gram-positive *S. aureus* (10.00 and 12.00), Bacillus subtilis (8.50 and 7.50) and Gram-negative *S. typhimurium* (no activity and 10.50), *E. coli* (9.50 and 11.50) microorganisms for AME and EAF, respectively. | [16]|
| *Cocos nucifera* L./ Dorsal side of the leaves | Water, ethanolic (70%), chloroform and diethyl ether extracts | On Müller Hinton agar medium, evaluated using the disc diffusion method. Ethanolic and water extracts were shown to have antibacterial activity among the four extracts. In comparison to ciprofloxacin 10 mm and control, the ethanolic (70%) and aqueous extract revealed inhibition zones (5.0 mm and 3.5 mm) against *E. coli*, respectively. | [109]|

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| Plant name/ part used | Extract or fraction | Method/ Result | Ref. |
|----------------------|---------------------|----------------|------|
| Borassus flabellifer L./ Fruits | Aqueous extract (BFAE) | Using the agar disc diffusion method on Müller Hinton agar, BFAE was evaluated against pathogenic bacteria B. cereus, B. subtilis, S. aureus, P. aeruginosa and E. coli. When, BFAE (30 μL) was added, a 23 mm diameter zone of inhibition was found against S. aureus. BFAE demonstrated IZs of about 24 and 28 mm in diameter against 20 and 30 μL of B. subtilis. | [50] |
| Mauritia flexuosa L. f./ Fruits | Chloroform, EtOAc and ethanolic fractions | The micro dilution method was used to test antibacterial and antifungal activities (B. cereus, S. aureus, E. coli, S. choleraesuis, C. albicans, C. krusei and C. tropicalis). The fractions have significant antimicrobial activity against Gram-positive and Candida strains. The most expressive result was obtained from the association of the chloroform fraction with cefotaxime, which produced a synergistic effect, reducing the MIC of the antibiotic from 1,024 to 256 μg/mL. | [51] |
| Caryota mitis Lour./ Leaves | Ethanol extract, n-hexane, chloroform, EtOAc, n-butanol and aqueous fractions | In comparison to the positive controls, the ethanolic extract and aqueous fraction had moderate bactericidal activity against S. aureus and E. coli, causing IZs (7-10 mm) and MIC (2.5 and 5 mg/mL). The EtOAc fraction had the strongest bactericidal activity against S. aureus when compared to the positive control (Ampicillin), causing IZ (20 mm) and MIC (2.5 mg/mL) and moderate activity against E. coli when compared to the positive control (Gentamycin), causing IZ (11 mm) and MIC (2.5 mg/mL). In comparison to positive controls, the n-butanol fraction showed high bactericidal activity against both S. aureus and E. coli, with IZs (17-19 mm) and MIC (2.5 mg/mL). The antifungal investigation against C. albicans strains demonstrated that the n-butanol and aqueous fractions had a considerable antifungal activity with IZ (12 mm) and MIC (5 mg/mL), while the other extracts had no antifungal activity. | [110] |
| Hyophorbe verschaffeltii H. Wendl./ Leaves | Methanolic extract (70%) | Antimicrobial activity against the microbial strains; B. subtilis, S. aureus, E. coli, P. aeruginosa, A. niger and C. albicans was evaluated using the standard agar well diffusion technique. Antibacterial activity of this extract (100 mg/mL) revealed that moderate bactericidal activity against B. subtilis, E. coli and strong bactericidal activity against P. aeruginosa with IZs of 16, 16, 13.5 mm diameter, respectively, relative to positive control (Ampicillin: 5 mg/mL). Furthermore, it showed antifungal effectiveness with the same concentration against C. albicans (IZ 22 mm), when compared to fluconazole (5 mg/mL) with IZ 40 mm, but both of them had no inhibition against A. niger. | [91] |
| Cocos nucifera L./ Fruits | Crude ethanolic, Chloroform, EtOAc, methanol and water extracts | Antifungal activities of the extracts were determined using the strip dilution method using Sabouraud dextrose agar. They were evaluated against A. flavus, A. fumigatus, A. niger, M. canis, M. gypseum, T. mentagrophytes, T. rubrum and T. verrucosum. Mycosis clinically isolated from Tinea corporis (ringworm)-infected patients. All measurements were recorded at 30 °C after 72 h. The percentage of inhibition activity was observed with methanolic extract from 90% to 77%. Moreover, the percentage of inhibition activity was recorded with EtOAc extract from 90% to 72%. Furthermore, the percentage of inhibition activity was observed with chloroform extract from 72.5% to 62%. | [52] |
| Cocos nucifera L./ Mesocarp | Acetone, benzene, chloroform, diethyl ether, ethanolic and formaldehyde extracts | The antibacterial activity against E. coli was stronger with the benzene solvent (IZ = 18 mm), but bioactivity against S. typhi was higher with the diethyl ether extract (IZ = 20 mm) when tested using the disc diffusion method. | [57] |
| Cocos nucifera L./ Endocarp | Ethanolic and aqueous extracts | The endocarp extracts showed substantial antibacterial action against B. subtilis, P. aeruginosa, S. aureus and M. luteus, when tested using the Kirby-Bauer disc diffusion method, but did not affect on E. coli. | [57] |
| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|----------------------|---------------------------------|----------------|-----|
| *Rhapis excels* Thumb./ Leaves | Methanolic extract | The extract was tested against a variety of *S. aureus* strains, including methicillin-resistant *S. aureus* (MRSA) by the disc diffusion method. It had little antibacterial action on its own, but it did show the ability to enhance the antibacterial activity of ciprofloxacin, tetracycline and oxacillin IZs (29.9 ± 2.3, 10.3 ± 0.6 and 20.0 ± 0.0). | [56] |
| *Cocos nucifera* L./ Husk | Alcoholic and hydro-alcoholic extracts | The antibacterial activity of husk extracts increased with increasing concentration and was found to be more efficient against Gram-negative (*P. vulgaris*) than Gram-positive (*S. aureus*) organisms using the disc diffusion method. *P. vulgaris* was shown to be more resistant to extracts with IZ 12 mg/mL as in the standard streptomycin. | [111] |
| *Hyphaene thebaica* L./ Fruits | Methanolic/ultrasonic (MU), methanol/water bath (MW), ethanol/ultrasonic (EU) and ethanol/water bath (EW) extracts | The extracts were tested *in vitro* against *S. aureus, L. monocytogenes, E. coli* and *S. typhi* using an agar disc diffusion assay. The extracts showed strong antibacterial activity against *S. aureus* and *S. typhi*, while the MU extract inhibited the growth of all pathogenic bacteria used in this study with IZs (*S. aureus*: 14.2± 0.72, *L. monocytogenes*: 8.2 ± 0.56, *E. coli*: 4.6 ± 0.53 and *S. typhi*:15.5± 0.81). | [58] |
| *Syagrus coronate* (Mart.) Becc./ Leaves, inflorescences, nut-shell, liquid and solid endosperm nuts | Aqueous and methanolic extracts | The aqueous extract was effective against *B. cereus* and the three *S. aureus* strains by agar diffusion test and the associated MIC and MCB values were lower (0.19, 0.78, 0.78 and 0.78) and (0.78, 3.12, 3.12 and 3.12) than those of the dichloromethane, EtOAc and butanol fractions of the same extract. The MIC and MBC values of the methanolic extract were greater (0.78 and 0.78) than those of EtOAc (1.56 and 6.25) and butanol (1.56 and 3.12) fractions of the same extract against *B. cereus*. | [112] |
| *Elaeis guineensis* Jacq./ Leaves | Methanolic extract | The antimicrobial activity was investigated using the disc diffusion method. The methanolic extract demonstrated high antibacterial efficacy *in vitro* against Gram-positive (*S. aureus* and *B. subtilis*), Gram-negative (*E. coli*, *Klebsiella pneumonia*, *Proteus mirabilis*, *P. aeruginosa* and *S. typhi*) and yeast (*C. albicans* and *Saccharomyces cerevisiae*) bacteria, as well as fungi (*Fusarium sp.*, *Fusarium oxysporium*, *A. niger*, *A. flavus*, *M. canis*, *Penicillium sp.*, *Mucor sp.*, *Rhizopus sp.*, *Trichoderma viride* and *T. mentagrophytes*), with IZs ranging from 11 to 15 mm. | [113] |
| *Phoenix dactylifera* L./ Spathe | Essential oil | The antibacterial activity of the essential oil was tested using the broth microdilution method against a variety of human infections, where a low inhibitory was observed (MIC 1000 µg/mL). The oil was evaluated further for antifungal activity against the strawberry anthracnose-causing fungal plant pathogens *C. acutatum*, *C. fragariae* and *C. gloeosporioides* using the direct overlay bioautography assay. As a result, the essential oil showed no antifungal activity at 80 and 160 µg/spot concentrations compared to standard antifungal agents. | [114] |
| Virgin coconut oil | Oil | The agar-well diffusion technique was used to investigate 52 recent *Candida* species with virgin coconut oil and fluconazole. *C. albicans* (17 isolates) was the most common isolate from clinical specimens, followed by *C. glabrata* (9 isolates), *C. tropicalis* (7 isolates), *C. parapsilosis* (7 isolates), *C. stellatoidea* (6 isolates) and *C. krusei* (6 isolates). Coconut oil had the maximum susceptibility (100%) with an MIC of 25% (1:4 dilution), while fluconazole had 100% susceptibility with an MIC of 64 µg/mL (1:2 dilution). With an MIC of 100% (undiluted), *C. krusei* demonstrated the most resistance to coconut oil, while fluconazole had a MIC of 128 µg/mL. When compared to fluconazole, coconut oil was effective against *Candida* species at 100% concentration. | [115] |

### 20) Anti-parasitic activity

| Plant name/ part used | Extract or fraction or compound | Method/ Result | Ref. |
|----------------------|---------------------------------|----------------|-----|
| *Cocos nucifera* L./ Husk fiber waste | EtOAc (CHEE) extract | Administration of CHEE (300 mg/kg, 0.2 mL) to *Leishmania braziliensis*-infected hamsters for 21 days did not reduce infected footpad edema or lymph node drainage weight, but decreased skin lesions after 14 days. | [57] |
| Plant name/ part used                     | Extract or fraction or compound | Method/ Result                                                                                                                                                                                                 | Ref. |
|------------------------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| *Cocos nucifera* L./ White flesh parts of the coconut | Methanolic extract | Several doses of methanolic extracts (50, 100, 200 and 400 mg/kg, p.o.) were tested in mice for antimalarial effectiveness against *Plasmodium berghei* (NK65) during early, established and residual infections. The reference medications were chloroquine (20 mg/kg) and pyrimethamine (1.2 mg/kg). In all three *in vivo* assessment experiments, the extract considerably reduced parasitaemia at 200 and 400 mg/kg dosages (2.00 ± 0.45 and 1.20 ± 0.20, respectively). On the other hand, it had no effect on the survival time of sick mice. | [116] |
| *Cocos nucifera* L./ Bark of the green coconut | Liquid and *n*-butanol extracts | Liquid extract of the green coconut bark did not reveal anthelmintic activity against the mouse intestinal worm burden nematodes *in vivo*, when compared to the negative control group. However, the *n*-butanol extract at 500 and 1000 mg/kg, demonstrated mean efficacy of 62.72% and 98.36%, respectively. | [117] |

**Figure 1:** Chemical structures of previously reported compounds of family Arecaceae (2021-2006).
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3. Conclusion

This review affords valuable information about the different phytoconstituents and biological activities of the family "Arecaceae" including 29 genera, and 49 species from 117 peer-reviewed articles. It is reported that "Arecaceae" plants contain different classes of chemical constituents including flavonoids, lignans, stilbenes, sterols, triterpenes, simple phenolic glycosides, phenolic acids, and their derivatives, fatty derivative compounds, sugars, miscellaneous compounds, together with several medicinal benefits such as anti-hyperlipidemic, anti-diabetic, anti-oxidant, anti-parasitic, anti-convulsant, renal protective, cardioprotective, cytotoxic, anti-microbial (antibacterial, antifungal and antiviral), anti-pyretic, anti-inflammatory, anti-mutagenic, hepatoprotective, antihypertensive, analgesic, anti-ulcer, neuropharmacological, anti-platelet, anti-acetylcholinesterase, and anti-alzheimer. According to the present review, many genera of the family "Arecaceae" are considered to be good points of interest that need more studies to isolate many classes of secondary metabolites as derivatives of (lignan, stilbenoid and triterpenoidal), simple phenolic glycosides and to explore the mechanisms of action of their pharmacological activities assisting the development and discovery of new or novel natural products.

Abbreviations

ALT: Alanine aminotransferase; ALP: Alkaline phosphatase; AST: Aspartate aminotransferase; A. flavus: Aspergillus flavus; A. fumigatus: Aspergillus fumigatus; A. niger: Aspergillus niger; ABTS: (2,2-Azinois-(3-ethylbenzo-thiazoline-6-sulfonic acid); B. cereus: Bacillus cereus; B. subtilis: Bacillus subtilis; b.wt.: Body weight; BHT: Butylated Hydroxytoluene; C. albicans: Candida albicans; C. acutatum: Colletotrichum acutatum; C. fragariae: Colletotrichum fragariae; C. gloeosporioides: Colletotrichum gloeosporioides; CK-MB: Creatine kinase-MB; DCM: Dichloromethane; DCPIP: 2,6-Dichlorophenolindophenol redox dye; DPPH: (2,2-Diphenyl-1-picryl hydrazyl); Epicut. wax: Epicuticular wax; E. coli: Escherichia coli; EtOAc: Ethyl acetate; EDTA: Ethylenediamine tetraacetic acid; FRAP: Ferric reducing ability of plasma; GGT: Gamma-glutamyl tansferase; GM: Gentamicin; GOT: Glutamate oxaloacetate transaminase; GPT: Glutamate pyruvate transaminase; GSH: Glutathione; IZs: Inhibition zones; IC50: Inhibitory concentration 50%; i.c.: Intracerebral injection; i.p.: Intraperitoneal injection; LDH: Lactate dehydrogenase; LC50: Lethal Concentration 50%; LPO: Lipid peroxidation; L. monocytogenes: Listeria monocytogenes; LDL: Low-density lipoprotein; MDA: Malondialdehyde; MMP1: Matrix metallopeptidase 1; M. luteus: Micrococcus luteus; M. canis: Microsporum canis; M. gypseum: Microsporum gypseum; MBC: Minimum Bactericidal Concentration; MIC: Minimum Inhibitory Concentration; NO: Nitric oxide; NDGA: NORDiHydroguaiaretic acid; PON1: Paraoxonase; P.O.: Per oral; Pet. ether: Petroleum ether; PBS: Phosphate buffered saline; P. vulgaris: Pseudomonas aeruginosa; Poll. grains; Pollen grains; S. typhi: Salmonella typhi; SC50: Scavenging capacity 50%; S. aureus: Staphylococcus aureus; s.c.: Subcutaneous injection; TLC: Thin layer chromatography; TBARS: Thiobarbituric acid reactive substances; T. mentagrophyte: Trichophyton mentagrophytes; T. rubrum: Trichophyton rubrum and T. verrucosum: Trichophyton verrucosum.

Conflict of Interests

The authors declare that there is no conflict of interests regarding this review.

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Figure 2: Distribution of the reported secondary metabolites of family Arecaceae (2021-2006).
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