Chempublish Journal
Journal Homepage: online-journal.unja.ac.id/chp
Department of Chemistry
Faculty of Science and Technology
Universitas Jambi
ISSN (Online): ISSN 2503-4588
No. 23/E/KPT/2019

Review

Secondary Metabolites of The Fabaceae Plant Family: A Review of Extraction Methods, Molecules and Bioactivity

Momodou Salieu Sowe[1*], Anayo Christian Etonihu[2], Indra Lasmana Tarigan[3], Afidatul Muadifah[4]

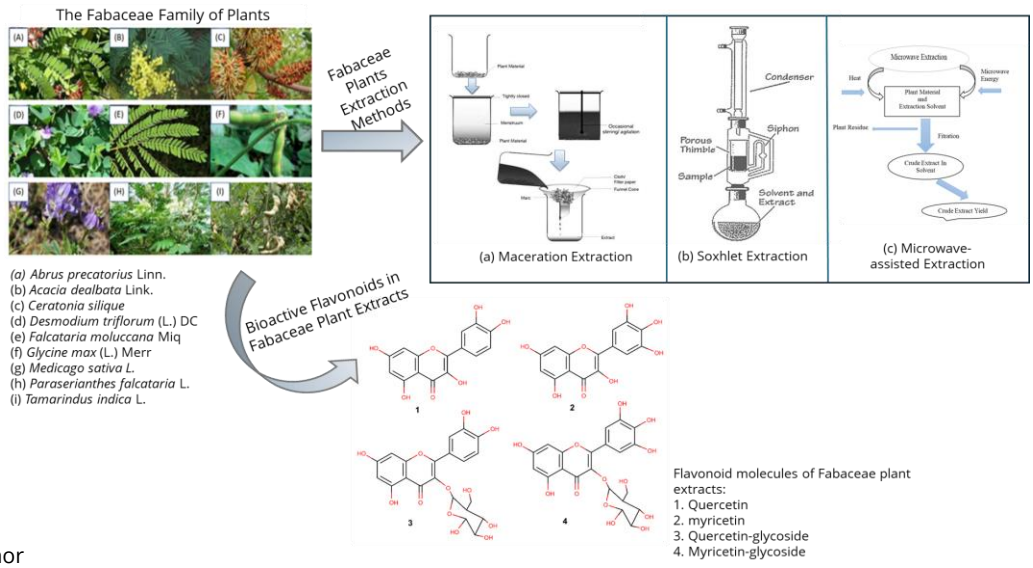
[1,2] *Chemistry Unit, Division of Physical & Natural Sciences, School of Arts & Sciences, University of The Gambia, Brikama Campus, The Gambia. P.O. Box 3530*
[3] *Department of Chemistry, Faculty of Science and Technology, Universitas Jambi, Indonesia*
[4] *Department of Pharmacy, STIKES Karya Putra Bangsa, Tulungagung 66291, East Java, Indonesia*

Abstract

Traditional medicine helps manage and treat various illnesses worldwide, particularly in Africa and Asia. For example, Traditional Indonesian Medicine (Jamu), Traditional Indian Medicine (Ayurveda), and Traditional African Medicine use a range of indigenous herbs to treat health conditions like fevers, malaria, diarrhea, diabetes mellitus, Asthma, and hypertension. Alkaloids, flavonoids, saponins, terpenoids, and polyphenols are bioactive substances with anti-inflammatory, antibacterial, and antioxidant effects in plants. The Fabaceae family consists of flowering plants, peas, legumes, woody trees, and shrubs. Fabaceae plants are widely used across Africa and Asia for traditional medicinal purposes. In addition, Fabaceae plants have significant economic value as a source of wood for the timber industry. This review highlights extraction methods, isolated molecules, and antimicrobial and antioxidant activity of Fabaceae plants found in Africa and Asia. We also detailed secondary metabolite molecules extracted from Fabaceae plant body parts and their identified bioactivities. This review compiles scientific information on the phytochemicals and pharmacological properties of plants in the Fabaceae family that could be useful for future drug candidate investigations.

Keywords: *Extraction*, *Fabaceae plants, molecular structure, traditional medicine*

Graphical Abstract



* Corresponding author
Email addresses: mssowe@utg.edu.gm

DOI: https://doi.org/10.22437/chp.v9i1.36964
Received August 31st 2024; **Accepted** January 01st 2025; **Available online** June 01st 2025

Introduction

Plants are systematically classified into phylum, class, family, genus, and species, enabling researchers to target specific groups, such as Fabaceae, for bioactive compound investigations [1]. The Fabaceae family of plants, also called Lugiminosae, has a diverse composition of about 20,000 species of plants distributed in about 727 genera [2,3]. The Fabaceae family is the third-known largest family of higher plants in the Plant Kingdom, with members mostly being flowering plants such as legumes, peas and trees, shrubs, and herbs (Figure 1) [4].

Human diseases and ailments are traditionally treated with various plant species from the Fabaceae family [5]. Fabaceae plant species are in many parts of Africa and Asia because they adapt to different climatic and environmental conditions suitable for wider ecological distribution [6,7]. Traditional medicine plays a vital role in primary healthcare across Africa and Asia, where Fabaceae plants are widely used due to their diverse bioactive compounds [8]. Compared to Asia, Africa is limited in terms of well-documented literature on phytochemical, pharmacological, and bioactivity studies of medicinal plants despite reports indicating that 80% of the population on the continent relies on some form of traditional medicine to treat ailments [9].

There is a vast potential to investigate the phytochemical constituents and pharmacological potentials of plants in Africa and Southeast Asia. For example, *Senna alata*, a shrub of the Fabaceae family and Caesalpinioideae subfamily found in Ghana, Nigeria, Niger, and Togo, has shown promising evidence of antimicrobial and analgesic properties against bacterial and inflammatory diseases [10-12]. Similarly, *Cassia siamea* of the Fabaceae family and Caesalpinioideae subfamily is traditionally used in North Sumatra, Indonesia, as an antimalarial plant. Antimalarial screening of *C. siamea* has shown potency for antimalarial activity, and phytochemical screening of *C. siamea* extracts has revealed alkaloids, flavonoids, tannins, steroids, triterpenoids, and cumarines [13].

Secondary metabolites, which have various structural variations and are non-nutritive chemical substances, oversee secondary metabolic mechanisms in plants, including communication and defence [14]. Secondary metabolite compounds are biologically active anti-inflammatory, anticancer, antibacterial, antimalarial, and antioxidant agents [15].

Recent advances in phytochemical and pharmacological research have highlighted the potential of secondary metabolites as single therapeutic agents or in combination for drug development [16]. The efficiency of extracting and isolating these compounds from plant sources largely depends on the choice of solvent and extraction technique. Traditional methods, such as maceration, Soxhlet extraction, and distillation using polar solvents, remain widely used [17]. However, recent studies have explored alternative approaches, including ultrasound-assisted extraction (UAE), microwave-assisted extraction (MAE), and pressurized-liquid extraction (PLE) [18]. These non-conventional techniques, which utilize pressure and wave-based energy, offer significant advantages in terms of extraction speed and reduced solvent consumption [19].

Fabaceae species have been widely studied for their secondary metabolites and bioactivities, including anticancer, antimicrobial, and antioxidant effects [20]. Phytochemical analyses have identified compounds such as alkaloids, flavonoids, saponins, tannins, steroids, and terpenoids in various plant parts—leaves, bark, stems, and roots (Figure 1) [21,22]. Structural characterization using mass spectrometry and NMR has confirmed these metabolites (Figures 2a–2c) [23–25]. Several extracts from Fabaceae plants have shown notable antioxidant, anticancer, anti-inflammatory, antibacterial, and antimalarial properties, supporting their potential use in drug discovery and development [20–25].

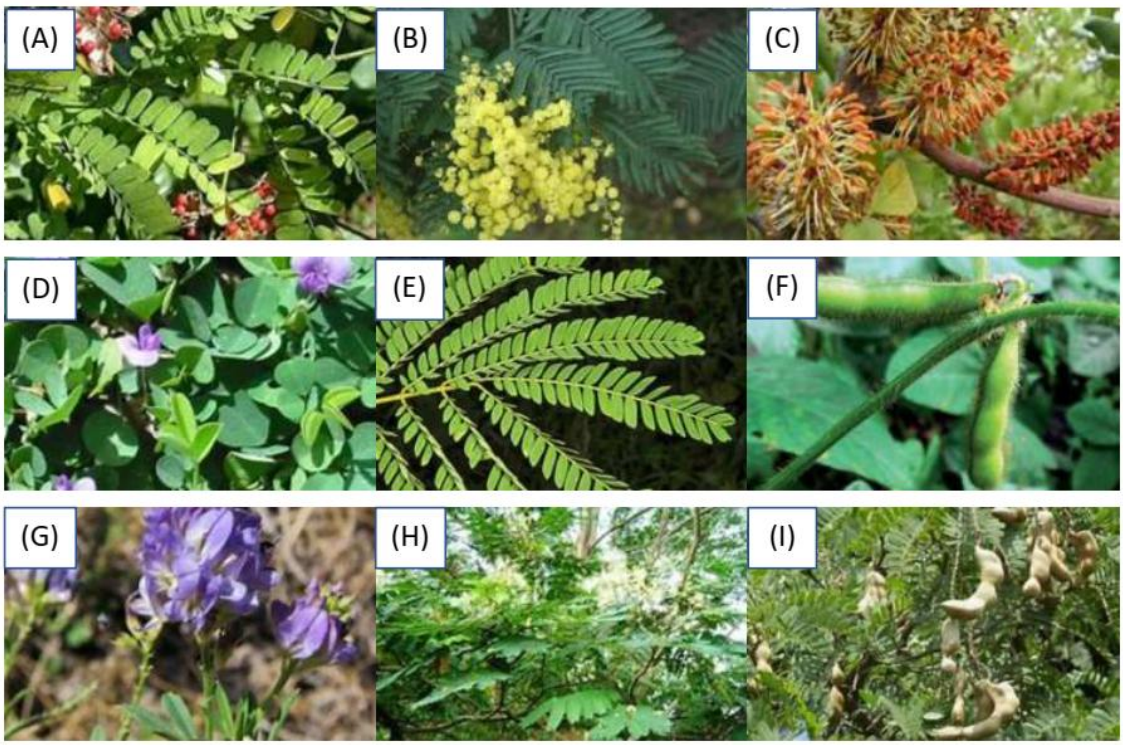


Figure 1. Pictorial representation of plants of the Fabaceae family: (a) *Abrus precatorius* Linn., (b) *Acacia dealbata* Link., (c) *Ceratonia silique,* (d) *Desmodium triflorum* (L.) DC, (e) *Falcataria moluccana* Miq, (f) *Glycine max* (L.) Merr, (g) *Medicago sativa L.*, (h) *Paraserianthes falcataria* L., (i) *Tamarindus indica* L.

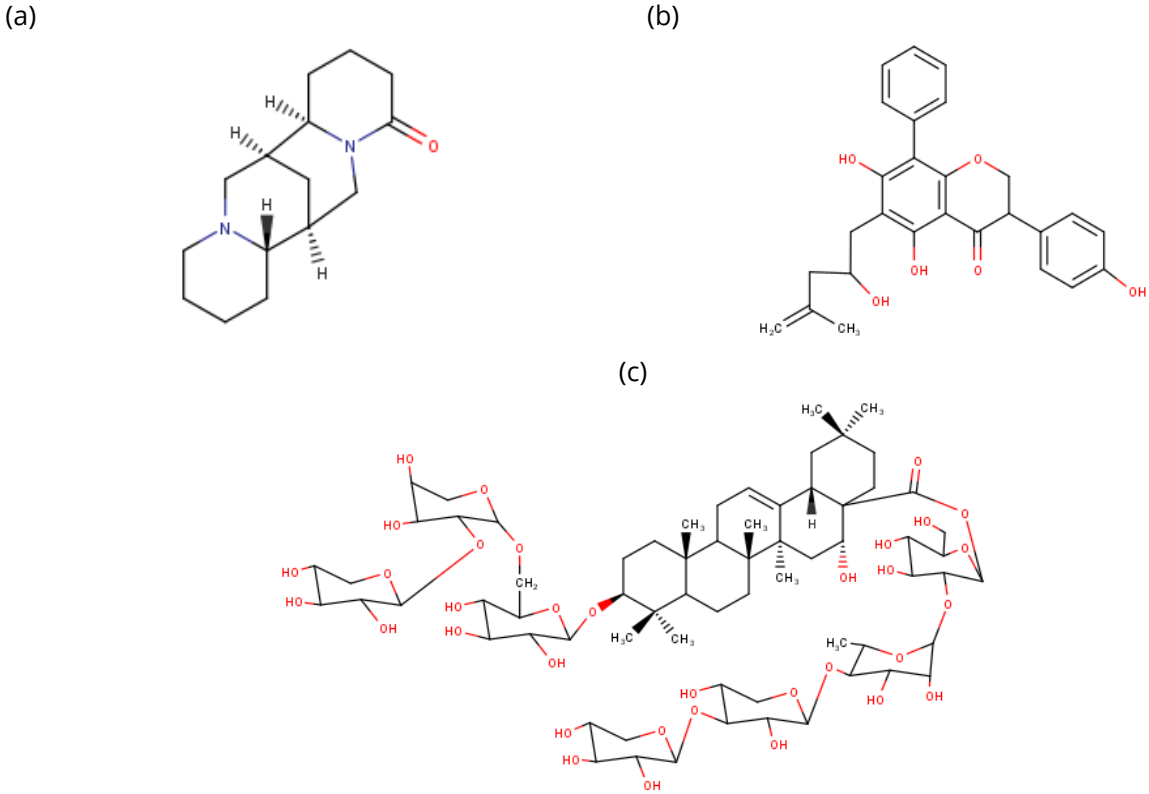


Figure 2. Chemical structures elucidated in Fabacaea plant extracts: (a) quinolizidine alkaloid (lupanine), (b) phenylated flavonoid (isoflavone), and (c) bisdesmosidic triterpenoid saponin.

In this review article, we discussed extraction methods applied in secondary metabolite isolation from plants of the Fabaceae family. We categorised the methods as (1) maceration, (2) soxhlet extraction, and microwave-assisted extraction. In addition, we discussed a variety of molecules extracted from stems, barks, leaves, stem barks, and roots of Fabaceae plants found mainly in Africa and Asia. We also identified critical reports in the literature on the bioactivity of the Fabaceae family plant extracts. The perspectives given in this review could be useful in future research and development in therapeutic potential compounds from secondary metabolites of Fabaceae plants.

Extraction Methods

The growing interest in secondary metabolites for applications in the fine chemical, food, beverage, nutraceutical, and pharmaceutical industries has prompted the development of advanced extraction techniques to improve their recovery. Conventional methods such as maceration, Soxhlet extraction, and hydrodistillation are well-documented in the literature. In contrast, modern energy-assisted techniques—including pressurized liquid extraction, supercritical fluid extraction, microwave-assisted extraction (MAE), and ultrasound-assisted extraction (UAE)—are increasingly utilized [26]. These methods are favored for their efficiency, reduced solvent consumption, shorter extraction times, and enhanced extract quality and yield [27,28]. Nevertheless, the selection of an extraction technique often depends on specific research objectives and practical considerations, as summarized in Table 1.

Maceration

Maceration is a traditional method of bioactive compound extraction from plant materials. The process involves crushing or grinding previously dried plant materials to fine particles and powder and dissolving the plant material in a polar or non-polar solvent. The maceration extraction process usually takes a long time, spanning hours, days, or weeks. The steps to conducting a maceration extraction process are: (i) place a powered sample material in a vessel that can be covered; (ii) mix the sample material with an appropriate solvent; (iii) agitate the mixture; (iv) cover and allow the vessel to stand for a target duration [29]. The crude extract is then separated from the solute sample mixture by filtration.

Polar solvents like water, methanol, and ethanol are popular choices in maceration extraction for phytochemical studies [30]. These are capable of dissolving plant materials (solubility) and separating phytochemicals from the extracellular parts of plants (selectivity). Despite some disadvantages of maceration, like long extraction process, large amounts of solvent consumption, and low extraction efficiency, maceration extracts thermally labile compounds without degradation [31].

Masruri *et al*. extracted 0.57% crude extract from the 3.5 Kg waste bark of *Paraserianthes falactaria* L. (sengon) macerated in n-hexane for 24 h [32]. Triterpenoids were identified as the major constituent with alkaloids and flavonoids. To extract the oil, Baihaqi et al. macerated 100g of waste *Paraserianthes falcataria* bark for two days in 70% ethanol [33]. Total phenolic (TPC) and total flavonoid contents (TFC) were reported to be 10 mg GAE/ g dw, 1.6 mg RE/ g dw, and 7.3 mg GAE/ g dw, respectively. After three days of maceration in 200 ml methanol, Rumidatul et al. extracted 145.21 mg GAE/g TPC and 95.39 mg QE/g TFC from a 50 g twig of *Falcataria moluccana* Miq [34]. Teinkela et al. produced 236.3 g of total crude extracts by extracting 1.3 kg of the root bark and 3.4 kg of the root wood from *Piptadeniastrum africanum* (hook.f.) Brennan [35]. Thakur et al. extracted 5.23 g from 50 g of powdered leaves of *Acacia catechu* (L.f) Willd using 500 mL of methanol-water (50:50, v/v) [36].

Sunday *et al*. subjected the leaves, seeds, and roots of *Abrus precatorius* Linn. to an agitated maceration in 1 L of sterile distilled water at 25 ^{o}C for 8 h [37]. The leaf, seed, and root extracts all had higher concentrations of tannins, phenols, and saponins than the root extracts. On the other hand, Shourie and Kalra [38] detected triterpenes, flavonoids, and glycosides from water extracts of stem and bark of *Abrus precatorius* L. Antimicrobial and antioxidant studies of *Fordia* s*plendidissima by* Kusuma *et al*.,

[39] a traditional medicinal plant used by the Bentian people of East Kalimantan, Indonesia to treat diabetes and fever showed that root extracts macerated in n-hexane, ethanol, and ethyl acetate for 48 h obtained extract yields of 0.36 g, 0.52 g and 0.53 respectively. *Calpurnia aurea* (Ait.) Benth, a plant used by some communities in Ethiopia to treat wounds, was confirmed by Ayal *et al.* to possess wound healing and anti-inflammation properties [40]. The wound healing leaves extracts of *Calpurnia aurea* (Ait.) Benth was obtained in 5 L methanol (80%) after 48 h. Belayneh and Birru [41] also extracted 900 g dried leaves of *Calpurnia aurea* (Ait.) Benth. for 72 h in 80% ethanol to investigate the antihyperglycemic properties of *C. aurea*.

Birru *et al.* reported the antidiarrheal activity of *Indigofera spicata* Forssk from methanol root extracts obtained after 72 h of maceration at ambient temperature [42]. The root extracts contained alkaloids, saponins, tannins, glycosides, and flavonoids. Obogwu et al. investigated the antioxidant activity of *Mucuna pruriens* (L) D.C. leaf extracts made by soaking 100 g in 1 L of hydroethanol (95% ethanol) for 48 hours [43]. Gupta and Patel revealed flavonoids, terpenoids, and steroids in seed methanol extracts of *Mucuna pruriens* after maceration of 100 g of sample in 450 mL of 95% methanol for 48 h [44].

Soxhlet Extraction

Soxhlet extraction is a non-conventional technique for bioactive molecule extraction from plants. The technique has been used since 1879 when German chemist Franz von Soxhlet first proposed it for lipids extraction [19]. Soxhlet apparatus consists of a thimble, an extractor, a round-bottomed flask, a siphon, and a condenser [45]. Extraction is carried out when a solid sample material in the thimble is run over by an extracting solvent heated from the round-bottom flask. The solvent with potential extractives from the sample material is repeatedly siphoned into the round-bottomed flask. This process is allowed to run under reflux for the duration of the extraction.

Several studies have reported soxhlet extraction for secondary metabolites from the Fabaceae plant family. Rosdiana *et al*. extracted 10 g of barks of *A. mangium* and *P. falcataria* wood tree species found in Indonesia in dichloromethane, acetone, toluene-ethanol (2:1, v/v), and water [46]. They reported total extract yields of 17.81% from *A. mangium* and 6.65% from *P. falcataria*. *Tamarindus indica* is a hardwood tropical tree widely distributed in some parts of Africa and Southeast Asia. *T. indica* used in traditional medicine to treat skin infections, diarrhea, and ulcers [47]. Borquaye *et al.* found that the ethanol roots and bark extracts of *T. indica* collected in Ghana have anti-inflammatory and antioxidant properties [48]. Soxhlet extraction afforded 10.4% root extract yield and 8.1% bark extract yield. The root extracts of *T. indica* L. from India were also found by Gupta and Singh [49] to possess antimicrobial, analgesic, and anti-inflammatory properties. Petroleum ether, ethanol, and water soxhlet extract all contained flavonoids, phenols, and tannins.

According to estimates, 463 million people had diabetes in 2019. By 2030, that number will climb to 578 million and by 2045, it will reach 700 million [50]. Diabetes mellitus elevates blood sugar levels due to metabolic disruptions of macromolecules like protein and carbohydrates. Yusro *et al.* investigated the methanol bark extracts of *Parkia intermedia*, *Parkia speciosa*, and *Parkia timoriana* for α-glucosidase inhibition [51]. These plants were investigated for scientific proof of their efficacy in traditional antidiabetic treatments in West Kalimantan Province, Indonesia. Roots (30 g) were extracted in 100 ml methanol at 70 ^{o}C for 1 h to yield 21.4%, 17.6%, and 7.2% crude extracts from *P. intermedia*, *P. speciose*, and *P*. *timoriana*. *Tamarindus indica* and *Cassia fistula* stem bark extracted in ethanol by a soxhlet method by Agnihotri and Singh also showed antidiabetic effects and antioxidant properties by lowering blood glucose and preventing renal complications associated with hyperglycemia in their study [52].

Oxidative stress, primarily caused by the accumulation of reactive oxygen species (ROS), plays a significant role in the pathogenesis of diabetes mellitus by inducing metabolic disturbances through oxidative damage to proteins, lipids, and carbohydrates. Sowndhararajan et al. [53] demonstrated the

antioxidant potential of bark extracts from various Indian *Acacia* species, including *A. leucophloea* (Roxb.) Willd., *A. ferruginea* DC., *A. dealbata* Link., and *A. pennata* (L.) Willd. Soxhlet extraction using acetone yielded 11.6% for *A. leucophloea*, 9.2% for *A. pennata*, 2.6% for *A. dealbata*, and 3.2% for *A. ferruginea*. In contrast, methanol extractions yielded 3.6% (*A. ferruginea*), 6.5% (*A. dealbata*), 6.6% (*A. leucophloea*), and 8.7% (*A. pennata*), suggesting that solvent polarity significantly affects extractive efficiency. Similarly, Bhosle [54] confirmed the anticonvulsant and antioxidant activities of ethanol extracts from *Desmodium triflorum* (L.) DC leaves. Extraction of 300 g of dried leaves at 45°C for 8–9 h yielded 30 g of extract containing alkaloids, flavonoids, saponins, and tannins. Multiple studies have further reported the analgesic and anti-inflammatory properties of various parts of *D. triflorum*, supporting its traditional medicinal use.

The Global Initiative for Asthma Report 2021 estimates that 1-18% of the global population are asthmatic [55]. Asthma is a lung disease caused by inflammations of the airway to the lungs. It results in tightness in the chest, which leads to breathing difficulties. Taur *et al.* extracted 500 g of leaf samples of *A. precatorius* Linn in 95% ethanol [56]. The leaf extracts exhibited antibacterial, anticancer, anti-diarrheal, and anti-asthma activities. Govindarajan et al. extracted 1000 g of *D. elata* (L.) leaves and seeds to research plant-based insect-repellant chemicals. They then diluted the sample with 5000 mL of hexane, ethyl acetate, benzene, chloroform, and methanol [57]. For every leaf and seed sample gram, they reported the highest yields (149.20 and 128.02) in methanol and lower yields (92.85 and 86.38 yields) in hexane, respectively. The other extract yields were 108.30 per-gram leaf and 100.20 per gram seed (benzene), 116.42 per gram leaf and 107.20 per gram seed (chloroform), and 129.95 per gram leaf and 116.50 per gram seed (ethyl acetate). These results suggest that solvent nature could influence crude extract yield in soxhlet extraction. Abdulrazak *et al.* extracted 400 g roots and stem bark of *C. sieberiana* (D.C.) in 700 mL of ethanol [58]. *C. sieberiana* is widely used in Sub-Saharan Africa for malaria treatments. They identified alkaloids, tannins, saponins, flavonoids, and triterpenoids in the stem bark extracts and revealed that the extracts have anti-plasmodial activity

Extraction Assisted by Microwave

One of four more recent energy-dependent technologies used to extract bioactive chemicals from plants is microwave-assisted extraction (MAE). MAE uses microwave radiation to heat plant materials and transfer components into an extraction solvent [59]. Several factors contribute to the efficiency of MAE: solvent nature, solute-to-solvent ratio, temperature, time, and microwave irradiation power [60]. Microwave extraction lowers extraction time and solvent consumption and increases the quality of extract yield [61]. It is considered a green method due to the small organic solvent used for extraction.

The total saponins (TSC) and total phenolic content (TPC) of fenugreek (*Trigonella foenum-graecum* L.) seed powder was identified by MAE by Akbari *et al* [62]. After 3 mins, 195.32 mg/g and 81.55 mg/g yields were recorded in 80% ethanol at 70 ^{o}C and 600 W. The best solute-solvent ratio was 1:10 g/mL from a tested range of 1:8 to 1:12 g/mL. Solarte *et al.* found that 32.5 min was the optimal time to extract 34.8 mg/g inositol from the leaves of *M. sativa* L. (Alfalfa) [63]. Mocan *et al.* extracted three isoflavones (puerarin, daidzein, and genistein) from the dried roots of *P. lobate* [64]. After 30 min, 10.9 µg/mg puerarin, 1.30 µg/mg daidzein, and 0.12 µg/mg genistein extract yields were achieved at 40^{o}C.

Mangang *et al.* studied different solvent natures (60-100%) for bioflavonoid extraction from the barks of *A. myriophylla* [65]. An optimum 156.81 mg/g yield was obtained in 70.36% ethanol. Zuluaga *et al*. tested inositol extraction from seed and pod of *Glycine max* (L.) Merr (Soybeans) by microwave in 0-100% ethanol concentrations [66]. High inositol yields of 28.51 mg/g and 50.97 mg/g were achieved in 0% ethanol at 120 ^{o}C after 16.5 min. Vila Verde *et al.* isolated caryophyllene and *trans*-α-bisabolol terpenes from 30 g dried fruit samples of *P. emarginatus* in 13.2 mL at a microwave power of 280 W [67]. Kumar *et al.* investigated the efficiency of microwave extraction of total anthocyanin (TAC) and total

phenolic content (TPC) from the seed coat *of Glycine max* L. (black soybean) [68]. They determined 59.99% hydro-ethanol and 569.46 W irradiation power was the best condition to yield 5094.9 mg/l TAC and 4442.94 mg/100 mL TPC extracts. Izirwan *et al.* extracted 0.457 mg/g (49.97%) anthocyanin from the flowers of *C. Ternatea* in 95% ethanol at 60 ^{o}C after 15 min [69]. Finally, Huma *et al.* extracted 70.11 mg/g TPC and 4.11 mg/g condensed tannins from the carob kibbles of *C. silique* in 45% ethanol at a microwave power of 340 W [70].

Fabaceae Plant Family Molecules

Sesbania grandiflora (L.) Pers. stem bark ethyl acetate extract was used by Noviany *et al.* to isolate flavonoids [71]. Two flavonoids, 2-(3,4-dihydroxy-2-methoxyphenyl) and 2-(4-hydroxy-2-methoxyphenyl)-5,6-dimethoxybenzofuran-3-carboxaldehyde, Dimeric sesbagrandiflorain A and B, 4-hydroxy-6-methoxybenzofuran-3-carbaldehyde, and sesbagrandiflorain were present. They identified a new flavonoid molecule, 2-arylbenzofuran, and mass spectroscopic elucidation (HR-TOF) confirmed the molecular formula of 2-arylbenzofuran to be $C_{17}H_{14}O_6$ (m/z 315.08765, $[M+H]^+$). ^{1}H NMR further confirmed that a chemical shift at 10.05 ppm for an aldehyde proton and two shifts at 7.10 ppm showed the presence of aromatic protons. Methyl carbons, aromatic ring carbons (Sp^2 hybridized), oxygenated and non-oxygenated quaternary carbons, and carbonyl carbon were all identified from the ^{13}C NMR spectra. In addition to some previously reported compounds like 3, 5, 7, 3', 4', and 5'-hexahydroxyflavone (flavonoid), quercetin-3-O-galactopyranoside (flavonoid), and myricetin-3-O-galactopyranoside (flavonoid), Ahmed *et al.* isolated what they called novel bioactive compounds, including 24-isopropylcholest-5-en-3,8-diol [72]. The chemical structures of 5, 7, 4', and 5' tetrahydroxy-2'-methoxyflavone and 24-isopropylcholest-5-en-3,8-diol were determined by HR-ESI-MS to be $C_{30}H_{52}O_2$ and $C_{16}H_{10}O_7$, respectively. Chemical shifts at 5.33 ppm and 3.05 ppm from the ^{1}H NMR spectra of 24-Isopropylcholest-5-en-3,8-diol revealed two distinct protonic environments, shifts at 0.659 and 0.988 ppm suggested methyl groups and the ^{13}C NMR revealed signals for all thirty (30) carbon atoms. In 5, 7, 4' 5' tetrahydroxy-2'-methoxyflavone, ^{1}H NMR shifts indicated the existence of methyl and five aromatic protons, while ^{13}C NMR shifts confirmed the presence of an isoetin flavone moiety. From ethanol leaf extracts of Bauhinia galpinii, Erhabor *et al.* found the flavonoids 2''-O-rhamnosylvitexin, myricetin 3-O-galactopyranoside, and quercetin 3-O-galactopyranoside [73].

Myricetin, quercetin, and rutin were extracted from the fruit extract of *Crotalaria retusa* L., as well as p-hydroxybenzoic acid derivatives (2,5 DHBA and 3,4 DHBA) from the flower, stem bark, and fruit methanol extracts by Sinan *et al* [74]. Mohotti *et al.* reported the isolation of rutin from aqueous leaf extracts of *Derris scandens* confirmed by HRESI-MS data [75]. Dalpanitin ($C_{22}H_{22}O_{11}$), vicenin-3 ($C_{26}H_{28}O_{14}$), and vicenin-2 ($C_{27}H_{30}O_{15}$) were also present in the extract, as confirmed by HREI-MS. Condensed tannins like proanthocyanidins and polyphenols such as robinetinidol, fisetinidol, and gallocatechin were isolated from ethanol bark extracts of *Acacia mangium* by Chen *et al* [76] Rosdiana *et al* [46] found high amounts of fatty acids such as palmitic acid in bark DCM extract of *Acacia mangium*. Tricosanol, 5-stigmasta-7,22-dien-3-ol, and piptadenamide were obtained from the hexane/ethyl acetate fraction of *Piptadeniastrum africanum* (hook. f.) Brennan root extracts by Teinkela *et al* [35].

From the ethanol seed extract of *Trigonella foenum-graecum L*. (fenugreek), Akbari *et al*. identified fifty (50) chemicals. The components were identified by LC-QTOF/MS analysis as steroids and terpenoid saponins [62]. A variety of phenolic compounds like campneoside I ($C_{30}H_{38}O_{16}$), forsythoside E ($C_{20}H_{30}O_{12}$), cistanoside C ($C_{30}H_{38}O_{15}$), and Quercetin-3-*O*-neohesperidoside ($C_{27}H_{30}O_{16}$) were detected. Some of the major compounds identified in positive ion mode were timosaponin B-2 ($C_{45}H_{76}O_{19}$), protodiosgenin ($C_{33}H_{54}O_9$), and cimicifugic acid B ($C_{21}H_{20}O_{11}$). Smilaxin ($C_{17}H_{16}O_6$), (-)-suspensaside B ($C_{33}H_{44}O_{16}$), and kuzubutenolide A ($C_{23}H_{24}O_{10}$) were detected in negative ion mode. In methanol seed extracts of fenugreek, Navarro del Hierro *et al.* and Herrera *et al.* established the existence of the steroidal saponins diosgenin-Xyl-GlcA-Rha, diosgenin-glu-

glu-xyl-rha, gitogenin-glu-rha-glu and diosgenin-rha-glu-rha-glu [77,78]. Twenty (20) compounds were isolated from twig methanol extract of *Falcataria moluccana* by Rumidatul *et al* [34]. In the extract's GC-MS analysis, the following compounds were discovered: terpinolene, dl-limonene, Bicyclo[4.1.0] hept-2-ene, 3,7,7-trimethyl-, and Delta 3-Carene. King *et al.* found guaiacol and 1-hydroxy-3-methoxy-6-methyl anthraquinone in the aqueous and methanol extracts, chondrila sterol and stigmast-7-en-3-ol in the n-hexane extract, ethyl iso-allocholate and ergosta-5,22-dien-3-ol in the methanol extract of *Albizia falcataria* [79]. By using HRESIMS, 1D, and 2D NMR, Fotso *et al.* identified several compounds in Albizia glaberrima extracts, including (+)-(2R, 3S, 4R)-3',4', 7-trihydroxy-4-methoxy-2,3-trans-flavan-3,4-trans-diol (5-dehydroxyflavon), flavans (+)-mollisacacidin, (+)-fustin, butin; steroids chondrillasterol, and chondrillasterone; and a triterpenoid lupeol [80].

In addition, Wang *et al*. identified acacic acid lactone 3-O-β-d-fucopyranosyl- (1→6)-β-d-glucopyranoside, acacic acid lactone 3-O-β-d-fucopyranosyl-(1→6)-β-d-2-deoxy-2-acetylamino glucopyranoside and acacic acid lactone 3-O-β-d-2-deoxy-2-acetylaminogluco pyranosidethree triterpenoid saponins from stem bark extracts of *Albizia julibrissin* [81]. Oleanane saponins 21-*O*-{(2*E*,6*S*)-2-hydroxymethyl-6-methyl-6-*O*-[3-*O*-(2'*E*,6'*S*)-2',6'-dimethyl-6'-*O*-*β*-D-quinovopyranosyl-2',7'-octadienoyl-*β*-D-quinovopyranosyl]-2,7-octadienoyl]}-3-*O*-[*β*-D-xylopyranosyl-(l→2)-*β*-D-fucopyranosyl-(1→6)-*β*-D-glucopyranosyl] acetic acid 28-*O*-*β*-D-glucopyranosyl-(l→3)-[*α*-L-arabinofuranosyl-(l→4)]-*α*-L-rhamnopyranosyl-(l→2)-*β*-D-glucopyranosyl ester; and 21-O- {(2*E*,6*S*)-2, 6-dimethyl-6-O- [4-O-(2′*E*, 6′*S*)-2', 6'-dimethyl-6'-*O*-*β*-D-xylopyranosyl-2',7'-octadienoyl-*β*-D-quinovopyranosyl]-2,7-octadienoyl]}-3-*O*-{*β*-D-xylopyranosyl-(l→2)-*β*-D-fucopyranosyl-(1→6)-[β-D-glucopyranosyl-(1→2)]-β-D-glucopyranosyl} machaerinic acid 28-O-*β*-D-glucopyranosyl-(l→3)-[α-L-arabinofuranosyl-(l→4)]-α-L-rhamnopyranosyl-(l→2)-β-D-glucopyranosyl ester were isolated from the stem bark of *Albizia julibrissin* by Han *et al* [82].

Flavonoids and polyphenolics are relatively prevalent secondary metabolite chemicals in plants of the Fabaceae family based on our thorough evaluation of the literature (Table 2). However, the leaves, roots, and stems of Fabaceae plants could also contain considerable levels of quinones, steroids, terpenoids, and alkaloids. Flavonoids like quercetin (**Figure 3**(10)) and myricetin (**Figure 3**(2)) and their derivatives such as quercetin-3-O-glucoside shown in **Figure 3**(3) and myricetin-3-O-glucoside shown in **Figure 3**(4) were found in several body parts of Fabaceae plant species. **Table 3** summarises the spectroscopic data recorded to elucidate isolated molecules with mass spectroscopy, NMR, HPLC, and GC-MS.

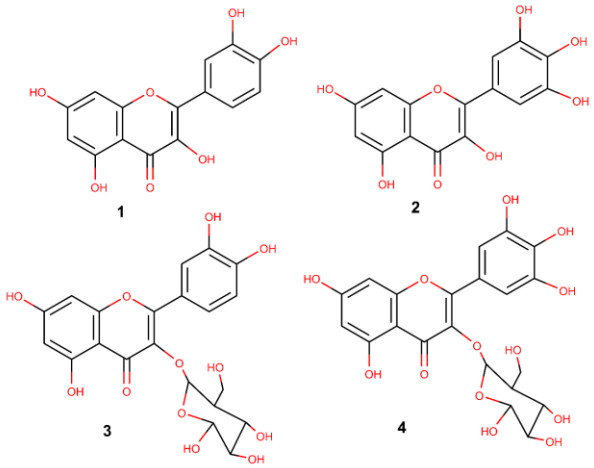


Figure 3. Flavonoid molecules of Fabaceae plant extracts: (1) quercetin, (2) myricetin, (3) Quercetin-glycoside, (4) Myricetin-glycoside.

Table 1. Reported Extraction Methods of Fabaceae Family Plants

No	Scientific Name	Extraction Method	Extraction Conditions	Summary of Results	References
1.	*Abrus precatorius* Linn.	Maceration	Plant part: Leaf, seed, root Solvent: Distilled water (1000 mL) Temperature: 25°C Time: 8 h	Leaf extract yield: 85.96 mg/g Seed extract yield: 75.86 mg/g Root extract yield: 37.52 mg/g	[37]
2.	*Abrus precatorius* L.	Maceration	Plant part: Stem, bark Sample quantity: 200 g Solvent: Ethanol (80%) Temperature: 40 °C, time: 48 h	Total yield: 21.40 g	[38]
3.	*Acacia catechu* (L.f) Willd	Maceration	Plant part: Leaf Sample quantity: 50 g Solvent: Methanol (50%,500 mL) Time = 48 h	Leaf extract yield: 5.23 g	[36]
4.	*Acacia dealbata* Link.	Soxhlet	Plant part: Bark Solvent: Methanol, acetone	Acetone extract yield: 9.2% MeOH extract yield: 8.7%	[53]
5.	*Acacia ferruginea* DC.	Soxhlet	Plant part: Bark Solvent: Methanol, acetone	Acetone extract yield: 3.2% MeOH extract yield: 3.6%	[53]
6.	*Acacia leucophloea* (Roxb.) Willd.	Soxhlet	Plant part: Bark Solvent: Methanol, acetone	Acetone extract yield: 11.6% MeOH extract yield: 6.6%	[53]
7.	*Acacia mangium*	Soxhlet	Plant part: Bark Sample Quantity: 10 g Solvent: DCM, Acetone, Toluene-ethanol (2:1), Water	Total extract yield: 17.81% DCM extract yield: 0.77% Acetone extract yield: 5.20% Toluene-ethanol yield: 7.31% Water extract yield: 4.52%	[46]
8.	*Acacia pennata* (L.) Willd.	Soxhlet	Plant part: Bark Solvent: Methanol, acetone	Acetone extract yield: 2.6% MeOH extract yield: 6.5%	[53]
9.	*Albizia myriophylla*	MAE	Plant part: Bark Microwave power: 400-900 W Solvent: Ethanol (60-100%) Solute-solvent ratio: 20-40 mL/g	Bioflavonoid yield: 156.81 mg/g	[65]

No	Scientific Name	Extraction Method	Extraction Conditions	Summary of Results	References
			Time: 20-40 min	Optimum condition: Microwave power 728 W, EtOH 70.36%, 39.86 min, 24.70 mL/g	
10.	*Calpurnia aurea* (Ait.) Benth	Maceration	Plant part: Leaf Sample quantity: 1 Kg Solvent: Methanol (80%, 5 L), Fraction: $CHCl_3$, ethyl acetate, water Time: 48 h	MeOH extract yield: 23% $CHCl_3$ extract yield: 10%, Ethyl acetate yield: 27.5% Water extract yield: 62.5%	[40]
11.	*Ceratonia silique*	MAE	Plant part: Kibbles Solvent: Ethanol (30%-90%) Microwave power: 170-900 W Solute-solvent ratio: 10-30 mL/g	Total phenolic yield: 70.11 mg/g Condensed tannin yield: 4.11 mg/g Optimum condition: Ethanol (45%), Power 340 W, 30 mL/g	[70]
12.	*Clitoria ternatea*	MAE	Plant part: Flower Solvent: Ethanol (95%) Solvent-solute ratio: 11, 15, 20, 25, 29 g/mL) Temperature: 32, 40, 50, 60, 68^oC Time: 11, 15, 20, 25 & 29 min	Anthocyanin yield: 0.457 mg/g (49.97%) Optimum condition: (T= 60 ^oC, 15 mg/mL, t = 15 min)	[69]
13.	*Delonix elata* (L.) Gamble	Soxhlet	Plant part: Leaf, seed Sample quantity: 1000 g Solvent: Hexane, Ethyl acetate, Benzene, Chloroform, Methanol (5000 mL) Time: 8 h	MeOH extracts yield: Leaf: 149.20 g Seed: 128.02 g Hexane extracts yield: Leaf: 92.85 g Seed: 86.38 g Benzene extracts yield Leaf: 108.30 g Seed: 100.20 g Chloroform extracts yield Leaf: 116.42 g Seed: 107.20 g Ethyl acetate extracts yield	[57]

No	Scientific Name	Extraction Method	Extraction Conditions	Summary of Results	References
				Leaf: 129.95 g Seed: 116.50 g	
14.	*Desmodium triflorum* (L.) D.C.	Soxhlet	Plant part: Leaf Sample quantity: 300 g Solvent: Ethanol Temperature: 45 ^{o}C, Time: 8-9 h	Extract yield: 30 g	[54]
15.	*Falcataria moluccana* Miq	Maceration	Plant part: Twiq Sample quantity: 50 g Solvent: Methanol (200 mL)	Total phenolic content: 145.21 mg/g Total flavonoid content: 95.39 mg/g	[34]
16.	*Fordia splendidissima*	Maceration	Plant part: Root Solvent: N-hexane, Ethyl acetate, and Ethanol Time: 48 h	Ethanol extract yield: 0.53 g (2.89%) Ethyl acetate extract yield: 0.52 g (2.84%) Hexane extract yield: 0.36 g (1.96%)	[39]
17.	*Glycine max* (L.) Merr	MAE	Plant part: Seed, pod Solvent: Ethanol (0-100%) Solute-solvent ratio: 0.5:10 g/mL Temperature = 50-120 ^{o}C, Time: 3-30 min	Inositol yield in seed extract: 28.51 mg/g Inositol yield in pod extract: 50.97 mg/g Optimum condition: (0% EtOH, 16.5 min, 120 ^{o}C)	[66]
18.	Glycine *max* L.	MAE	Plant part: Seed coat Solvent: Hydro-ethanol (59.99%) Solute-solvent ratio: 1:40 g/mL Microwave Power: 569.46 W Time: 4.38 min	Total anthocyanin yield: 5094.9 mg/L Total phenolic yield: 4442.94 mg/100 mL	[68]
19.	*Medicago sativa* L. (Alfalfa)	MAE	Plant part: Leaf, Seed Solute-solvent ratio: 0.1-0.5 g/10 mL Microwave power: 900 W Temperature: 40-120 ^{o}C,	Inositol yield in leaf extract: 34.8 mg/g Optimum condition: 0.1g/10 mL, 32.5 min, 40 ^{o}C	[63]

No	Scientific Name	Extraction Method	Extraction Conditions	Summary of Results	References
			Time: 5-60 min	Inositol yield in seed: 30.9 mg/g Optimum condition: 0.1g/10 mL, 60 min, 80 °C	
20.	*Paraserianthes falcataria* L.	Soxhlet	Plant part: Bark Sample Quantity: 10 g Solvent: DCM, acetone, toluene-ethanol (2:1), Water	Total extract yield: 6.65% DCM extract yield: 1.05% Acetone extract yield: 0.74% Toluene-ethanol yield: 1.16% Water extract yield: 3.69%	[46]
21.	*Paraserianthes falcataria* L.	Maceration	Plant part: Bark Sample quantity: 3.5 Kg Solvent: n-Hexane	Extract yield: 0.57%	[32]
22.	Paraserianthes *falcataria* L.	Maceration	Plant part: Bark Sample quantity: 100 g Solvent: Ethanol (70%), water	TPC in ethanol: 10 mg/g TPC in water: 7.5 mg/g TFC in ethanol: 1.6 mg/g TFC in ethanol: 3.3 mg/g	[33]
23.	*Parkia intermedia*	Soxhlet	Plant part: Bark Sample quantity: 30 g Solvent: Methanol (100 mL) Temperature: 70°C, Time: 1 h	Extract yield: 21.4%	[51]
24.	*Parkia speciosa*	Soxhlet	Plant part: Bark Sample quantity: 30 g Solvent: Methanol (100 mL) Temperature: 70°C, Time:1 h	Extract yield: 17.6%	[51]
25.	*Parkia timoriana*	Soxhlet	Plant part: Bark Sample quantity: 30 g Solvent: Methanol (100 mL) Temperature:70°C, Time: 1 h	Extract yield: 7.2%	[51]

No	Scientific Name	Extraction Method	Extraction Conditions	Summary of Results	References
26.	*Piptadeniastrum africanum* (hook.f.) Brennan	Maceration	Plant part: Root bark (1.3 kg), root wood (4.3 kg) Solvent: Methanol Room temperature, Time: 48 h	Total extract yield: 236.3 g	[35]
27.	*Pterodon emarginatus*	MAE	Plant part: Fruit Solvent: Water Solute-solvent ratio: 30g/13.2mL Microwave power 220, 250, 280 W Time: 29 min	Terpene yield: 6.6% v/w Optimum microwave power: 280 W	[67]
28.	*Trigonella foenum-graecum* L.	MAE	Plant part: Seed Microwave power: 500-700 W Solvent: Ethanol (40-80%) Solute-solvent ratio: 1:8-1:12 g/mL Temperature: 70^{o}C, Time: 3 & 4 min	Total saponin yield: 195.32 mg/g Total phenolic yield: 81.55 mg/g Optimum condition: 600 W, 80% EtOH, 3 min, 1:10 g/mL	[62]
29.	*Tamarindus indica* L.	Soxhlet	Plant part: Root, bark Solvent: Ethanol (99%) Solute-solvent: 1:5 g/mL	Root extract yield: 10.4% Bark extract yield: 8.1%	[48]
30.	*Pueraria lobate*	MAE	Plant part: Root Solvent: Water (65%, 5 mL), Ethanol (65%, 10 mL), Solvent-sample ratio: 0.1:5 - 0.1:10 g/mL Microwave power: 0-300 W Temperature: 40, 60, 100^{o}C, Time: 0, 30, 60 min	Total isoflavone yield: 12.32 µg/mg Puerarin yield: 10.9 µg/mg Optimum condition: EtOH (65%), 30 min, 0.1:5 g/mL, 40^{o}C	[64]

TPC = Total Phenolic Content, TFC = Total Flavonoid Content, MAE = Microwave-Assisted Extraction

Table 2. Reported Molecules of Fabaceae Family Plants

No.	Scientific name	Plant part	Molecular class	Molecules	Spectroscopic analysis	References
1.	*Acacia mangium*	Bark	Condensed tannins	Proanthocyanidins: robinetinidol, fisetinidol, gallocatechin	MALDI-TOF/TOF-MS HPLC/MS	[76]
			n.d	Hexadecanoic acid (Palmitic acid)	GC-MS	[46]
2.	*Albizia falcataria*	Sawdust	Phenolic	Guaiacol	GC-MS	[79]
			Anthraquinone derivative	1-Hydroxy-3-methoxy-6-methylanthraquinone		
			Phytosterol	Chondrillasterol		
			Phytosterol Derivative	Stigmast-7-en-3-ol, (3B,5a`)-		
			Steroid	Ethyl iso-allocholate		
			Sterol derivative	Acetate, Ergosta-5,22-dien-3-ol		
			Sapogenin aglycone	(3a´) -(Erythrodiol), Olean-12-ene-3,28-diol		
3.	*Albizia glaberrima*	Root bark	Flavonoid	5-dehydroxyflavon ((+) -(2R, 3S, 4R)-3',4', 7-trihydroxy-4-methoxy-2,3-trans-flavan-3,4-trans-diol)	HR-ESI-MS, HMQC, 1D and 2D NMR, HMBC	[80]
			Flavans	Butin, (+)-mollisacacidin, (+) fustin		
			Steroid	Chondrillasterone, Chondrillasterol, Lupeol		

			Triterpenoid			
4	*Albizia julibrissin*	Stem bark	Triterpenoid saponin	Acacic acid lactone 3-*O*-*β*-d-fucopyranosyl-(1→6)-*β*-d-glucopyranoside. Acacic acid lactone 3-*O*-*β*-d-fucopyranosyl-(1→6)-*β*-d-2-deoxy-2-acetylaminoglucopyranoside; Acacic acid lactone 3-*O*-*β*-d-2-deoxy-2-acetylaminoglucopyranoside	HR-ESI-MS ^{1}H, ^{13}C NMR, HMBC	[81]
			Oleanane saponins	21-*O*-{(2*E*,6*S*)-2-hydroxymethyl-6-methyl-6-*O*-[3-*O*-(2'*E*,6'*S*)-2',6'-dimethyl-6'-*O*-*β*-D-quinovopyranosyl-2',7'-octadienoyl-*β*-D-quinovopyranosyl]-2,7-octadienoyl]}-3-*O*-[*β*-D-xylopyranosyl-(l→2)-*β*-D-fucopyranosyl-(1→6)-*β*-D-glucopyranosyl] acacic acid 28-*O*-*β*-D-glucopyranosyl-(l→3)-[*α*-L-arabinofuranosyl-(l→4)]-*α*-L-rhamnopyranosyl-(l→2)-*β*-D-glucopyranosyl ester; 21-O- {(2*E*,6*S*)-2, 6-dimethyl-6-O- [4-O-(2′*E*, 6′*S*)-2', 6'-dimethyl-6'-*O*-*β*-D-xylopyranosyl-2',7'-octadienoyl-*β*-D-quinovopyranosyl]-2,7-octadienoyl]}-3-*O*-{*β*-D-xylopyranosyl-(l→2)-*β*-D-fucopyranosyl-(1→6)-[β-D-glucopyranosyl-(1→2)]-β-D-	MALDI-TOF-MS ^{1}H & ^{13}C NMR data	[82]

				glucopyranosyl} machaerinic acid 28-O-*β*-D-glucopyranosyl-(l→3)-[α-L-arabinofuranosyl-(l→4)]-α-L-rhamnopyranosyl-(l→2)-β-D-glucopyranosyl ester		
5	*Bauhinia galpinii*	Leaves	Flavonoid	Isoetin 2'-methyl ether (5, 7, 4' 5' tetrahydroxy-2'-methoxyflavone); Quercetin (3, 5, 7, 3′, 4′-pentahydroxyflavone)	HR-ESI-MS ^{1}H and ^{13}C NMR UV-Vis	[72]
			Flavonoid glycoside	Myreciten (3, 5, 7, 3', 4', 5'-hexahydroxyflavone); Myricetin-3-O-β-galactopyranoside; Isopropylcholest-5-en-3,8-diol		
			Triterpenoid	Quercetin-3-O-β-galactopyranoside; 2''-O-rhamnosylvitexin	UPLC-MS-ESI	
			Flavonoid glycosides	Myricetin-3-O-galactopyranoside; Quercetin-3-O-galactopyranoside		[73]
6	*Crotalaria retusa* L.	Fruit	Flavonoids	Myricetin, quercetin, rutin	LC-ESI-QTOF-MS/MS LC-QQQ- MS/MS	[74]
			Phenolics	*p*-hydroxybenzoic acid derivatives (2,5 DHBA and 3,4 DHBA)		
		Stem bark	Flavonoids	Quercetin, rutin		
			Phenolics	*p*-hydroxybenzoic acid derivatives (2,5 DHBA and 3,4 DHBA)		
		Flower	Phenolics	*p*-hydroxybenzoic acid derivatives (2,5 DHBA and 3,4 DHBA)		
			Alkaloids	Floridanine		

		Stem bark Fruit	Alkaloids	Serecionine N-oxide usaramine, retrosine		
7	*Derris scandens*	Leaves	Flavonoid	Dalpanitin, vicenin-3, vicenin-2, rutin,	^{1}H and ^{13}C NMR HRESI-MS	[75]
8	*Falcataria moluccana*	Twig	Terpenes n.d	Bicyclo[4.1.0] hept-2-ene, 3,7,7-trimethyl-, delta 3-carene, α-Terpinolene, dl-limonene Hexadecanoic acid	GC-MS	[34]
9	*Paraserianthes falcataria*	Bark	Terpenoid n.d	3b,22E-ergosta-7,22-dien-3-ol β –amyrin, hexadecanoic acid	GC-MS	[46]
10.	*Piptadeniastrum africanum* (hook.f.) Brennan	Root	Flavonoid Phenolics Alkaloids	5α-stigmasta-7,22-dien-3-β-ol Oleanolic acid, Tricosanol, Betulinic acid, Piptadenamide	1D & 2D NMR	[35]
11.	*Sesbania grandiflora* (L.) Pers.	Stem bark	Flavonoids	2-(3,4-dihydroxy-2-methoxyphenyl)-4-hydroxy-6-methoxybenzofuran-3-carbaldehyde, 2-(4-hydroxy-2-methoxyphenyl)-5,6-dimethoxybenzofuran-3-carboxaldehyde, 2-arylbenzofuran, Sesbagrandiflorain A, Sesbagrandiflorain B	HR-TOF-MS ESI-TOF-MS ^{1}H & ^{13}C NMR U.V., I.R.	[71]
12.	*Trigonella foenum-graecum* L. (Fenugreek)	Seed	Terpenoid saponins Phenolics	Timosaponin B-2 Protodiosgenin Campneoside I, forsythoside E, cistanoside C, Quercetin-3-*O*-neohesperidoside, cimicifugic acid B,	LC-QTOF-MS	[62]

	Steroidal saponins	smilaxin, (-)-suspensaside B, kuzubutenolide A Rha, Gitogenin-Glu-Rha-Glu-Xyl-Rha Diosgenin-Xyl-GlcA-Rha, Diosgenin-Glu-Glu-Xyl- Glu, Diosgenin-Rha-Glu-Rha-Glu, Diosgenin-GlcA-	HPLC-MS/DAD		[77], [78]

n.d = Not determined

Table 3. Spectrometric Data of Isolated Molecules of Fabaceae Family Plants

No.	Plant	Molecule	Formulas	Molecular weight [a](g/mol); [b]mass-to-charge ratio (m/z)	RT (min)	Method of analysis	References
1	*Albizia falcataria*	Guaiacol	n.d	124[a]	n.d	GC-MS	[79]
		1-Hydroxy-3-methoxy-6-methylanthraquinone;	n.d	340[a]	n.d		
		Chondrillasterol	n.d	412[a]	n.d		
		Ethyl iso-allocholate	n.d	414[a]	n.d		
		Stigmast-7-en-3-ol, (3B,5a`)-	n.d	436[a]	n.d		
		Ergosta-5,22-dien-3-ol	n.d	440[a]	n.d		
		Acetate	n.d	442[a]	n.d		
2	*Albizia glaberrima*	(+) -(2R, 3S, 4R)-3',4', 7-trihydroxy-4-methoxy-2,3-trans-flavan-3,4-trans-diol	$C_{16}H_{16}O_6$	327.08389[b] $[M + Na]^+$	n.d	HR-ESI-MS	[80]
		(5-dehydroxyflavon);	n.d	n.d	n.d		
		(+)-mollisacacidin	n.d	n.d	n.d		
		(+)-fustin	n.d	n.d	n.d		
		Butin	n.d	n.d	n.d		
		Chondrillasterol Chondrillasterone	n.d	n.d	n.d		
		Lupeol	n.d	n.d	n.d		

No.	Plant	Molecule	Formulas	Molecular weight [a](g/mol); [b]mass-to-charge ratio (m/z)	RT (min)	Method of analysis	References
3	*Albizia julibrissin*	Acacic acid lactone 3-O-β-d-fucopyranosyl-(1→6)-β-d-glucopyranoside;	$C_{42}H_{66}O_{13}$	801.4407[b] [M + Na]$^+$/ 777.4406 [M-H]$^-$	n.d	^{13}C NMR, HR-ESI-MS	[81]
		Acacia acid lactone 3-*O*-*β*-d-fucopyranosyl-(1→6)-*β*-d-2-deoxy-2-acetylaminoglucopyranoside;	$C_{44}H_{69}NO_{13}$	820.4852[b] [M+H]$^+$	n.d		
		Acacia acid lactone 3-*O*-*β*-d-2-deoxy-2-acetylaminoglucopyranoside	$C_{38}H_{59}NO_9$	674.4275[b] [M+H]$^+$	n.d		
4	*Albizia julibrissin*	21-*O*-{(2*E*,6*S*)-2-hydroxymethyl-6-methyl-6-*O*-[3-*O*-(2'*E*,6'*S*)-2',6'-dimethyl-6'-*O*-*β*-D-quinovopyranosyl-2',7'-octadienoyl-*β*-D-quinovopyranosyl]-2,7-octadienoyl]}-3-*O*-[*β*-D-xylopyranosyl-(l→2)-*β*-D-fucopyranosyl-(1→6)-*β*-D-glucopyranosyl] acacia acid; 28-*O*-*β*-D-glucopyranosyl-(l→3)-[*α*-L-arabinofuranosyl-(l→4)]-*α*-L-rhamnopyranosyl-(l→2)-*β*-D-glucopyranosyl ester	$C_{102}H_{162}O_{49}$	2193.7686[b] [M + Na]$^+$ 2209.7573[b] [M + K]$^+$	n.d	MALDI-TOF-MS	[82]
			$C_{107}H_{170}O_{52}$	2310.0022[b] [M + Na]$^+$ 2325.9697[b] [M + K]$^+$	n.d		
		21-O- {(2*E*,6*S*)-2, 6-dimethyl-6-O- [4-O-(2'*E*, 6'*S*)-2', 6'-dimethyl-6'-*O*-*β*-D-xylopyranosyl-2',7'-octadienoyl-*β*-D-quinovopyranosyl]-2,7-octadienoyl]}-3-*O*-{*β*-D-xylopyranosyl-(l→2)-*β*-D-fucopyranosyl-(1→6)-[β-D-glucopyranosyl-(1→2)]-β-D-					

No.	Plant	Molecule	Formulas	Molecular weight [a](g/mol); [b]mass-to-charge ratio (m/z)	RT (min)	Method of analysis	References
		glucopyranosyl} machaerinic acid 28-O-*β*-D-glucopyranosyl-(l→3)-[α-L-arabinofuranosyl-(l→4)]-α-L-rhamnopyranosyl-(l→2)-β-D-glucopyranosyl ester					
5	*Bauhinia galpinii*	24-Isopropylcholest-5-en-3,8-diol;	$C_{30}H_{52}O_2$	n.d	n.d	n.d	[72]
		5, 7, 4' 5' tetrahydroxy-2'-methoxyflavone (isoetin 2'-methyl ether);	$C_{16}H_{10}O_7$	315.054[b] $[M]^-$	n.d	ES-MS	
		3, 5, 7, 3', 4'-pentahydroxyflavone (Quercetin);	n.d		n.d		
		3, 5, 7, 3', 4', 5'-hexahydroxyflavone (Myricetin);	n.d		n.d		
		Quercetin-3-O-β-galactopyranoside	n.d		n.d		
		myricetin-3-O-β-galactopyranoside	n.d		n.d		
6	*Bauhinia galpinii*	2''-O-rhamnosylvitexin	n.d	578[a], 577.1552[b] $[M-H]^-$	6.34	UPLC-MS-ESI	[73]
		Myricetin-3-O-galactopyranoside	n.d	480[a], 479.0816[b] $[M-H]^-$	5.88		
		Quercetin-3-O-galactopyranoside	n.d	464[a], 463.0872[b] $[M-H]^-$	6.50		
7	*Crotalaria retusa* L	Floridanine	$C_{21}H_{31}NO_9$	442.2060[b]	n.d	LC-QTOF MS/MS (ESI-QTOF-MS/MS)	[74]
		Serecionine N-oxide	$C_{18}H_{25}NO_6$	352.1737[b]	n.d		
		Usaramine	$C_{18}H_{25}NO_6$	352.1737[b]	n.d		
		Retrosine	$C_{18}H_{25}NO_6$	352.1737[b]	n.d		
8	*Derris scandens*	Dalpanitin	$C_{22}H_{22}O_{11}$	463.1004[b] $(M + H)^+$	16	HRESI-MS HPLC-UV	[75]

No.	Plant	Molecule	Formulas	Molecular weight [a](g/mol); [b]mass-to-charge ratio (m/z)	RT (min)	Method of analysis	References
		Vicenin-3	$C_{26}H_{28}O_{14}$	565.1442[b] $(M + H)^+$	18		
		Vicenin-2	$C_{27}H_{30}O_{15}$	595.1668[b] $(M + H)^+$	17		
		Rutin	n.d	611.14 $(M + H)^+$	19		
9	*Falcataria moluccana*	α-Terpinolene	$C_{10}H_{16}$	136.23[a]	6.776	GC-MS	[34]
		dl-limonene	$C_{10}H_{16}$	136.23[a]	5.892		
		bicyclo[4.1.0] hept-2-ene	$C_{13}H_{20}$	176.3[a]	5.710		
		3,7,7-trimethyl-Delta 3-Carene	$C_{10}H_{16}$	136.23[a]	5.632		
		Hexadecanoic acid	$C_{16}H_{32}O_2$	256.42[a]	17.374		
10	*Sesbania grandiflora* (L.) Pers.	2-(4-hydroxy-2-methoxyphenyl)-5,6-dimethoxybenzofuran-3-carboxaldehyde	$C_{18}H_{16}O_6$	329.10330[b] $[M+H]^+$	n.d	HR-TOF-MS	[71]
		2-(3,4-dihydroxy-2-methoxyphenyl)-4-hydroxy-6-methoxybenzofuran-3-carbaldehyde	$C_{17}H_{14}O_7$	331.08261[b] $[M+H]^+$	n.d	ESI-TOF-MS	
		2-arylbenzofuran	$C_{17}H_{14}O_6$	315.08765[b] $[M+H]^+$	n.d		
11	Trigonella foenum-graecum L. (Fenugreek)	Timosaponin B-2	$C_{45}H_{76}O_{19}$	943.4872[b] +Na	3.10	LC-QTOF-MS	[62]
		Protodiosgenin	$C_{33}H_{54}O_9$	595.3839[b] +H	3.04		
		Campneoside I	$C_{30}H_{38}O_{16}$	653.2090[b] -H	0.89		
		Forsythoside E	$C_{20}H_{30}O_{12}$	461.1677[b] -H	0.97		
		Cistanoside C	$C_{30}H_{38}O_{15}$	637.2150[b] -H	0.65		
		Quercetin-3-*O*-neohesperidoside	$C_{27}H_{30}O_{16}$	611.1615[b] +H	1.79		
		Cimicifugic acid B					
		Smilaxin	$C_{21}H_{20}O_{11}$	449.1076[b] +H	2.50		
		(-)-suspensaside B Kuzubutenolide A	$C_{17}H_{16}O_6$	315.0875[b] -H	2.86		
			$C_{33}H_{44}O_{16}$	695.2563[b] -H	0.87		

No.	Plant	Molecule	Formulas	Molecular weight [a](g/mol); [b]mass-to-charge ratio (m/z)	RT (min)	Method of analysis	References
			$C_{23}H_{24}O_{10}$	459.1304[b] -H	2.80		
12	Trigonella foenum-graecum L. (Fenugreek)	Diosgenin-Xyl-GlcA-Rha Diosgenin-Glu-Glu-Xyl-Rha Gitogenin-Glu-Rha-Glu	n.d	n.d	12.78	HPLC-MS-DAD	[77]
			n.d	n.d	12.87		
			n.d	n.d	13.09		
		Diosgenin-Rha-Glu-Rha-Glu	n.d	n.d	14.17		
		Diosgenin-GlcA-Glu-Xyl-Rha	n.d	n.d	14.79		
13	Trigonella foenum-graecum L. (Fenugreek)	Diosgenin-Xyl-GlcA-Rha Diosgenin-Glu-Glu-Xyl-Rha Gitogenin-Glu-Rha-Glu	n.d	415[b] $[M+H]^+$	13.5	HPLC-MS-EPI	[78]
			n.d	415[b] $[M+H]^+$	13.8		
			n.d	415[b] $[M+H]^+$	14.1		
		Diosgenin-Rha-Glu-Rha-Glu	n.d	415[b] $[M+H]^+$	14.5		
		Diosgenin-GlcA-Glu-Xyl-Rha	n.d	417[b] $[M+H]^+$	15.0		
14	*Melilotus officinalis*	Protocatechuic acid	n.d	n.d	10.8	LC	[89]
		Caffeic acid	n.d	n.d	21.9		
		Epicatechin	n.d	n.d	22.7		
		Coumaric acid	n.d	n.d	24.4		
		Rutin	n.d	n.d	25.7		
		Rosmarinic acid	n.d	n.d	28.8		
		Resveratrol	n.d	n.d	31.9		
		Kaempferol	n.d	n.d	34.9		
15	*Coronilla varia*	Gallic acid	n.d	n.d	4.8	LC	[89]
		Protocatechuic acid	n.d	n.d	10.8		
		Caffeic acid	n.d	n.d	21.9		
		Epicatechin	n.d	n.d	22.7		
		Coumaric acid	n.d	n.d	24.4		
		Rutin	n.d	n.d	25.7		
		Quercetin	n.d	n.d	32.1		
		Rosmarinic acid	n.d	n.d	28.8		
		Resveratrol	n.d	n.d	31.9		
		Kaempferol	n.d	n.d	34.9		

No.	Plant	Molecule	Formulas	Molecular weight [a](g/mol); [b]mass-to-charge ratio (m/z)	RT (min)	Method of analysis	References
16	*Ononis spinosa*	Gallic acid	n.d	n.d	4.8		
		Protocatechuic acid	n.d	n.d	10.8		
		Caffeic acid	n.d	n.d	21.9	LC	
		Coumaric acid	n.d	n.d	24.4		
		Ferulic acid	n.d	n.d	24.7		
		Rutin	n.d	n.d	25.7		
		Rosmarinic acid	n.d	n.d	28.8		
		Resveratrol	n.d	n.d	31.9		
		Quercetin	n.d	n.d	32.1		
		Kaempferol	n.d	n.d	34.9		
17	*Robinia pseudoacacia*	Gallic acid	n.d	n.d	4.8		
		Protocatechuic acid	n.d	n.d	10.8		
		Caffeic acid	n.d	n.d	21.9		
		Coumaric acid	n.d	n.d	24.4		
		Rutin	n.d	n.d	25.7		
		Rosmarinic acid	n.d	n.d	28.8		
		Resveratrol	n.d	n.d	31.9		
		Quercetin	n.d	n.d	32.1		
		Kaempferol	n.d	n.d	34.9		
18	*Sutherlandia frutescens*	Quercetin glycoside	$C_{38}H_{46}O_{25}$	903.2404[b] $[M+H]^+$ 771.1998[b] $[M+H]^+$	6.31	LC-MS	[106]
		Quercetin-glycoside	$C_{33}H_{38}O_{21}$	609.1469[b] $[M+H]^+$ 1079.2913[b] $[M+H]^+$	6.80		
		Quercetin-glycoside	$C_{27}H_{28}O_{16}$	813.4630[b] $[M+H]^+$	7.99		
		Quercetin-glycoside	$C_{66}H_{45}O_{15}$	755.2021[b] $[M+H]^+$ 593.1501[b]	9.01		
		Cycloartanol glycoside	$C_{42}H_{68}O_{15}$	$[M+H]^+$ 427.1911[b]	15.97		
		Kaempferol glycoside	$C_{33}H_{38}O_{20}$	$[M+H]^+$	7.66		

No.	Plant	Molecule	Formulas	Molecular weight [a](g/mol); [b]mass-to-charge ratio (m/z)	RT (min)	Method of analysis	References
		Kaempferol glycoside	$C_{27}H_{28}O_{15}$		8.73		
		Unknown flavonoid	$C_{28}H_{26}O_4$		6.66		
19	*Erythrina excelsa*	Excelsanone	$C_{20}H_{18}O_4$	204.9671[b] [M– $2CH_3CO_2$]$^-$	n.d	HR-ESI-MS$^-$	[107]
20	*Caragana ambigua*	Sphalleroside A	$C_{16}H_{22}O_8$	341.12[a]	9.0	UHPLC-MS	[96]
		Gingerol	$C_{17}H_{26}O_4$	293.17[a]	13.16		
		(±)-Naringenin	$C_{15}H_{12}O_5$	271.06[a]	9.7		
		2,6,3',4'-Tetrahydroxy-2-benzylcoumaranone	$C_{15}H_{12}O_6$	287.05[a]	9.8		
		Kaempferide	$C_{16}H_{12}O_6$	299.05[a]	10.00		
		Texasin	$C_{16}H_{12}O_5$	283.06[a]	10.573		
		8-Methoxycoumestrol	$C_{16}H_{10}O_6$	297.04[a]	11.225		
		7,8,3',4',5'-Pentamethoxyflavone	$C_{20}H_{20}O_7$	371.11[a]	12.177		
		Phellodensin D	$C_{20}H_{20}O_6$	355.11[a]	13.118		
		Aurmillone	$C_{21}H_{20}O_6$	367.120[a]	14.268		
21	*Caragana brachyantha* Rech. f	2,4,60-Trihydroxybenzoic acid	$C_7H_6O_5$	170.0216[a]	1.58	UHPLC-MS	[97]
		7,8-Dihydroxycoumarin	$C_9H_6O_4$	178.0272[a]	7.485		
		Artemisinin	$C_{15}H_{22}O_5$	282.1473[a]	7.901		
		Quercetin3-(6''-ethyl glucuronide	$C_{23}H_{22}O_{13}$	506.1083[a]	9.41		
		5,7,4'-Trihydroxy-3'-C-methylflavone4'-rhamnoside	$C_{22}H_{22}O_9$				
		Texasin	$C_{16}H_{12}O_5$	430.1276[a]	9.855		
		(±)-Naringenin	$C_{15}H_{12}O_5$	284.0679[a]	10.745		
		Kaempferide	$C_{16}H_{12}O_6$	272.0683[a]	11.285		
				300.042[a]	11.454		
22	*Senna auriculata (L.) Roxb.*	Dimethoxyglycerol Docosyl Ether	$C_{27}H_{56}O_5$	460[a]	7.40	GC-MS	[98]
		Mome inositol	$C_7H_{14}O_6$	194[a]	10.76		

No.	Plant	Molecule	Formulas	Molecular weight [a](g/mol); [b]mass-to-charge ratio (m/z)	RT (min)	Method of analysis	References
		Octadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{21}H_{42}O_4$	358	25.34		
23	*Myrocarpus frondosus*	3,4-dimethoxycinnamic acid	$C_{11}H_{12}O_4$	209.0330[b] $[M+H]^+$	4.82	UPLC-HRMS	[103]
		Biochanin A	$C_{16}H_{12}O_5$	283.0606[b] $[M-H]^-$ 267.0674[b]	5.19		
		Formononetin	$C_{16}H_{12}O_4$	$[M-H]^-$ 329.1039[b] $[M+H]^+$,	6.44		
		Hydroxy-trimethoxyisoflavone	$C_{18}H_{16}O_6$	327.0835[b] $[M-H]^-$	6.58		
		Trimethoxyisoflavone	$C_{18}H_{16}O_5$	313.1089[b] $[M+H]^+$ 283.0984[b] $[M+H]^+$	7.32		
		Dimethoxyisoflavone	$C_{17}H_{14}O_4$	273.1131[b] $[M+H]^+$	7.83		
		Benzyl 2,5-dimethoxybenzoate	$C_{16}H_{16}O_4$		8.27		
24	*Abrus precatorius* Linn.	(S)-8-Hydroxy 6,7, 5'-trimethoxyisoflavan-1',4'-quinone	$C_{18}H_{18}O_7$	346.1125[b] $[M+H]^+$	n.d	HRESI-MS	[108]
		(S)-7,3´-dihydroxy-6,5'-dimethoxyisoflavan-1',4'-quinone	$C_{17}H_{16}O_7$	333.0965[b] $[M+H]^+$	n.d		
		(R)-6,8,5´-trimethoxyisoflavan-1',4'-quinone	$C_{18}H_{18}O_6$	330.3402[b] $[M+H]^+$	n.d		
		(R)-6,7,8,3´-tetramethoxyisoflavan-1',4'-quinone	$C_{19}H_{20}O_7$	361.1283[b] $[M+H]^+$	n.d		

n.d=Not determinedResults and Discussions

Bioactivity of Fabecease Plants

The growing demand for antimicrobial drugs to fight against pathogenic diseases is being driven by the evolution of new strains of drug-resistant pathogens. Drug-resistant pathogens have rendered previously effective drugs against bacteria and parasites ineffective. To keep up with the surge in pathogenic diseases and to curb the spread of drug-resistant pathogens, alternative approaches to discovering active molecules against pathogens and parasites should be investigated [83]. Secondary metabolite plant constituents are evaluated against cancer cells, bacterial, parasitic, and antioxidant assays to determine anticancer, antibacterial, antiparasitic, anti-inflammatory, antioxidant, antimalarial, and immunosuppressant properties. The objective is to explore molecules of important bioactive and pharmacological effects that could be applied in pharmaceutical or nutraceutical industries as precursor molecules. Until now, several researchers have been investigating the bioactive efficacy of plant-based extracts for this purpose.

Antibacterial Activity

Acacia ligulata, an Australian traditional medicine plant used for treating chest infections, was found to have antibacterial action, according to Jæger *et al* [84]. With MIC values of 1000 g/mL for *S. epidermidis* and *S. aureus* and 62.5 g/mL for *S. pyogenes*, the ethanol bark extract proved effective against these bacteria. The bark, leaves, and seeds of *C. ferrea* C. Mart. are used in Brazilian traditional medicine for tea, concoction, and infusion in treating respiratory conditions [85]. By microdilution, Luna *et al.*'s study of chloroform leaf extract of *C. ferrea* revealed activity against *S. aureus* and *B. subtilis* at MIC values of 0.78 mg/mL [86]. they also stated that terpenes and flavonoids were detected in the extract. Using an agar well diffusion method with a MIC of 1.95 mg/mL, Belay *et al.* demonstrated the effectiveness of *Calpurnia aurea's* ethyl acetate, n-hexane, and DCM leaf extracts against *S. typhi* [87] For the ethyl acetate stem bark fraction of *Macrolobium latifolium* Vogel, Ferraz et al [88] demonstrated better antibacterial activity against *S. aureus*, *S. epidermidis*, *K. pneumoniae*, and *P. mirabilis* with MIC of 250 mg/mL, 50 mg/mL, 100 mg/mL, and 100 mg/mL for the corresponding bacterial strains [88]. Interestingly, the chemical profile of the fraction indicated the presence of oleanane triterpenoid and quercetin aglycone compounds.

According to Obistioiu *et al.*, *R. pseudoacacia* aerial parts ethanol extracts inhibited S. pyogenes growth at MIC 25 L/mL. High levels of rutin (a flavonoid) in *R. pseudoacacia's* aerial portions were ascribed to the plant's antibacterial properties [89]. Obistioiu and co. also indicated that the aerial parts extract of *M. officinalis* had antibacterial effects against *P. seudomonas aeruginosa* (MIC 25 µL/mL). The antibacterial activity was attributed to protocatechuic acid in the plant. Some tropical regions of Africa are home to Erythrina abyssinica Lam. ex D.C. The herb has anti-inflammatory, antibacterial, antioxidant, antiplasmodial, antifungal, anti-HIV 1, and antidiabetic activities, according to Obakiro et al.

Erythrina abyssinica Lam. Ex.DC. is found in some tropical parts of Africa. (+)-Erysodine (alkaloid), Licoagrochalcone A (chalcone), and Indicanine B (coumarin) have been profiled in the seed, twig, and root bark extracts of *E. abyssinica* [90] With MIC values of 104 g/mL and 5 g/mL, stem bark DCM extract of *E. lysistemon* exhibited good antibacterial activity against S. aureus and S. epidermidis, according to Sadgrove *et al* [91], the DCM extract of *E. lysistemon* contained isoflavone derivatives such as Erybraedin A, phaseollidin, abyssinone V-4'methyl ether, eryzerin C, alpumisoflavone, cristacarpin, and lysisteisoflavone.

Finally, Heydari *et al.* (2019) [92] demonstrated in a broth dilution test against *B. subtilis* and *E. coli* that the ethyl acetate aerial component extracts of five species of *Lathyrus L.*, including *armenus*, *aureus*, *cilicicus Karaman*, *laxiflorus* subsp. *Laxiflorus*, and *pratensis*, exhibit some antibacterial activity [92]. When do Nascimento *et al.* tested an ethanol flower extract of S. macranthera for antibacterial activity, they discovered modest activity against *P. gingivalis* at MIC values of 400 g/mL [93]. The ethyl acetate fraction of *S. macranthera* was used to identify flavones (gallocatechin) and proanthocyanidins (guibourtinidol-gallocatechin). *Pseudarthria*

hookeri whole plant dichloromethane/methanol extratcs were reported to contain flavonoids by Dzoyem *et al* [94]. At a MIC value of 4 g/mL, pseudorflavone A and 6-prenylpinocembrin exhibited the strongest antibacterial activity against Escherichia coli. In respect to E. *coli*, *K. pneumoniae*, *P. aeruginosa*, *E. faecalis*, and *S. aureus*, pseudorhodopsin A, desmoxyphyllin, 6,7-(2'',2''-dimethylchromano) flavanone, 6-prenylpinocembrin, and boeravinone L demonstrated promising antibacterial action.

Antioxidant Activity

The phenolic content of the stem bark methanol extract of *C. cajan* (L.) Millsp and antioxidant activity were found to be correlated, according to Sinan *et al.* [95]. The extract's significant antioxidant activity was detected by a DPPH radical scavenging experiment, which was 38.41 0.05 mg TE/g. According to Khan *et al.*, the ethyl acetate extract of *C. ambigua's* strong radical scavenging activity (83.32 6.22 mgTE/g) in the DPPH assay was caused by the extract's high phenolic (85.87 2.96 mg GAE/g) and flavonoid contents (66.45 0.37 mg RE/g) contents [96]. Ali *et al.* also confirmed high phenolic and flavonoid contents in *C*. *brachyantha* Rech. F [97]. A relationship was established between TPC and TFC with antioxidant activity because the ethyl acetate extract assayed by DPPH showed antioxidant activity of 77.91±4.96 mgTE/g. The TPC and TFC of the methanol leaves extract of *S. auriculata* (L.) Roxb., which had an IC_{50} of 76.24 mg/mL, may have also contributed to the extract's ability to scavenge free radicals, according to Parasathkumar *et al* [98]. Indrianingsih *et al.* agreed with Sinan *et al* [95] and Ali *et al* [97] by suggesting low phenolic content in the methanol flower extract of *C. ternatea* was responsible for the poor radical scavenging activity of the extract by showing IC_{50} of 800 µg/mL [99].

Haidara and Al-Oqail [100] indicated that rutin and quercetin ethyl acetate fraction of *C. italica* exhibited about 100% antioxidant capacity in DPPH. According to Kurt-Celep *et al* [101], rutin from the methanol aerial portions of *A. campylosema* has antioxidant activity ranging from 47.13 to 48.10 mg TE/g. Enyl-2,2'-dimethylpyrano-(6,7),5,2',4'-trihydroxyisoflavanone and -enyl-2,2'-dimethylpyrano-(6,7),2,4'-dihydroxy-5-methoxy isoflavane were isoflavonoids that Mboussaah *et al* [102] identified from the methanol roots extract of *D. intortum* and showed values of 38.9 ± 0.96 µM. 7,4-dihydroxy-6-methoxycoumaronochromone and (2S)-3'-enyl-2',2'-dimethyl pyrano-(6,7)2',4'-dihydroxy-5-methoxyisoflavane, respectively, had IC_{50} values of 49.6 0.62 µM and 39.6 0.82 µM. By expressing an IC_{50} of 47.4 g/mL, the isoflavones biochanin A and formononetin that Bottamedi *et al* [103] extracted from the ethanol trunk bark extract of *M. frondosus* demonstrated free radical scavenging action. For Król-Grzymała and Amarowicz [104], their extracted isoflavones daidzein, genistein, malonyldaidzein, malonylgenistein, daidzin, and genistin from the seeds extract of *G. max* L. Merr. expressed radical scavenging potential in the value of 45.4 ± 0.3 µmol Trolox/g. Similar expressions were observed by Rocchetti *et al* [105] for isolated anthocyanins from the methanol aerial parts of *A. scabrifolium.* An antioxidant potential of 27.30 ± 0.56 mg TE/g was reported.

Conclusion

The Fabaceae family comprises species of considerable ecological and economic significance. In addition to providing food, medicine, and shelter, many Fabaceae trees serve as vital sources of economic value through their roles as food crops, dye sources, forage and fodder plants, ornamentals, and timber-yielding species. This review highlights both conventional extraction methods—such as maceration and Soxhlet extraction—and advanced, technology-driven techniques, including microwave-assisted extraction, employed in the recovery of secondary metabolites from Fabaceae plants. We summarize extract yields obtained from various plant parts (leaves, roots, bark, stems, and pods), taking into account the influence of solvent polarity, extraction duration, and temperature. The review also identifies key secondary metabolites isolated from different plant organs, with flavonoids and polyphenolic compounds emerging as the predominant constituents. Notably, flavonoids such as quercetin, myricetin, and their glycosylated derivatives (e.g., quercetin-3-O-glucoside and myricetin-3-O-glucoside) are

commonly reported. Although isolating sufficient quantities of bioactive compounds from plant sources remains a challenge, the integration of natural product chemistry with synthetic drug development is increasingly recognized for its potential. Natural product-derived pharmaceuticals tend to be more widely accepted than synthetic counterparts due to their lower toxicity and higher therapeutic efficacy. Numerous studies have reported the antibacterial, antioxidant, and anti-inflammatory properties of Fabaceae extracts. This review compiles evidence of antibacterial activities against strains such as *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Staphylococcus aureus*, and *Escherichia coli*, assessed using methods including minimum bactericidal concentration (MBC), agar well diffusion, and microdilution assays. Furthermore, this review highlights recent studies assessing the antioxidant capacities of Fabaceae species through assays such as 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging and ferric reducing antioxidant power (FRAP), underscoring the therapeutic potential of this plant family.

Acknowledgement

The authors acknowledge the support from the University of Brawijaya and the University of The Gambia respectively.

Author Contributions

Conceptualisation, M.S.S; Literature Survey, M.S.S., A.C.E., I.L.T., and A.M; Writing – Original Draft Preparation, M.S.S; Writing – Review & Editing, M.S.S., A.C.E., I.L.T., and A.M.

Conflic of Interest

The authors declare no conflict of interest.

References

[1]. Pullaiah, T. (Ed.). *Global Biodiversity*: Volume 2: Selected European Countries (1st ed.). Apple Academic Press. 2018. https://doi.org/10.1201/9780429487750

[2]. Kenicer, G. Legumes of the World. *Edinburgh Journal of Botany.* 2005*, 62*(3), 195–196. https://doi:10.1017/S0960428606190198

[3]. USDA, Agricultural Research Service, National Plant Germplasm System. 2023. *Germplasm Resources Information Network (GRIN Taxonomy). National Germplasm Resources Laboratory,* Beltsville, Maryland. URL: http://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomydetail?26017. Accessed January 14, 2023.

[4]. Grygier, A.; Chakradhari, S.; Ratusz, K.; Rudzinska, M.; Patel, K. S.; Lazdina, D., Gornas. P. Seven underutilized species of the Fabaceae family with high potential for industrial application as alternative sources of oil and lipophilic bioactive compounds. *Industrial Crops and Products.* 2022; 186, 115251. https://doi:10.1016/j.indcrop.2022.115251.

[5]. Garza, W. Fabaceae: Classification, Nutrient Composition, and Health Benefits; Nova Science Publishers, Inc: New York, 2015; p.131.

[6]. Frimpong, E. K.; Asong, J. A.; Aremu, A. O. A Review on Medicinal Plants Used in the Management of Headache in Africa. *Plants (Basel)*. 2021; 10(10), 2038. https://doi: 10.3390/plants10102038.

[7]. Gao, T.; Yao, H.; Song, J.; Liu, C.; Zhu, Y.; Ma, X.; Pang, X.; Xu, H.; Chen, S. Identification of medicinal plants in the family Fabaceae using a potential DNA barcode ITS2. *Journal of Ethnopharmacology.* 2010; 130 (1), 116–121. https://doi.org/10.1016/j.jep.2010.04.026.

[8]. Auditeau, E.; Chassagne, F.; Bourdy, G.; Bounlu, M.; Jost, J.; Luna, J.; Ratsimbazafy, V.; Preux, P-M.; Boumediene, F. Herbal medicine for epilepsy seizures in Asia, Africa, and Latin America: A systematic review. *Journal of Ethnopharmacology.* 2019; 234, 119–153. https://doi.org/10.1016/j.jep.2018.12.049.

[9]. Yuan, H.; Ma, Q.; Ye, L.; Piao, G. The Traditional Medicine and Modern Medicine from Natural Products. *Molecules.* 2016; 21 (5), 559. https://doi.org/10.3390/molecules21050559.

[10]. Oladele, A. T.; Dairo, B. A.; Elujoba, A. A.; Oyelami, A. O. Management of Superficial Fungal Infections with Senna Alata ("Alata") Soap: A Preliminary Report. *Journal of Pharmacognosy and Phytochemistry*. 2010; 4 (3), 098–103.

[11]. Oladeji, S. O.; Adelowo, F. E.; Odelade, K. A. Mass Spectroscopic and Phytochemical Screening of Phenolic Compounds in the Leaf Extract of Senna Alata (L.) Roxb. (Fabales: Fabaceae). *Braz. J. Biol. Sci.* 2016; 3 (5), 209. https://doi.org/10.21472/bjbs.030519.

[12]. Mt, Y.; Ao, A.; At, O.; Ma, A.; Ob, O.; Ga, J.; Awo, O.; Aj, A. Abortifacient Potential of Aqueous Extract of Senna Alata Leaves in Rats. *Journal of Reproduction and Contraception.* 2010; 21 (3), 163–177. https://doi.org/10.1016/S1001-7844(10)60025-9.

[13]. Abdillah, S.; Tambunan, R. M.; Farida, Y.; Sandhiutami, N. M. D.; Dewi, R. M. Phytochemical Screening and Antimalarial Activity of Some Plants Traditionally Used in Indonesia. Asian Pacific Journal of Tropical Disease. 2015; 5 (6), 454–457. https://doi.org/10.1016/S2222-1808(15)60814–3.

[14]. Chávez-Arias, C. Camilo.; Ramírez-Godoy, A.; Restrepo-Díaz, H. Influence of drought, high temperatures, and/or defense against arthropod herbivory on the production of secondary metabolites in maize plants. A review. *Current Plant Biology* 2022, 32, 100268. https://doi.org/10.1016/j.cpb.2022.100268.

[15]. Romo-Rico, J.; Krishna, S. M.; Bazaka, K.; Golledge, J.; Jacob, M. V. Potential of plant secondary metabolite-based polymers to enhance wound healing. *Acta Biomaterialia.* 2022;147,p34–49. https://doi.org/10.1016/j.actbio.2022.05.043.

[16]. Ji, S.; Fattahi, A.; Raffel, N.; Hoffmann, I.; Beckmann, W. M.; Dittrich, R.; Schrauder, M. Antioxidant Effect of Aqueous Extract of Four Plants with Therapeutic Potential on Gynecological Siseases; Semen persicae, Leonurus, cardiaca, Hedyotis diffusa, and Curcuma zedoaria. *European Journal of Medical Research.2017*;22(1),50. https://doi.org/10.1186/s40001-017-0293-6.

[17]. Jha, A. K.; Sit, Nandan. Extraction of bioactive compounds from plant materials using combination of various novel methods: A review, *Trends in Food Science & Technology*. 2022; 119, 579-591. https://doi.org/10.1016/j.tifs.2021.11.019.

[18]. Kaczmarska, A.; Pieczywek, P. M.; Cybulska, J.; Zdunek, A. A mini-review on the plant sources and methods for extraction of rhamnogalacturonan I, *Food Chemistry*. 2023; 403,134378. https://doi.org/10.1016/j.foodchem.2022.134378.

[19]. Zhang, H-F.; Yang, X-H.; Wang, Y. Microwave assisted extraction of secondary metabolites from plants: Current status and future directions. *Trends in Food Science & Technology.* 2011;22(12),672–688. https://doi.org/10.1016/j.tifs.2011.07.003.

[20]. El-Masry, S.; Hammoda, H. M.; Zaatout, H. H.; Alqasoumi, S. I.; Abdel-Kader, M. S. Constituents of Erythrina Caffra Stem Bark Grown in Egypt. *Natural Product Sciences*.2010;16(4),6. https://doi: 10.1016/s0031-9422(02)00202–9.

[21]. Ahmed Hassan, L. E.; Khadeer Ahamed, M. B.; Abdul Majid, A. S.; Iqbal, M. A.; Al Suede, F. S. R.; Haque, R. A.; Ismail, Z.; Ein, O. C.; Majid, A. M. S. A. Crystal Structure Elucidation and Anticancer Studies of (-)-Pseudosemiglabrin: A Flavanone Isolated from the Aerial Parts of Tephrosia Apollinea. *PLoS ONE. 2014*; 9(3), e90806. https://doi.org/10.1371/journal.pone.0090806.

[22]. Mohammed, M. M. D.; Ibrahim, N. A.; Awad, N. E.; Matloub, A. A.; Mohamed-Ali, A. G.; Barakat, E. E.; Mohamed, A. E.; Colla, P. L. Anti-HIV-1 and Cytotoxicity of the Alkaloids of Erythrina Abyssinica Lam. Growing in Sudan. *Natural Product Research*. 2012;26(17),1565–1575. https://doi.org/10.1080/14786419.2011.573791

[23]. El-Masry, S.; Amer, M. E.; Abdel-Kader, M. S.; Zaatout, H. H. Prenylated Flavonoids of Erythrina Lysistemon Grown in Egypt. *Phytochemistry.2002*;60(8),783–787. https://doi.org/10.1016/S0031-9422(02)00202–9.

[24]. Nasser Singab, A.; Youssef, F. S. Medicinal Plants with Potential Antidiabetic Activity and Their Assessment. *Med Aromat Plants* 2014, 03 (01). https://doi.org/10.4172/2167-0412.1000151.

[25]. Melek, F. R.; Kassem, I. A. A.; Miyase, T.; Fayad, W. Caspicaosides E–K, Triterpenoid Saponins and Cytotoxic Acylated Saponins from Fruits of Gleditsia Caspica Desf. *Phytochemistry*.2014;100,110–119. https://doi.org/10.1016/j.phytochem.2014.01.019.

[26]. Barba, F. J.; Putnik, P.; Bursać Kovačević, D.; Poojary, M. M.; Roohinejad, S.; Lorenzo, J. M.; Koubaa, M. Impact of Conventional and Non-Conventional Processing on Prickly Pear (Opuntia Spp.) and Their Derived Products: From Preservation of Beverages to Valorization of by-Products. *Trends in Food Science & Technology.* 2017;67,260–270. https://doi.org/10.1016/j.tifs.2017.07.012.

[27]. Bursać Kovačević, D.; Maras, M.; Barba, F. J.; Granato, D.; Roohinejad, S.; Mallikarjunan, K.; Montesano, D.; Lorenzo, J. M.; Putnik, P. Innovative Technologies for the Recovery of Phytochemicals from Stevia Rebaudiana

Bertoni Leaves: A Review. *Food Chemistry*. 2018; 268,513–521. https://doi.org/10.1016/j.foodchem.2018.06.091.

[28]. Rocchetti, G.; Blasi, F.; Montesano, D.; Ghisoni, S.; Marcotullio, M. C.; Sabatini, S.; Cossignani, L.; Lucini, L. Impact of Conventional/Non-Conventional Extraction Methods on the Untargeted Phenolic Profile of Moringa Oleifera Leaves. *Food Research International*. 2019;115, 319–327. https://doi:10.1016/j.foodres.2018.11.046.

[29]. Sasidharan, S.; Shanmugapriya; Jothy, S. L.; Vijayarathna, S.; Kavitha, N.; Oon, C. E.; Chen, Y.; Dharmaraj, S.; Lai, N. S.; Kanwar, J. R. Conventional and Non-Conventional Approach towards the Extraction of Bioorganic Phase. In Bioorganic Phase in Natural Food: An Overview; Roopan, S. M., Madhumitha, G., Eds.; Springer International Publishing: *Cham*. 2018: 41–57. https://doi.org/10.1007/978-3-319-74210-6_4.

[30]. Zhang, Q.-W.; Lin, L.-G.; Ye, W.-C. Techniques for Extraction and Isolation of Natural Products: A Comprehensive Review. *Chin Med*; 2018, 13 (1), 20. https://doi.org/10.1186/s13020-018-0177-x.

[31]. Ćujić, N.; Šavikin, K.; Janković, T.; Pljevljakušić, D.; Zdunić, G.; Ibrić, S. Optimization of Polyphenols Extraction from Dried Chokeberry Using Maceration as Traditional Technique. *Food Chemistry*.2016;194,135–142. https://doi.org/10.1016/j.foodchem.2015.08.008

[32]. Masruri, M., Pangestin, N. D., Pangesti, A. P., Arini, W. Reducing Environmental Effect of Bark Waste of Sengon (Paraserianthes falcataria L.) by Applying As a Source of Green Ingredients To Lower Glucose-related Diseases. *IOP Conf. Series: Earth and Environmental Science* 239. 2019,012025. https://doi:10.1088/17551315/239/1/012025

[33]. Baihaqi, Z. A.; Widiyono, I.; Nurcahyo, W. In Vitro Anthelmintic Activity of Aqueous and Ethanol Extracts of Paraserianthes Falcataria Bark Waste against Haemonchus Contortus Obtained from a Local Slaughterhouse in Indonesia. *Veterinary World*. 2020;13(8):1549-1554.
https://doi: 10.14202/vetworld.2020.1549-1554

[34]. Rumidatul, A.; Aryantha, I. N. P.; Sulistyawati, E. Phytochemicals Screening, GC/MS Characterization, and Antioxidant Activity of Falcataria Moluccana Miq. Barneby and J. W. Grimes Methanolic Extract. *Pharmacognosy Journal*.2021;13(2),6. http://dx.doi.org/10.5530/pj.2021.13.57

[35]. Teinkela, J. E. M., Noundou, X. S., Mimba, J. E. Z., Meyer, F., Tabouguia, O. M., Nguedia, J. C. A., Hoppe, H. C., Krause, R. W. M., Wintjens, R., Azebaze, G. A. B. Compound isolation and biological activities of Piptadeniastrum africanum (hook.f.) Brennan roots. *Journal of Ethnopharmacology*.2020;255,112716. https://doi.org/10.1016/j.jep.2020.112716

[36]. Thakur, A. V.; Ambwani, S.; Kumar, T. Preliminary Phytochemical Screening and GC-MS Analysis of Leaf Extract of Acacia Catechu (L.f.) Willd. *International Journal of Herbal Medicine*. 2018;6(2),81–85.

[37]. Sunday, O. J., Babatunde, S. K., Ajiboye, A. E., Adedayo, R. M., Ajao, M. A., Ajuwon, B. I. Evaluation of Phytochemical Properties and In-vitro Antibacterial Activity of the Aqueous Extracts of Leaf, Seed and Root of Abrus precatorius Linn. Against Salmonella and Shigella. *Asian Pac J Trop Biomed*. 2016;6(9),755–799. http://dx.doi.org/10.1016/j.apjtb.2016.07.002.

[38]. Shourie, A., Kalra, K. Analysis of Phytochemical Constituents and Pharmacological Properties of Abrus Precatorius L. Int J Pharm Bio Sci 2013, 4 (1), 91–101.

[39]. Kusuma, I. W.; Murdiyanto; Arung, E. T.; Syafrizal; Kim, Y. Antimicrobial and Antioxidant Properties of Medicinal Plants Used by the Bentian Tribe from Indonesia. *Food Science and Human Wellness*. 2014;3(3–4),191–196. https://doi.org/10.1016/j.fshw.2014.12.004.

[40]. Ayal, G.; Belay, A.; Kahaliw, W. Evaluation of Wound Healing and Anti-Inflammatory Activity of the Leaves of Calpurnia Aurea (Ait.) Benth (Fabaceae) in Mice. *Wound Medicine*.2019;25 (1), 100151. https://doi.org/10.1016/j.wndm.2019.100151.

[41]. Belayneh, Y. M.; Birru, E. M. Antidiabetic Activities of Hydromethanolic Leaf Extract of Calpurnia Aurea (Ait.) Benth. Subspecies Aurea (Fabaceae) in Mice. *Evidence-Based Complementary and Alternative Medicine*. 2018; 3509073. https://doi.org/10.1155/2018/3509073.

[42]. Birru, E. M.; Asrie, A. B.; Adinew, G. M.; Tsegaw, A. Antidiarrheal Activity of Crude Methanolic Root Extract of Idigofera Spicata Forssk.(Fabaceae). *BMC Complement Altern Med*.2016,*16*(1),272. https://doi.org/10.1186/s12906-016-1252-4.

[43]. Obogwu, M. B.; Akindele, A. J.; Adeyemi, O. O. Hepatoprotective and in Vivo Antioxidant Activities of the Hydroethanolic Leaf Extract of Mucuna Pruriens (Fabaceae) in Antitubercular Drugs and Alcohol Models. *Chinese Journal of Natural Medicines*. 2014;12(4),273–283. https://doi.org/10.1016/S1875-5364(14)60054–6.

[44]. Gupta, P. S.; Patel, S. In Vitro Antimitotic and Cytotoxic Potential of Plant Extracts: A Comparative Study of Mucuna Pruriens, Asteracantha Longifolia and Sphaeranthus Indicus. *Futur J Pharm Sci*. 2020; 6(1),115. https://doi.org/10.1186/s43094-020-00137-8.

[45]. Bhargavi, G.; Nageswara Rao, P.; Renganathan, S. Review on the Extraction Methods of Crude Oil from All Generation Biofuels in Last Few Decades. IOP Conf. Ser.: Mater. Sci. Eng. 2018; 330, 012024. https://doi.org/10.1088/1757-899X/330/1/012024.

[46]. Rosdiana, N. A., Dumarçay, S., Gérardin, C., Chapuis, H., Santiago-Medina, F. J., Sari, R. K., Syafii, W., Gelhaye, E., Raharivelomanana, P., Mohammed, R., Gérardin, P. Characterization of bark extractives of different industrial Indonesian wood species for potential valorization. *Industrial Crops and Products*. 2017;108,121–127. https://doi.org/10.1016/j.indcrop.2017.06.034.

[47]. Komakech, R.; Kim, Y.; Matsabisa, G. M.; Kang, Y. Anti-Inflammatory and Analgesic Potential of Tamarindus Indica Linn. (Fabaceae): A Narrative Review. *Integrative Medicine Research*.2019;8(3), 181–186. https://doi.org/10.1016/j.imr.2019.07.002.

[48]. Borquaye, L. S.; Doetse, M. S.; Baah, S. O.; Mensah, J. A. Anti-Inflammatory and Antioxidant Activities of Ethanolic Extracts of *Tamarindus Indica* L. (Fabaceae). *Cogent Chemistry*.2020;6(1),1743403. https://doi.org/10.1080/23312009.2020.1743403.

[49]. Gupta, S.; Singh, A. Antimicrobial, Analgesic and Anti - Inflammatory Activity Reported on Tamarindus Indica Linn Root Extract. *PJ* 2017, 9 (3), 410–416. https://doi.org/10.5530/pj.2017.3.70.

[50]. International Diabetes Federation. *IDF Diabetes Atlas, 9th ed.* Brussels, Belgium: International Diabetes Federation, 2019.

[51]. Yusro, F., Ohtani, K., Kubota, S. Inhibition of α-Glucosidase by Methanol Extracts from Wood Bark of Anacardiaceae, Fabaceae, Malvaceae and Phyllanthaceae Plants Family in West Kalimantan, Indonesia. *Kuroshio Science* 2016, 9 (2), 108-122. https://doi:10.1111/1750-3841.16098.

[52]. Agnihotri, A., & Singh, V. Effect of Tamarindus indica Linn. and Cassia fistula Linn. stem bark extracts on oxidative stress and diabetic conditions. *Acta poloniae pharmaceutica,* 2013**,** *70* (6), 1011-9. https://pubmed.ncbi.nlm.nih.gov/24383324/

[53]. Sowndhararajan, K.; Joseph, J. M.; Manian, S. Antioxidant and Free Radical Scavenging Activities of Indian *Acacias* : *Acacia Leucophloea* (Roxb.) Willd., *Acacia Ferruginea* Dc., *Acacia Dealbata* Link. and *Acacia Pennata* (L.) Willd. *International Journal of Food Properties* 2013, *16* (8), 1717–1729. https://doi.org/10.1080/10942912.2011.604895

[54]. Bhosle, V. Anticonvulsant and Antioxidant Activity of Aqueous Leaves Extract of Desmodium Triflorum in Mice against Pentylenetetrazole and Maximal Electroshock Induced Convulsion. *Revista Brasileira de Farmacognosia*.2013;23(4),692–698. https://doi.org/10.1590/S0102-695X2013005000047.

[55]. Alomary, S. A., Al Madani A.J., Althagafi, W.A., Adam, I.F., Elsherif, O.E., Al-Abdullah, A.A., Al-jahdali, H., Jokhar, H.A., Alqahtani, S.H., Nahhas, M.A., Alfawaz, R.A. Prevalence of asthma symptoms and associated risk factors among adults in Saudi Arabia: A national survey from Global Asthma Network Phase Ⅰ. *World Allergy Organ J*. 2022;15(1):100623. doi:10.1016/j.waojou.2021.100623

[56]. Taur, D. J.; Patil, R. N.; Patil, R. Y. Antiasthmatic Related Properties of Abrus Precatorius Leaves on Various Models. *Journal of Traditional and Complementary Medicine*. 2017;7(4),428–432. https://doi.org/10.1016/j.jtcme.2016.12.007

[57]. Govindarajan, M.; Rajeswary, M.; Sivakumar, R. Repellent Properties of Delonix Elata (L.) Gamble (Family: Fabaceae) against Malaria Vector Anopheles Stephensi (Liston) (Diptera: Culicidae). *Journal of the Saudi Society of Agricultural Sciences*. 2015;14(2),128–133. https://doi.org/10.1016/j.jssas.2013.08.005.

[58]. Abdulrazak, N.; Asiya, U.; Usman, N.; Unata, I.; Farida, A. Antiplasmodial Activity of Ethanolic Extract of Root and Stem Back of *Cassia sieberiana* DC on Mice. *J Intercult Ethnopharmacol*.2015;4(2),96. https://doi.org/10.5455/jice.20141231014333.

[59]. Chizoba Ekezie, F.-G.; Sun, D.-W.; Han, Z.; Cheng, J.-H. Microwave-Assisted Food Processing Technologies for Enhancing Product Quality and Process Efficiency: A Review of Recent Developments. *Trends in Food Science & Technology*.2017;67,58–69. https://doi.org/10.1016/j.tifs.2017.05.014.

[60]. Lefebvre, T.; Destandau, E.; Lesellier, E. Selective Extraction of Bioactive Compounds from Plants Using Recent Extraction Techniques: A Review. *Journal of Chromatography A.* 2021; *1635*, 461770. https://doi.org/10.1016/j.chroma.2020.461770.

[61]. Vinatoru, M.; Mason, T. J.; Calinescu, I. Ultrasonically Assisted Extraction (UAE) and Microwave Assisted Extraction (MAE) of Functional Compounds from Plant Materials. *TrAC Trends in Analytical Chemistry*. 2017; 97, 159–178. https://doi.org/10.1016/j.trac.2017.09.002.

[62]. Akbari, S.; Abdurahman, N. H.; Yunus, R. M. Optimization of Saponins, Phenolics, and Antioxidants Extracted from Fenugreek Seeds Using Microwave-Assisted Extraction and Response Surface Methodology as an Optimizing Tool. *Comptes Rendus Chimie*. 2019;22(11–12),714–727. https://doi.org/10.1016/j.crci.2019.07.007.

[63]. Solarte, D. A.; Ruiz-Matute, A. I.; Chito-Trujillo, D. M.; Rada-Mendoza, M.; Sanz, M. L. Microwave Assisted Extraction of Bioactive Carbohydrates from Different Morphological Parts of Alfalfa (*Medicago sativa* L.). *Foods.* 2021;10(2),346. https://doi.org/10.3390/foods10020346.

[64]. Mocan, A.; Carradori, S.; Locatelli, M.; Secci, D.; Cesa, S.; Mollica, A.; Riga, S.; Angeli, A.; Supuran, C. T.; Celia, C.; Di Marzio, L. Bioactive Isoflavones from Pueraria Lobata Root and Starch: Different Extraction Techniques and Carbonic Anhydrase Inhibition. Food and Chemical Toxicology. 2018;112,441–447. https://doi.org/10.1016/j.fct.2017.08.009.

[65]. Mangang, K. C. S.; Chakraborty, S.; Deka, S. C. Optimized Microwave-Assisted Extraction of Bioflavonoids from Albizia Myriophylla Bark Using Response Surface Methodology. *J Food Sci Technol*.2020,57(6),2107–2117. https://doi.org/10.1007/s13197-020-04246-3.

[66]. Zuluaga, A. M.; Mena-García, A.; Soria Monzón, A. C.; Rada-Mendoza, M.; Chito, D. M.; Ruiz-Matute, A. I.; Sanz, M. L. Microwave Assisted Extraction of Inositols for the Valorization of Legume By-Products. *LWT.* 2020;133,109971. https://doi.org/10.1016/j.lwt.2020.109971.

[67]. Vila Verde, G. M.; Barros, D. A.; Oliveira, M.; Aquino, G.; M. Santos, D.; de Paula, J.; Dias, L.; Piñeiro, M.; M. Pereira, M. A Green Protocol for Microwave-Assisted Extraction of Volatile Oil Terpenes from Pterodon Emarginatus Vogel. (Fabaceae). *Molecules*. 2018,23(3),651. https://doi.org/10.3390/molecules23030651.

[68]. Kumar, M.; Dahuja, A.; Sachdev, A.; Kaur, C.; Varghese, E.; Saha, S.; Sairam, K. V. S. S. Evaluation of Enzyme and Microwave-Assisted Conditions on Extraction of Anthocyanins and Total Phenolics from Black Soybean (Glycine Max L.) Seed Coat. *International Journal of Biological Macromolecules*. 2019;135,1070–1081. https://doi.org/10.1016/j.ijbiomac.2019.06.034.

[69]. Izirwan, I.; Munusamy, T. D.; Hamidi, N. H.; Sulaiman, S. Z. Optimization of Microwave-Assisted Extraction of Anthocyanin from Clitoria Ternatea Flowers. *IJMERR* 2020, 1246–1252. https://doi.org/10.18178/ijmerr.9.9.1246-1252.

[70]. Huma, Z.; Jayasena, V.; Nasar-Abbas, S. M.; Imran, M.; Khan, M. K. Process Optimization of Polyphenol Extraction from Carob (*Ceratonia Siliqua*) Kibbles Using Microwave-assisted Technique. *J Food Process Preserv*. 2018;42,(2), e13450. https://doi.org/10.1111/jfpp.13450.

[71]. Noviany, N.; Samadi, A.; Yuliyan, N.; Hadi, S.; Aziz, M.; Purwitasari, N.; Mohamad, S.; Ismail, N. N.; Gable, K. P.; Mahmud, T. Structure Characterization and Biological Activity of 2-Arylbenzofurans from an Indonesian Plant, Sesbania Grandiflora (L.) Pers. *Phytochemistry Letters*. 2020;35,211–215. https://doi.org/10.1016/j.phytol.2019.12.008.

[72]. Ahmed, A. S.; Moodley, N.; Eloff, J. N. Bioactive Compounds from the Leaf Extract of Bauhinia Galpinii (Fabaceae) Used as Antidiarrhoeal Therapy in Southern Africa. *South African Journal of Botany*. 2019;126, 345–353. https://doi.org/10.1016/j.sajb.2019.06.011.

[73]. Erhabor, J. O.; Omokhua, A. G.; Ondua, M.; Abdalla, M. A.; McGaw, L. J. Pharmacological Evaluation of Hydro-Ethanol and Hot Water Leaf Extracts of *Bauhinia galpinii* (Fabaceae): A South African Ethnomedicinal Plant. *South African Journal of Botany.* 2020; 128,28–34. https://doi.org/10.1016/j.sajb.2019.10.008.

[74]. Sinan, K. I.; Saftić, L.; Peršurić, Ž.; Pavelić, S. K.; Etienne, O. K.; Picot-Allain, M. C. N.; Mahomoodally, M. F.; Zengin, G. A Comparative Study of the Chemical Composition, Biological

and Multivariate Analysis of Crotalaria Retusa L. Stem Barks, Fruits, and Flowers Obtained via Different Extraction Protocols. *South African Journal of Botany*. 2020;128,101–108. https://doi.org/10.1016/j.sajb.2019.10.019.

[75]. Mohotti, S.; Rajendran, S.; Muhammad, T.; Strömstedt, A. A.; Adhikari, A.; Burman, R.; de Silva, E. D.; Göransson, U.; Hettiarachchi, C. M.; Gunasekera, S. Screening for Bioactive Secondary Metabolites in Sri Lankan Medicinal Plants by Microfractionation and Targeted Isolation of Antimicrobial Flavonoids from Derris Scandens. *Journal of Ethnopharmacology*. 2020; 246, 112158. https://doi.org/10.1016/j.jep.2019.112158.

[76]. Chen, X.; Xiong, J.; He, Q.; Wang, F. Characterization and Potential Antidiabetic Activity of Proanthocyanidins from the Barks of Acacia Mangium and Larix Gmelinii. *Journal of Chemistry*.2019,1–9. https://doi.org/10.1155/2019/4793047.

[77]. Navarro del Hierro, J.; Reglero, G.; Martin, D. Chemical Characterization and Bioaccessibility of Bioactive Compounds from Saponin-Rich Extracts and Their Acid-Hydrolysates Obtained from Fenugreek and Quinoa. *Foods*. 2020;9(9), 1159. https://doi.org/10.3390/foods9091159.

[78]. Herrera, T.; Navarro del Hierro, J.; Fornari, T.; Reglero, G.; Martin, D. Acid Hydrolysis of Saponin-rich Extracts of Quinoa, Lentil, Fenugreek and Soybean to Yield Sapogenin-rich Extracts and Other Bioactive Compounds. *J. Sci. Food Agric.* 2019;99(6),3157–3167. https://doi.org/10.1002/jsfa.9531.

[79]. King, M.; Catranis, C.; Leigh, B. M. Phytochemical and Toxicological Analysis of Albizia falcataria Sawdust. *International Wood Products Journal* . 2013;232–241. https://doi.org/10.1179/2042645312Y.0000000029.

[80]. Fotso, G. W.; Kamga, J.; Ngameni, B.; Uesugi, S.; Ohno, M.; Kimura, K.-I.; Momma, H.; Kwon, E.; Furuno, H.; Shiono, Y.; Ingrid, S. K.; Yeboah, S. O.; Ngadjui, B. T. Secondary Metabolites with Antiproliferative Effects from *Albizia glaberrima* Var Glabrescens Oliv. (Mimosoideae). *Natural Product Research*.2017;31(17),1981–1987. https://doi.org/10.1080/14786419.2016.1269097.

[81]. Wang, X.-D.; Han, Q.-H.; Zhang, J.; Zhang, Q.-Y.; Tu, P.-F.; Liang, H. Three New Triterpenoid Saponins from Albizia Julibrissin. *Journal of Asian Natural Products Research*. 2019;21(6),535–541. https://doi.org/10.1080/10286020.2018.1473385.

[82]. Han, Q.; Qian, Y.; Wang, X.; Zhang, Q.; Cui, J.; Tu, P.; Liang, H. Oleanane-Type Saponins and Prosapogenins from Albizia Julibrissin and Their Cytotoxic Activities. *Phytochemistry*. 2021;185, 112674. https://doi.org/10.1016/j.phytochem.2021.112674.

[83]. Anand, S.; Deighton, M.; Livanos, G.; Morrison, P. D.; Pang, E. C. K.; Mantri, N. Antimicrobial Activity of Agastache Honey and Characterization of Its Bioactive Compounds in Comparison With Important Commercial Honeys. *Front. Microbiol.* 2019;10,263. https://doi.org/10.3389/fmicb.2019.00263.

[84]. Jæger, D.; Simpson, B. S.; Ndi, C. P.; Jäger, A. K.; Crocoll, C.; Møller, B. L.; Weinstein, P.; Semple, S. J. Biological Activity and LC-MS/MS Profiling of Extracts from the Australian Medicinal Plant *Acacia ligulata* (Fabaceae). *Natural Product Research*.2018;32(5),576–581. https://doi.org/10.1080/14786419.2017.1318383.

[85]. Macêdo, N. S.; Silveira, Z. de S.; Bezerra, A. H.; Costa, J. G. M. da; Coutinho, H. D. M.; Romano, B.; Capasso, R.; Cunha, F. A. B. da; da Silva, M. V. *Caesalpinia ferrea* C. Mart. (Fabaceae) Phytochemistry, Ethnobotany, and Bioactivities: A Review. *Molecules*. 2020;25(17),3831. https://doi.org/10.3390/molecules25173831.

[86]. Luna, M. S. M.; de Paula, R. A.; Brandão Costa, R. M. P.; dos Anjos, J. V.; da Silva, M. V.; Correia, M. T. S. Bioprospection of Libidibia Ferrea Var. Ferrea: Phytochemical Properties and Antibacterial Activity. *South African Journal of Botany*.2020;130,103–108. https://doi.org/10.1016/j.sajb.2019.12.013.

[87]. Belay, D.; Kenubih, A.; Yesuf, M.; Kebede, E.; Yayeh, M.; Birhan, M. Antioxidant and Antimicrobial Activity of Solvent Fractions of Calpurnia Aurea (Ait.) Benth. (Fabaceae). *JEP*. 2021;13,499–509. https://doi.org/10.2147/JEP.S285872.

[88]. Ferraz, C. M. dos S.; Santos, A. Q.; Santos, M. de J.; Silva, V. R.; Santos, L. de S.; Soares, M. B. P.; Bezerra, D. P.; de Macedo, G. E. L.; de Paula, V. F.; Queiroz, R. F. Chemical Composition and Antioxidant, Antibacterial and Antiproliferative Activities of Macrolobium Latifolium Vogel (Fabaceae) Stem Bark. *South African Journal of Botany*.2021;140,210–217. https://doi.org/10.1016/j.sajb.2021.04.013.

[89]. Obistioiu, D.; Cocan, I.; Tîrziu, E.; Herman, V.; Negrea, M.; Cucerzan, A.; Neacsu, A.-G.; Cozma, A. L.; Nichita, I.; Hulea, A.; Radulov, I.; Alexa, E. Phytochemical Profile and Microbiological Activity of Some Plants Belonging to the Fabaceae Family. *Antibiotics*.2021;10(6),662. https://doi.org/10.3390/antibiotics10060662.

[90]. Obakiro, S. B.; Kiprop, A.; Kigondu, E.; K'Owino, I.; Odero, M. P.; Manyim, S.; Omara, T.; Namukobe, J.; Owor, R. O.; Gavamukulya, Y.; Bunalema, L. Traditional Medicinal Uses, Phytoconstituents, Bioactivities, and Toxicities of Erythrina Abyssinica Lam. Ex DC. (Fabaceae): A Systematic Review. *Evidence-Based Complementary and Alternative Medicine*. 2021, 2021,1–43. https://doi.org/10.1155/2021/5513484.

[91]. Sadgrove, N. J.; Oliveira, T. B.; Khumalo, G. P.; van Vuuren, S. F.; van Wyk, B.-E. Antimicrobial Isoflavones and Derivatives from Erythrina (Fabaceae): Structure Activity Perspective (Sar & Qsar) on Experimental and Mined Values Against *Staphylococcus aureus*. *Antibiotics*. 2020;9(5),223. https://doi.org/10.3390/antibiotics9050223.

[92]. Heydarî, H.; Saltan İŞcan, G.; Eryilmaz, M.; Bahadir Acikara, Ö.; Yilmaz Sarialtin, S.; TekiN, M.; Çoban, T. Antimicrobial and Anti-Inflammatory Activity of Some Lathyrus L. (Fabaceae) Species Growing in Turkey. *tjps*. 2019;16(2),240–245. https://doi.org/10.4274/tjps.galenos.2018.86719.

[93]. do Nascimento, M. N. G.; Machado Martins, M.; Scalon Cunha, L. C.; de Souza Santos, P.; Goulart, L. R.; de Souza Silva, T.; Gomes Martins, C. H.; de Morais, S. A. L.; Pivatto, M. Antimicrobial and Cytotoxic Activities of Senna and Cassia Species (Fabaceae) Extracts. *Industrial Crops and Products*.2020;148,112081. https://doi.org/10.1016/j.indcrop.2019.112081.

[94]. Dzoyem, J. P.; Tchamgoue, J.; Tchouankeu, J. C.; Kouam, S. F.; Choudhary, M. I.; Bakowsky, U. Antibacterial Activity and Cytotoxicity of Flavonoids Compounds Isolated from *Pseudarthria hookeri* Wight & Arn. (Fabaceae). *South African Journal of Botany*. 2018;114,100–103. https://doi.org/10.1016/j.sajb.2017.11.001.

[95]. Sinan, K. I.; Mahomoodally, M. F.; Eyupoglu, O. E.; Etienne, O. K.; Sadeer, N. B.; Ak, G.; Behl, T.; Zengin, G. HPLC-FRAP Methodology and Biological Activities of Different Stem Bark Extracts of Cajanus Cajan (L.) Millsp. *Journal of Pharmaceutical and Biomedical Analysis*. 2021;192,113678. https://doi.org/10.1016/j.jpba.2020.113678.

[96]. Khan, S.; Nazir, M.; Raiz, N.; Saleem, M.; Zengin, G.; Fazal, G.; Saleem, H.; Mukhtar, M.; Tousif, M. I.; Tareen, R. B.; Abdallah, H. H.; Mahomoodally, F. M. Phytochemical Profiling, in Vitro Biological Properties and in Silico Studies on Caragana Ambigua Stocks (Fabaceae): A Comprehensive Approach. *Industrial Crops and Products*.2019;131,117–124. https://doi.org/10.1016/j.indcrop.2019.01.044.

[97]. Ali, L.; Khan, S.; Nazir, M.; Raiz, N.; Naz, S.; Zengin, G.; Mukhtar, M.; Parveen, S.; Shazmeen, N.; Saleem, M.; Tareen, R. B. Chemical Profiling, in Vitro Biological Activities and Pearson Correlation between Phenolic Contents and Antioxidant Activities of Caragana Brachyantha Rech.f. *South African Journal of Botany*. 2021;140, 189–193. https://doi.org/10.1016/j.sajb.2021.04.009.

[98]. Prasathkumar, M.; Raja, K.; Vasanth, K.; Khusro, A.; Sadhasivam, S.; Sahibzada, M. U. K.; Gawwad, M. R. A.; Al Farraj, D. A.; Elshikh, M. S. Phytochemical Screening and in Vitro Antibacterial, Antioxidant, Anti-Inflammatory, Anti-Diabetic, and Wound Healing Attributes of Senna Auriculata (L.) Roxb. Leaves. *Arabian Journal of Chemistry*. 2021;14(9),103345.

[99]. Indrianingsih, A. W.; Wulanjati, M. P.; Windarsih, A.; Bhattacharjya, D. K.; Suzuki, T.; Katayama, T. In Vitro Studies of Antioxidant, Antidiabetic, and Antibacterial Activities of Theobroma Cacao, Anonna Muricata and Clitoria Ternatea. *Biocatalysis and Agricultural Biotechnology*. 2021; 3,101995. https://doi.org/10.1016/j.bcab.2021.101995.

[100]. Al-Haidari, R. A.; Al-Oqail, M. M. New Benzoic Acid Derivatives from Cassia Italica Growing in Saudi Arabia and Their Antioxidant Activity. *Saudi Pharmaceutical Journal*. 2020;28(9),1112–1117. https://doi.org/10.1016/j.jsps.2020.07.012.

[101]. Kurt-Celep, İ.; Zengin, G.; Sinan, K. I.; Ak, G.; Elbasan, F.; Yıldıztugay, E.; Maggi, F.; Caprioli, G.; Angeloni, S.; Sharmeen, J. B.; Mahomoodally, M. F. Comprehensive Evaluation of Two Astragalus Species (A. Campylosema and A. Hirsutus) Based on Biological, Toxicological Properties and Chemical Profiling. *Food and Chemical Toxicology* 2021, 154, 112330. https://doi.org/10.1016/j.fct.2021.112330.

[102]. 132. Mboussaah, A. D. K.; Lateef, M.; Fodouop, S. P. C.; Nkengfack, A. E.; Lenta, B. N.; Ali, M. S.; Tapondjou, L. A. Intortins A–C: New Isoflavonoids from the Roots of Desmodiumintortum(Fabaceae). *Chemical Data Collections*.2021;33,100678. https://doi.org/10.1016/j.cdc.2021.100678.

[103]. Bottamedi, M.; Pereira dos Santos Nascimento, M. V.; Fratoni, E.; Kinoshita Moon, Y. J.; Faqueti, L.; Tizziani, T.; Sandjo, L. P.; Siminski, A.; Dalmarco, E. M.; Mendes, B. G. Antioxidant and Anti-Inflammatory Action (in Vivo and in Vitro) from the Trunk Barks of Cabreúva (Myrocarpus Frondosus Allemao, Fabaceae). *Journal of Ethnopharmacology*.2021;267,113545. https://doi.org/10.1016/j.jep.2020.113545.

[104]. Król-Grzymała, A.; Amarowicz, R. Phenolic Compounds of Soybean Seeds from Two European Countries and Their Antioxidant Properties. *Molecules*. 2020;25(9),2075. https://doi.org/10.3390/molecules25092075.

[105]. Rocchetti, G.; Zhang, L.; Bocchi, S.; Giuberti, G.; Ak, G.; Elbasan, F.; Yıldıztugay, E.; Ceylan, R.; Picot-Allain, M. C. N.; Mahomoodally, M. F.; Lucini, L.; Zengin, G. The Functional Potential of Nine Allium Species Related to Their Untargeted Phytochemical Characterization, Antioxidant Capacity and Enzyme Inhibitory Ability. *Food Chemistry*.2022;368,130782. https://doi.org/10.1016/j.foodchem.2021.130782.

[106]. Zonyane, S.; Fawole, O. A.; la Grange, C.; Stander, M. A.; Opara, U. L.; Makunga, N. P. The Implication of Chemotypic Variation on the Antioxidant and Anticancer Activities of *Sutherlandia frutescens* (L.) R.Br. (Fabaceae) from Different Geographic Locations. *Antioxidants*. 2020;9(2),152. https://doi.org/10.3390/antiox9020152.

[107]. Gbaweng, A. J. Y.; Daïrou, H.; Zingué, S.; Emmanuel, T.; Tchinda, A. T.; Frédérich, M.; Mbafor, J. T. Excelsanone, a New Isoflavonoid from *Erythrina excelsa* (Fabaceae), with in Vitro Antioxidant and in Vitro Cytotoxic Effects on Prostate Cancer Cells Lines. *Natural Product Research*.2020;34(5),659–667. https://doi.org/10.1080/14786419.2018.1495639.

[108]. Okoro, E. E.; Maharjan, R.; Jabeen, A.; Ahmad, M. S.; Azhar, M.; Shehla, N.; Zaman, W.; Shams, S.; Osoniyi, O. R.; Onajobi, F. D.; Choudhary, M. I. Isoflavanquinones from Abrus Precatorius Roots with Their Antiproliferative and Anti-Inflammatory Effects. *Phytochemistry*. 2021;187, 112743. https://doi.org/10.1016/j.phytochem.2021.112743