Journal of Chemistry and Nutritional Biochemistry
https://jcnb.sabapub.com
E ISSN: 2709-5932

*2022 Volume 3, Issue 1 : 24 – 36*
*DOI : 10.48185/jcnb.v3i1.543*

# A REVIEW ON PHYTOCHEMICHAL AND PHARMACHOLOGICAL PROPORTIES OF *COFFEE* ARABICA PLANT

**Y. abdulwahab[1,3,*], A. Ahmad[1], I. wahid[2], P. Taba[1]**

[1]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Hasanuddin University, Perenties Legerdemain Street Km. 20 Tamalera, Makassar 90245, Indonesia.
[2]Department of parasitology, Faculty of Medicine, Hasanuddin University, Perenties Legerdemain Street Km. 20 Tamalera, Makassar 90245, Indonesia.
[3]Department of Biology, Faculty of applied Sciences, Taiz University, Taiz, Yemen.

Received: 03.07.2022 • Accepted: 26.07.2022 • Published: 06.08.2022 • Final Version: 06.08.2022

**Abstract:** Coffee, which is a member of the Rubiaceae family and is one of the most exporters and importers and consumed drinks globally, is also used as food and medicine. It contains a lot of terpenes, amino acids, sugars, fatty acids, lipids, alkaloids, saponins, glycosides, flavonoids, and other compounds that have antioxidant, anti-inflammatory, anticancer, antidiabetic, live-protective, and neuroprotective activities. In order to provide a data basis for potential opportunities of pharmaceutical development, we collected data on the advancement of phytoconstituents and bioactivities of *coffee arabica*.
**Keywords**: *Coffea arabica*, Phytoconstituents, pharmacological Activities, progress.

## 1. INTRODUCTION

Chemical substances that can treat many human diseases can be found in plants. Natural goods have long been valued as a source of cutting-edge therapeutic ingredients. For the purpose of creating synthetic molecular analogs, many plant-based substances are used as lead molecules. There are 125 species of plants in the genus coffee, and they are indigenous to tropical and southern Africa as well as tropical Asia [1] Volatile oils are thought to be abundant in plants in the Rubiaceae family [2]. Different biological characteristics of these plant species include anesthetic, antifungal, antibacterial, antiviral, anticarcinogenic, and antioxidant action. [3]. In order to purge their wombs of the evil blood that has become connected to them during or after the menstrual cycle or after childbirth, women combine the outer layer of the coffee fruit (locally known as Gisher), Which is up to half of the coffee fruit, with hot water and drink the extract. [4]

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The plant's pharmacological studies, major chemical components, essential oils found in the plant *Coffee arabica*, and its pharmacological qualities were all covered in the current review paper. The primary chemical constituents of C. arabica include the following: fructose,

* Corresponding Author: youdefahmef@gmail.com

asparagine, cysteine, serine, betalamic acid, dopaxanthin, palmitic acid, linolenic acid, linoleic acid, stearic acid, and decanoic acid, The secondary chemical constituents include fluoride, γ-Quinide, flavonoids, N-methylpyridinium, alkyl esters, shikimoyl esters, melanoidins, cafestol, trigonelline, polyphenolic content, choline, caffeine and kahweol, flu Inorganic components including K, Mg, Mn, Zn, Rb, Sr, V, Co, Ni, Ba, Ca, Na, Fe, Cu, and B minerals as well as trace amounts of B, C, P, and B3 vitamins are also present in the plant [6,7], also Several researches report Coffee seeds are high in physiologically active chemicals and polyphenols all of which have antioxidant, hepatoprotective, antibacterial, antiviral, anti-inflammatory, and hypolipidemic properties [8,9].

## 2. METHODS

Methodology and selection standards for literature searches Data for this review paper were gathered using Google Web, Google Scholar, Web of Science, Hindawi, and PubMed. Research publications from the past 10 to 20 years were consulted for this review.

## 3. HISTORICAL BACKGROUND

### 3.1. Botanical Description of the Plant

Coffee species are densely or lowly branched shrubs or small trees (no more than 6-8 m tall) that are mainly evergreens and seldom deciduous. The leaves are arranged in a diagonal pattern. The leaf blade is whole, with a wavy edge, and is oval or lance-shaped. It features an obtuse tip and a wedge-shaped base that leads to the summit lateral veins, which are visible on both the lustrous dark green surface and the dull, lighter abaxial side, flowers with a maximum length of 5 cm appear in clusters at the base of the leaves, producing short inflorescences. A calyx has a short barrel and five sepal lobes that are broad and triangular in shape. The bottom half of the 5-8-membered white corolla forms a tube, and the petals acquire lobes throughout the blooming time [10].

**Table 1.** Taxonomy Coffee arabica plant [11]

| | |
|---|---|
| Kingdom | Plantae |
| Phylum | Magnoliophyta |
| Subphylum | Rosophytina |
| Class | Rosopsida |
| Subclass | Asteridae |
| Order | Rubiales |
| Family | Rubiaceae |
| Genus | Coffee |
| Species | arabica |

### 3.2. Chemical Constituents in Seeds

Numerous chemical molecules are produced by plants as primary and secondary metabolites. While secondary metabolites are functionally protective and reduce the risk of many diseases, primary metabolites are crucial to the metabolism of plants. The principal metabolites found in coffee arabica seeds include lipids, fatty acids, sugar, and cysteine. Betulin, phytol, citronellal, friedelin, crocetin, nicotine, hydroquinidine, quercetin, isoquercetin, kaempferol, ferulic acid, scopoletin, xanthotoxin, wedelolactone, and saponins are among the secondary metabolites found in the plant. The primary and secondary metabolites found in green and roasted seeds are shown in Tables 2. and 3.

**Table 2.** Primary Metabolites present in Coffee arabica

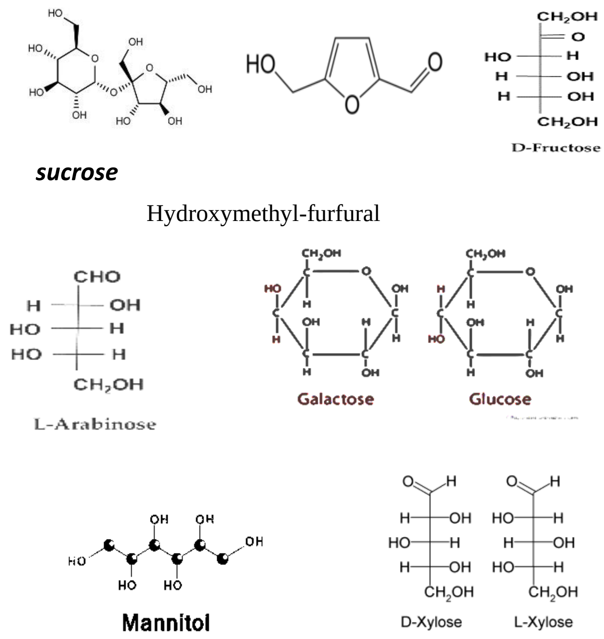
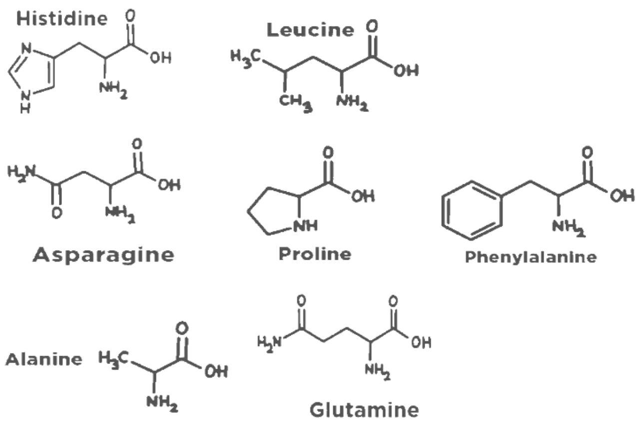
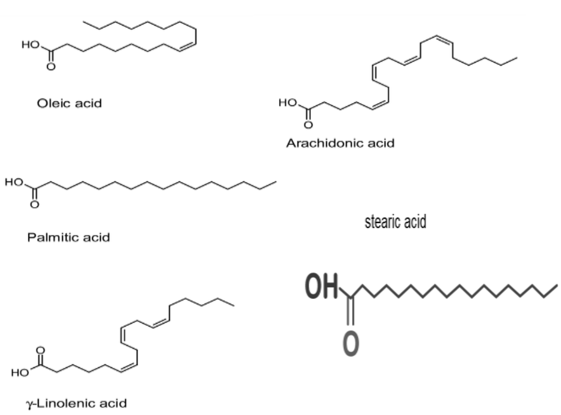
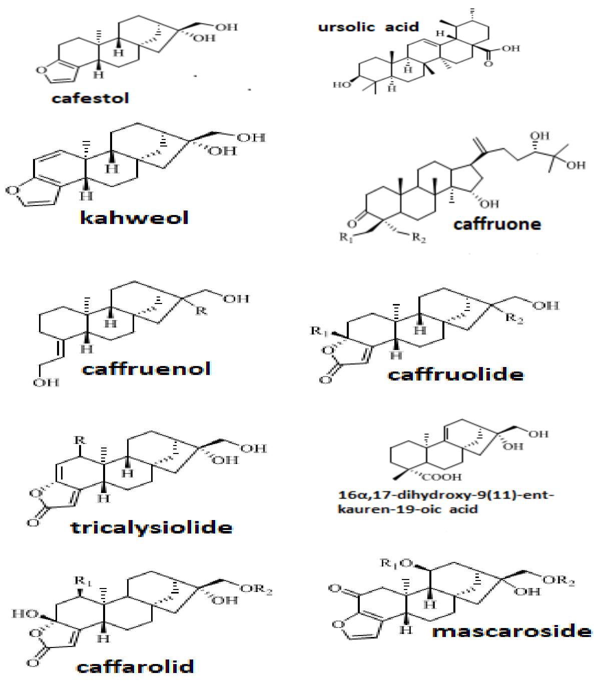
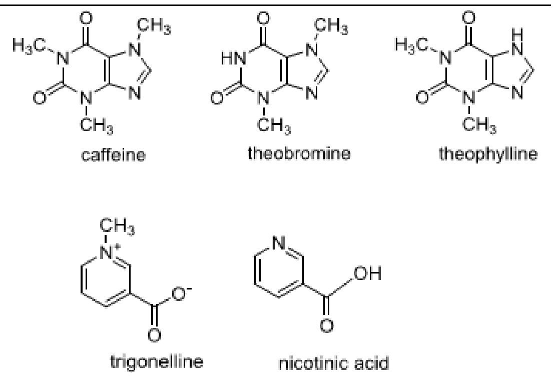
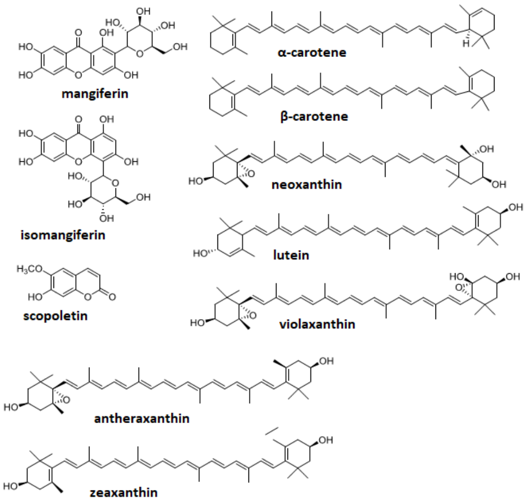
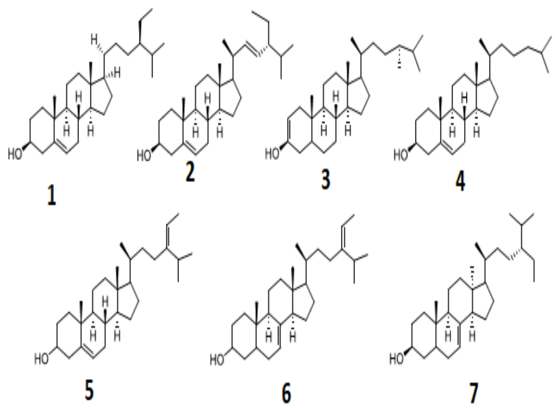
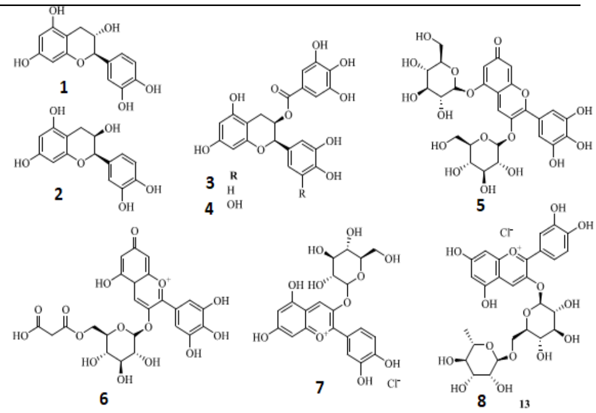
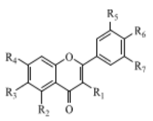
| Metabolite | Type | Chemical Structures |
|---|---|---|
| Sugars | Sucrose, fructose, arabinos, galactose, glucose, mannose, mannitol, xylose, ribose Hydroxymethyl-furfural [12,13] |  |
| Proteins and amino acids | Asparagine, proline, glutamine, histidine, leucine, phenylalanine, alanine, Protein [14,15] |  |
| Fatty acids and lipids | Palmitic, stearic, arachidic, linolenic, oleic, arachidic [16] |  |

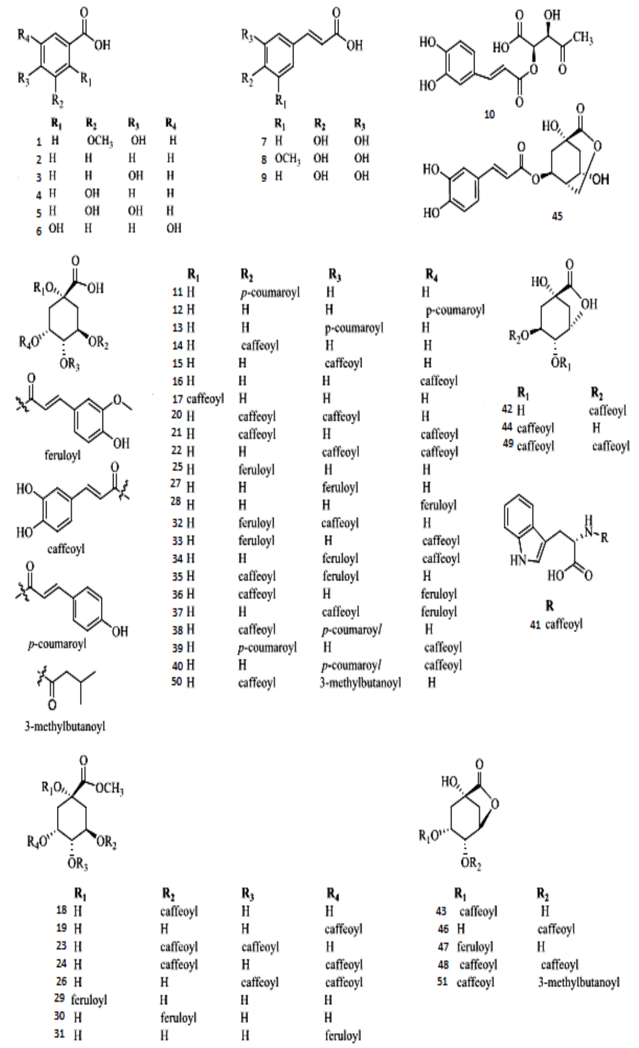
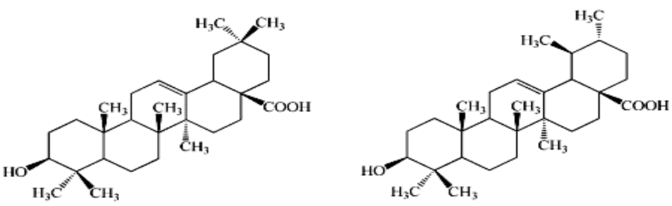
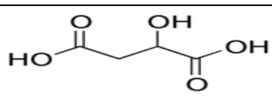
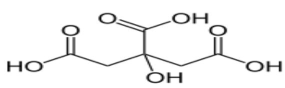
**Table 3.** Secondary Metabolites present in c. arabica

| Metabolite | Type | Chemical Structures |
|---|---|---|
| Terpenoids | diterpene alcohols, cafestol and kahweol [17,18,19] ursolic acid [20],caffruone, caffruenol, caffruolide, tricalysiolide, 9β, 16α,17-dihydroxy-9 -ent-kauren-19-oic acid [21], caffarolide [22], mascaroside [23] |  |
| Alkaloids | caffeine, theobromine, theophylline, trigonelline and nicotinic acid [24] |  |

| | | |
|---|---|---|
| Carotenoids and coumarins | Violaxanthin, Neoxanthin, Chlorophyll b, Lutein, Chlorophyll a, α-Carotene, β-Carotene [25,26] and mangiferin, isomangiferin, scopoletin, antheraxanthin and zeaxanthin [27,28] |  |
| Sterols | β-sitosterol (1), stigmasterol (2), campesterol (3), cholesterol (4), 5-avenasterol (5), 7-avenasterol (6), and delta -7-stigmastenol (7) [ 24] |  |
| Flavonoids | Catechin1, epicatechin2, epicatechin gallate3 and epigallocatechin gallate4, delphinidin 3,5-diglucoside5 and delphinidin 3-(6"-malonyl-glucoside)6 cyanidin-3-O-Glu7, cyanidin-3-O- rutinoside8, kaempferol9, kaempferol-3-O-Glc10, kaempferol-3-O-Glc-Hex-DeHex11, kaempferol-3-O-Glc-Hex12, kaempferol-3-O-Glc-(6"-Rha)13, quercetin14, quercitrin15, isoquercitrin16, rutin17, hyperoside18, quercetin-3-O-Glc-Hex-DeHex19, quercetin-3-O-Glu20, luteolin21, patuletin22, fisetin23, Myricetin24 and apigenin25 [29] |  |

| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | $R_6$ | $R_7$ |
|---|---|---|---|---|---|---|---|
| 9 | OH | OH | H | OH | H | OH | H |
| 10 | O-Glc | OH | H | OH | H | OH | H |
| 11 | O-Glc-Hex-DeHex | OH | H | OH | H | OH | H |
| 12 | O-Glc-Hex | OH | H | OH | H | OH | H |
| 13 | O-Glc-(6"-Rha) | OH | H | OH | H | OH | H |
| 14 | OH | OH | H | OH | OH | OH | H |
| 15 | O-Rha | OH | H | OH | OH | OH | H |
| 16 | O-Glc | OH | H | OH | OH | OH | H |
| 17 | O-Glc-(6"-Rha) | OH | H | OH | OH | OH | H |
| 18 | O-Gal | OH | H | OH | OH | OH | H |
| 19 | O-Glc-Hex-DeHex | OH | H | OH | OH | OH | H |
| 20 | O-Glu | OH | H | OH | OH | OH | H |
| 21 | H | OH | H | OH | OH | OH | H |
| 22 | OH | OH | $OCH_3$ | OH | H | OH | OH |
| 23 | OH | H | H | OH | H | OH | OH |
| 24 | OH | OH | H | OH | OH | OH | OH |
| 25 | H | OH | H | OH | H | OH | H |

**Glc:** Glucose
**Hex:** Hexose
**DeHex:** Deoxyhexose
**Rha:** Rhamnose
**Glu:** Glucuronide
**Gal:** Galactose

| | | |
|---|---|---|
| Phenolic acids and their similar | vanillic acid 1, benzoic acid 2, p-hydroxybenzoic acid 3, 3-hydroxybenzoic acid 4, gentosic acid 5, protocatechuic acid 6, caffeic acid 7, sinapic acid 8, p-coumaric acid 9, caftaric acid 10, 3-O- p-coumaroylquinic acid 11, 5-O-p-coumaroylquinic acid 12, 4-O-p-coumaroylquinic acid 13, 3-O-caffeoylquinic acid 14, 4-O-caffeoylquinic acid 15, 4-O-caffeoylquinic acid 16,1-O-caffeoylquinic acid 17, 3-O-caffeoylquinic acid methyl ester 18, 5-O-caffeoylquinic acid methyl ester 19, 3,4-di-O-caffeoylquinic acid 20, 3,4-di-O-caffeoylquinic acid 21, 4,5-di-O-caffeoylquinic acid 22, 3,4-di-O-caffeoylquinic acid methyl ester 23, 3,5-di-Ocaffeoylquinic acid methyl ester 24, 4,5-di-O-caffeoylquinic acid methyl ester 25,3-O- fer uloylquinic acid 26, 4-O-feruloylquinic acid 27, 5-O-feruloylquinic acid 28, 1-O-feruloylquinic acid methyl ester 29, 3-O-feruloylquinic acid methyl ester 30, 5-O-feruloylquinic acid methyl ester 31, 3-O-feruloyl-5-O-caffeoylquinic acid 32, 3-O-feruloyl-4-O-caffeoylquinic acid 33, 4-O-feruloyl-5-O-caffeoylquinic acid 34, 3-O-caffeoyl-4-O-feruloylquinic acid 35, O-feruloylquinic acid 36, 4-O-caffeoyl-5-O-feruloylquinic acid 37, 3-O-feruloyl-4-O-p-coumaroylquinic acid 38, 3-O-p-coumaroyl-5-O-feruloyl quinic acid 39, 4-O-p-coumaroyl-5-O-caffeoylquinic acid 40, caffeoyl-N-tryptophan 41, 5-O-caffeoyl-1,3-quinide 42, 3-O-caffeoyl-1,5-quinide 43, 4-O-caffeoyl-1,3-3-quinide 44, 5-O-caffeoyl-1,4-quinide 45, 4-O-caffeoyl-1,5-quinide 46, 3-O-feruloyl-1,5-quinide 47, 3,4-di-Ocaffeoyl-1,5-quinide 48, 4,5-di-O-caffeoyl-1,3-quinide 49, 3-O-caffeoyl-4-O-3-methylbutanoylquinic acid 50 and 3-Ocaffeoyl-4-O-3-methylbutanoyl-1,5-quinide 51 [30] |  |
| saponins | oleanolic acid (OA) and ursolic acid (UA) [31] |  |
| Carboxylic acid | citric acid and malic acid [32] |  Malic acid  Citric acid |

### 3.3. Coffee Essential Oils

Al-Yousef and Amina, 2018 discovered a large quantity of the volatile oil in coffee husks. Butylatedhydroxy (65.83 percent), 1, 2-benzenedicarboxilic acid (7.28 percent), phenylethyl alcohol (1.69 percent), and 2, 3-isopropylidene-6-decoxyhexo(1.63 percent) were the most prevalent components in oil. Antimicrobial and antioxidant activities of essential oils and ethanol extract were tested, and both substances showed activity in the assays [33]

### 3.4. Pharmacological Actions

According to the pharmacological investigation, live protection and neuroprotective activity are two important types of activity in the crude extracts of C. arabica . also biological properties include antioxidation, anti-inflammatory, anticancer, and antidiabetic activity.

#### 3.4.1. Anti-microbial Activity

Coffee is an anti-inflammatory beverage that also fights fungi, gram-positive bacteria, and gram-negative bacteria. [34]. n recent research, Nassar et al. investigated the antibacterial properties of Turkish, Arabica and Brazilian coffee. Arabica coffee extracts demonstrated the strongest antibacterial activity when compared to the other coffee extracts. [35]

Examining the biological effects of oil extract on two different gram-positive and gram-negative bacterial species (Staphylococcus aureus and Escherichia coli). The results of the plant extract showed that Staphylococcus aureus had the largest inhibition zone (2.5 mm), while E. coli had the smallest inhibition zone(1 mm). This suggests that coffee oil extract had variable degrees of inhibition against the test organisms [36]

Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Candida albicans were used in the tests, and both essential oil and ethanol extract of coffee were found to be effective against these microbes (14.0 ± 1.3, 17.0 ± 1.9, 13.0 ± 2.0 and 15.0 ± 1.3 mm) [33] .

A number of bacteria, including Proteus vulgaris, Escherichia coli, Klebsiella pneumonia, Vibrio cholerae, Salmonella typhimurium, Salmonella typhi, Streptococcus faecalis, and Staphylococcus aureus, are resistant to the antibacterial properties found in Bengal coffee fruits, according to recent studies. [37]

#### 3.4.2. Larvicidal Activity

Coffee has potential as a naturally acceptable alternate toxicant for the control of slugs and snails on food crops [38]

Mosquitoes can spread diseases such as dengue fever, chikungunya, encephalitis, malaria, and filariasis. To kill the larvae, most countries use chemicals, however these are bad for the environment and many mosquito species have developed a resistance to DDT and other pyrethroid insecticides. Standard larvicidal plants are therefore your best bet. Early stages of Aedes aegypti development were inhibited by treatments with caffeine and its grounds at concentrations of 1.0 mg/mL and 50 mg/mL, respectively. In later stages and even in adults, lower levels of both substances were found. [39]

Another study examined the effects of used coffee powder aqueous solutions at concentrations of 75, 150, 250, and 300 mg/ml on larval mortality over time. Larval mortality was observed daily in the experimental breeding locations; the most efficient dose, 300 mg/ml, provided 100% larval mortality for nine days. [40,41].

other study, many mosquitoes perished when immersed in the mediums, with the number of insects dying in coffee grounds being greater. These findings are indicating that caffein and coffee grounds might be used as auxiliaries in the control of Aedes aegypti [42].

Ceratitis capitata (Wiedemann) was more quickly affected by coffee oils than Anastrepha fraterculus (Wiedemann). Both Green and roasted Coffee showed promising results for fruit fly control [43]

#### 3.4.3. Antioxidant Activity

Many human illnesses are defended by dietary antioxidants and phytochemicals, specially neurological disorders, atherosclerosis, rheumatoid arthritis, cancer, diabetes, and stroke. Antioxidant enzymes such as catalase, glutathione reductase, superoxide dismutase, and glutathione peroxidase, as well as antioxidants such as selenium, zinc, and glutathione, arginine, tocopherol.

Zhang et al. [44] assessed the antioxidant volumes of the extracts from C. arabica L. by the scavenging DPPH and ABTS. The LC50 values of scavenging DPPH free radical and ABTS + were 1.082 and 1.085 mg/mL, respectively

According to Samuchaya et al., [45] the methanolic extract from C. arabica L. leaves exhibited strong antioxidant activity. The percentages of fresh young (92%), fresh mature (92%), dried young (95%) and dried mature (93%) antioxidant activity were substantially correlated with drying and maturity. In the DPPH test, the methanolic extract of green beans from C. arabica L. has an $IC_{50}$ value of 86.14 g/mL. [46]

### 3.4.4. Antidiabetic Activity

Sake et al. [47] In study comparison, coffee arabica bean and leaf extract to the control group found significantly reduced blood glucose levels. Mell bye et al. [48] discovered that cafestol might increase glucose absorption in human skeletal muscle cells and glucose-stimulated insulin production in vitro. Compared to the control group, cafestol improved insulin production from isolated islets by 75%–87%. Liu et al. [49] discovered that trigonelline, by lowering blood glucose, has preventive effectiveness against type 2 diabetes and diabetic peripheral neuropathy. ginsenoside and trigonelline may prevent the onset of diabetic renal lesions. [50]

### 3.4.5. Anti-inflammatory activity

An ointment made with a methanolic extract of green beans from C. arabica L. histological was tested for its ability to reduce inflammation on the skin.[46]

n addition to having anti-inflammatory properties, the coffee arabica graphene oxide nanoparticles suggest that they will soon find use in bio-medical applications. [51]

### 3.4.6. Antitumor activity

According to a new study by Ei-Garawani, on a malignant cell line and normal human lymphocytes, the apoptotic anticancer route of green and roasted C. arabica L. extracts was positive effect. [52].

Another study found that coffee extracts exhibited cytotoxic and antiproliferative effects on breast cancer cells in 2D and 3D culture settings, however the viability of human epithelial breast cell lines was unaffected, which is unexpected (noncarcinogens). According to the study's findings, both green and roasted coffee bean extracts have a high bioactive capacity, increasing cell viability loss, disrupting the cell cycle, having a cytostatic effect, changing the shape of the mitochondria, altering MMP levels, and impairing clonogenic potential. [53].

### 3.4.7. Live protection activity

Wiltberger et al. [54] observed that drinking coffee increases survival after orthotopic liver transplantation and is linked to a lower risk of hepatocellular carcinoma recurrence. Coffee consumption appeared as a significant determinant of hazard reduction for overall survival postoperatively, according to multivariate analysis. Vitaglione et al. [55] stated that drinking coffee helped decrease the effects of high-fat diet-induced liver macrovesicular steatosis as well as serum levels of glucose, alanine aminotransferase, and cholesterol.

### 3.4.8. Neuroprotective activity

Ishida et al. [56] discovered that A fibrils were destroyed by 5-caffeoylquinic acid, one of the main coffee polyphenols. Zeitlinet et al.[57] found that coffee stimulated pro-survival cascades and blocked pro-apoptotic pathways in the striatum and/or cortex to counteract AD by shifting the balance between neurodegeneration and neuronal survival, Chen et al. [58] confirmed that caffeine may ward against Parkinson’s disease by partially stabilizing the BBB. Theanine and caffeine together may have a neuroprotective effect. [59].Trigonelline has a neuroprotective impact that can enhance cognition and lessen neuronal loss, as well as a potential therapeutic effect on the heart tissue of colitis. [60,61].

### 3.4.9. Coffee and Pharmacokinetic Properties of Drugs

Several research and medical case reports have clearly demonstrated that drinking coffee while taking other medications has a major impact on drug absorption, distribution, metabolism, and excretion. Coffee's influence on medication pharmacokinetics might result in improved therapeutic response, therapeutic failure, or hazardous responses so should be optimum period between medicine and coffee consumption [62,63,64]. Additionally, pharmacists and doctors should give patients the right guidance by being aware of any potential hazards associated with drug-coffee interactions.

## 4. CONCLUSION

Coffee arabica is a member of the Rubaceae family. The presence of alkaloids, flavonoids, terpenes, phenolic acids and their derivatives, sterols, taste compounds, and other chemicals gives the plants in this genus a wide range of pharmacological qualities. The review details the plant Coffee arabica's numerous advantages, which give it a wealth of inherent potential. The plant can be a great source for research on the separation, characterisation, and purification of active ingredients with antimicrobial, antioxidant, anticancer, and anti-diabetic properties. In the near future, the plant's antioxidant, anti-diabetic, and anti-cancer properties can be further studied utilizing various appropriate animal models.

## 5. ACKNOWLEDGEMENT

The authors would like to thank the Mathematics and Natural Science faculty (FMIPA) of Hasanuddin university for their assistance in completing this review work.

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