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PHYTOCHEMICAL AND NUTRITIONAL CHARACTERISTICS OF *GREWIA ASIATICA* L. (PHALSA)

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ABSTRACT: Phalsa (*Grewia asiatica* L.) is a Southeast Asian food plant that is cultivated principally for its fruit. The fruit of the phalsa plant is eaten raw or added to food or beverages. In addition to being a great source of nutrients like fiber, vitamin C, potassium, folate, antioxidants and minerals, fruits also include a number of bioactive substances, including flavonoids, phenolics, tannins, and anthocyanins. The outcome of various researches implies that these constituents provide antibacterial, anticancer, radioprotective, antidiabetic, antioxidant, and anti-hyperlipidemia properties. Although phalsa possesses nutritional and a physiological benefit, a brief investigation *accomplished*, on the plant's possible applications in health supplements. Research has recently started to create more and more innovative, phalsa-improved products. Phalsa might not be as marketable as other things that are produced, but that doesn't diminish its potential advantages. Nowadays, phalsa is processed on a small scale to produce a variety of edible products, including squash, juice, syrup, jam, and other drinks. However, the deficiency of the necessary equipment to fully utilize the plant's potential uses and related advantages constraints the phalsa-based products. Therefore, there is a necessity to increase official publications and research on the phalsa plant, especially in the area of applying innovative methods to enhance its food value and quality. Therefore, the aim of this review is to investigate the phalsa botanical description, nutritional studies, phytochemical, and other potential benefits of the phalsa plant.

INTRODUCTION: *Grewia asiatica* L. [Family: Tiliaceae (Malvaceae)], often known as Phalsa, scientifically recognized for its rich nutritional and pharmacological properties. Phalsa holds significant scientific importance due to the presence of numerous bioactive compounds like; flavonoid and phenolic compounds, anthocyanins, fibers, vitamins, ascorbic acid, minerals magnesium, calcium, carbohydrate.

Continuous research on different part of *Grewia asiatica* for their medicinal benefits shows that due to its nutritional value and presence of bioactive compounds phalsa used to treat various illnesses such as antimicrobial, antidiabetic, anti-inflammatory, hepatoprotective, osteoporosis, wound healing property and used in skin disorders, intestinal infections, coughing, fever, diarrhea, jaundice, and stomach problems²⁻⁵.

Considering all this, the objective of the present review article is to bring a bank of knowledge and will thoroughly describe the major aspects of Phalsa like, botanical description, types of Phalsa, geographical distribution, physicochemical and nutritional composition, presence of macro and micronutrients, phytochemistry and also examine the nutritional approaches of Phalsa.

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METHODOLOGY: A comprehensive review of published research on the *Grewia* has been prepared from every print and digital source, including Google Scholar, Sci Finder, Web of Science, PubChem, PubMed, ChemSpider, NCBI (National Centre for Biotechnology Information), ScienceDirect, The Plant List Database, and Scopus. The search period for this review article was (last two years, from 2024 to 2025). Numerous combinations of keywords were entered into the search engine such as Phalsa, *Grewia asiatica*, Types of Phalsa, Phytochemistry, Macro and micronutrients etc. All of the phytochemical structures have been drawn by using ChemBioDraw Ultra 14.0 software.

Botanical Description: Leaves are simple, may be cordate to ovate, deciduous and almost up to 20x16mm. Apex of the leaves are acute to acuminate, subglabrous above, densely tomentose beneath, maximum length of petiole is 1.5cm⁶⁻⁹.

Flowers are hermaphrodite; grow mainly on the current growing season on the new shoots. It takes 45 to 55 days from flowering to fruiting maturity. Flower buds are thick appearing in clusters of four

to six. The middle bud is usually larger than the others, mature in 20-21 days. Generally small fruits contain single seed. The size of the largest fruits is 1.7 cm⁶⁻⁸.

The diameter of phalsa fruit is 1 to 2 cm, warty 6-nd with stellate hairs. Fruit are like a globose berry with fleshy, fibrous, soft and greenish purple stained with purplish at maturity, sour and acidic taste¹⁰⁻¹⁴. The main preserving agents are jams, jellies, pies, squashes etc. Although, they can have short shelf lives, spoil early if not stored and used properly. These products are appropriate only for local marketing^{15, 16}.

Grewia consist of 1-2 seeds with a hard seed coat, having grooved on the surface and pointed at the end¹⁷⁻¹⁹. Overview of *Grewia asiatica* whole plant is given in **Fig. 1**.

TAXONOMICAL CLASSIFICATION²⁰

Kingdom	Plante
Order	Malvales
Family	Tiliaceae or Malvaceae
Sub-family	Grewioideae
Genus	Grewia
Species	Asiatica



FIG. 1: PHOTOGRAPHS OF GREWIA ASIATICA (A): GREWIA ASIATICA WHOLE PLANT. (B): FLOWER, (C): UNRIPE FRUIT, (D): RIPE FRUIT

Types of *Grewia asiatica*: Two different variety of Phalsa have been identified: Tall and short (dwarf) type. The dwarf type of phalsa is very beneficial and has been grown commonly. It accumulates higher level of reducing and sugars and non-reducing sugars compared to the tall counterparts. The tall type of phalsa produces more

juice than dwarf type of phalsa. Graphical representation of physical appearance and structure of the tall and dwarf type of *Grewia asiatica* given in (**Fig. 2 & Table 2**). Compared to the dwarf form, the tall type has more producing capacity of reducing sugars, titrable acidity, and seed protein²¹.

TABLE 1: CHARACTERISTICS OF TALL AND DWARF TYPES OF GREWIA ASIATICA²¹

Content (%)	Tall	Dwarf
Edible portion	91.30	90.79
Juice yield	67.50	65.90
Pomace	32.50	34.10
Moisture	76.80	74.83
Seed	8.70	9.21
Fruit protein	3.13	1.89
Seed protein	8.75	7.00
Pulp protein	1.40	7.00
Reducing sugars	1.24	0.99
Non-reducing sugars	4.49	6.96
Titration acidity	1.48	1.12

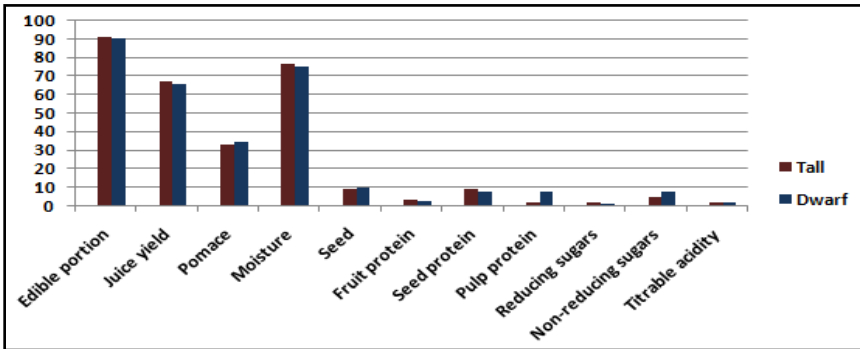


FIG. 2: CHARACTERISTICS OF TALL AND DWARF TYPE OF GREWIA ASIATIC²¹

Area and Distribution: Phalsa (*Grewia asiatica*), is originally indigenous to India and Southeast Asia, is primarily cultivation in the Himalayan regions of India, Punjab, Uttar Pradesh, Madhya Pradesh, Haryana, Rajasthan, and other states.

States like Karnataka, Maharashtra, Andhra Pradesh, Gujarat, West Bengal, and Biha also cultivate it on a smaller scale **Fig. 3**.

Among all these regions the largest, smaller and limited cultivation are as:

Prominent Areas of Cultivation: The Himalayan regions, Punjab, Uttar Pradesh, Haryana, and Rajasthan are the main growing regions.

Smaller-scale Cultivation: States with smaller-scale farming include Karnataka, Maharashtra, Andhra Pradesh, Gujarat, West Bengal, and Bihar²¹.

Narrow Growing Area: Phalsa has a lot of promise, but due to its small size, short shelf life, and need for regular harvesting; its production is limited to less than 1000 hectares in India.

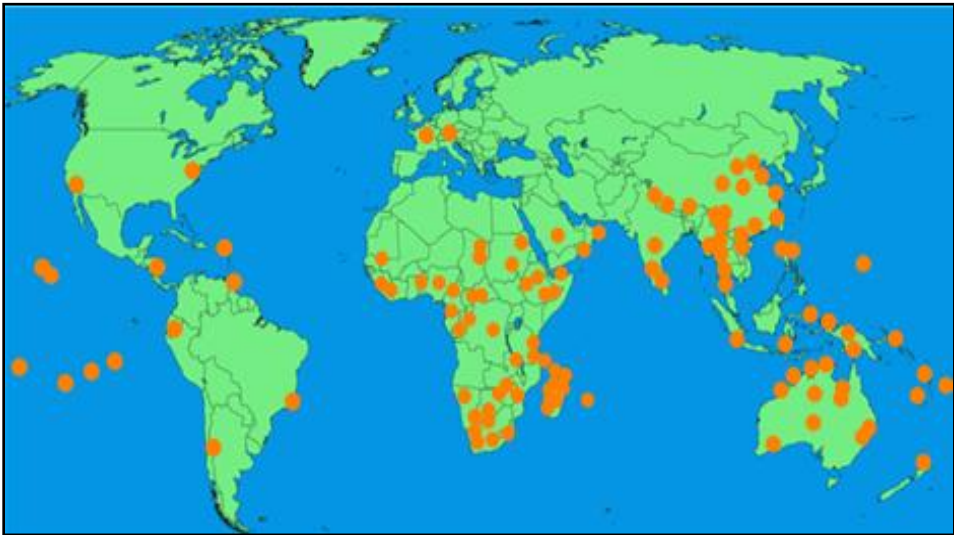


FIG. 3: AREA AND DISTRIBUTION OF PHALSA²²

Ecology: *Grewia* (*Grewia asiatica*) has been identified as an environmental weed in the Northern Territory. It grows successfully in areas with distinct summer and winter seasons, although, it is able to endure a range of temperatures, with the exception of high altitude. High temperature, abundant rainfall and humid subtropical atmosphere are acceptable for its growth. It can survive in hostile situations by reason of its extreme adaptability²³.

Physicochemical and Nutritional Value of Phalsa: Nutrients such as fiber, vitamin C, potassium, folate and antioxidants are found in

fruits that essential for preserving and improving good health. Fruit provides a multiple health advantages, integral to a healthy eating plan; fruitarians are likely to diminish the chance of developing some chronic conditions, such as heart attacks and strokes, and some types of cancer. Fruits are utilized as a natural cure in a number of medical situations and to give unique flavor and taste to health drinks²⁴. The nutritional composition of *Grewia* both macro and micro (carbohydrate, fiber, fat, moisture, protein, starch, and sugar) shown in **Fig. 4**.

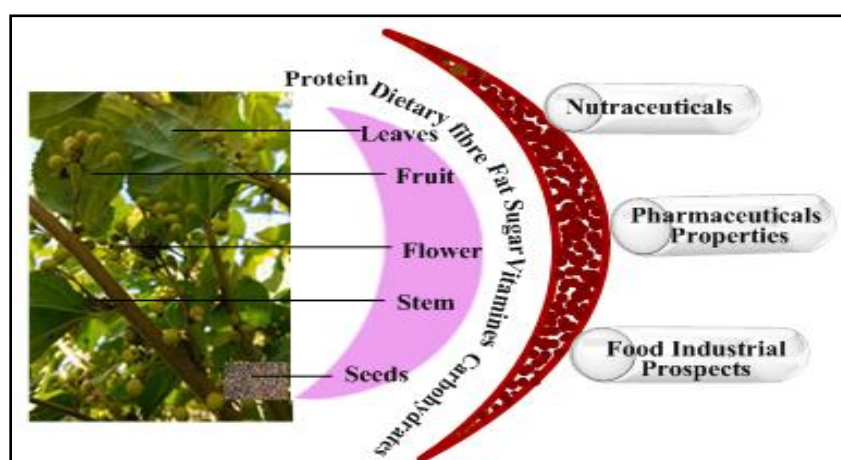


FIG. 4: NUTRITIONAL COMPOSITION OF GREWIA ASIATICA FRUIT

Protein: According to the dry weight of the various parts, the protein percentage varied from 1.57 to 17.41%. *G. asiatica* fruits have high protein content (17.41%)²⁵⁻²⁶.

Dietary Fiber: Nutritional fiber is health promoting, crucial for good health and nutrition. Fruits and vegetables include fiber, is essential for nourishing gastrointestinal health and reducing the susceptibility of chronic diseases.

The well-known benefit of fiber is its potential to alleviate constipation. It helps keep the digestive system healthy have 5.53mg/100g fibre in Phalsa fruit²⁶.

Carbohydrates: Carbohydrates from fruits and berries provide constant energy that maintain throughout the day. The intake of fruit that are rich in carbohydrates gives fiber, vitamins and minerals. These things all together enhance the health. Reported range for carbohydrates in *Grewia* fruits is 21.10–87.09%²⁶.

Fat, Starch and Sugar: Fruits are low in calories; they exclusively contain only small amounts of fat. Fruits contain natural sugar, primarily fructose and glucose, in varying amounts. Most of fruits are low in starch. Fat, starch and sugar content in phalsa are (0.1-11%), (22-44.8%) & (10-32.93%) respectively^{26, 27}.

Macro and Micronutrients: Phalsa fruits are low in fat and calories but high in fiber, minerals (calcium, phosphorus and iron), and vitamins A and C (around 16.11 and 4.38 mg). The complete nutritional profile of underused fruit as reported by multiple researches is shown in **Table 3 & 4**²⁷⁻³².

Vitamins: A diet rich in fruits and vegetables contain vitamins that reduce the risk of heart disease. Vitamins A, C, E, are essential for healthy blood flow and immune function that can help to protect from some diseases. *Grewia* fruit exhibit Vitamin A (retinol) (16.11 mg/100 g), riboflavin (0.264 mg/100g), Vitamin B3 (niacin)

(0.825 mg/100 g) and Vitamin C(ascorbic acid) (4.385 mg/100 g).

Minerals: Existence of all these nutritional composition, minerals and vitamins recommend that *Grewia* fruits employed as a regular dietary supplement, an alternative economic source of minerals, vitamins and natural antioxidant with less or no side effects³³⁻³⁷.

Phalsa fruit contains a sufficient amount of minerals sodium (17.30 mg/100g), potassium (372.00 mg/100g), calcium (136 mg/100g), chromium (0.48 mg/100g), zinc (1.44 mg/100g), iron (1.08mg/100g), nickel (2.61 mg/100g), phosphorus (24.20 mg/100g), cobalt (0.99 mg/100g).

TABLE 2: NUTRITIONAL COMPOSITION OF GREWIA ASIATICA^{35, 37}

Nutrients	Values (g/100 g)
Protein (g)	1.57
Total lipid (fat) (g)	<0.1
Carbohydrate (g)	21.1
Ash (g)	1.1
Fibre (g)	5.53
Calcium (mg)	136
Iron (mg)	1.08
Phosphorus (mg)	24.2
Potassium (mg)	-
Sodium (mg)	17.3
Vitamins (mg/100 g)	
Vitamin B1 (mg)	0.02
Vitamin B3 (mg)	0.825
Vitamin C (mg)	4.385
Vitamin B2 (mg)	0.264
Vitamin A (g)	16.11
Riboflavin (mg)	0.264
Carotene (ug)	419

TABLE 3: MINERAL CONTENTS OF GREWIA ASIATICA FRUIT^{35, 37}

Mineral	mg/100 g FW *	µg/100 g DW **
Cobalt	0.99	-
Chromium	1.08	-
Copper	0.48	16
Nickel	2.61	87
Zinc	144	48
Iron	140.8	1695

*FW = Fresh weight (Fresh fruit); **DW = Dry weight (After removal of moisture from fresh fruit).

Phytochemistry: The chemical constituents of *Grewia* are extensively obtained from alcoholic extracts, particularly in the methanolic (60.43%) extract. The major group of compounds in this

species is the flavonoids (48.51%), although sufficient levels of phenolic acids (15.68%), steroids (9.7%), terpenoids (8.96%), lignans (5.23%), alkaloids (5.23%), and isoflavones (4.48%) have been published³⁸⁻⁴².

Alkaloids: *Grewia* roots extracted in methanolic and petroleum ether have been shown to contain alkaloids belonging to the piperidine (1-4) and β -carboline (5-7) classes. Structures of alkaloids are given in **Fig. 5**. These alkaloids share a fundamental skeleton with the structural members of the piperidine family, which explains why they so resemble them. They vary, though, in that the original alkaloids at positions N-1, C-3, and C-8 have been replaced by CH₃ (1, 2, and 4) or OH (1 and 3)^{43, 44}.

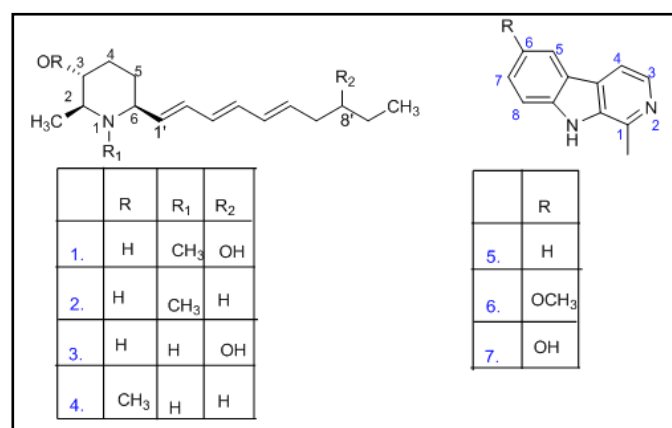


FIG. 5: STRUCTURE OF ALKALOIDS (1-7)

Flavonoids: Flavonoid belongs to the class of polyphenolic secondary metabolites composed of 15-carbon skeleton: Different flavonoid classes distinguish themselves by degree of oxidation and their pattern of substitution of the C ring⁴⁵.

Flavonoids act as a chemical messengers, and necessary for UV filtration, nitrogen fixation, and cell cycle inhibition. The stem, callus, leaves, bark, etc. of phalsa contain the highest concentrations of flavonoids³¹. Quercetin can help to alleviate eczema, sinusitis, asthma, and hay fever. The phytoconstituents in the *Grewia* species is represented by flavonoids (8–71), that including flavans (8–12) given in **Fig. 6**. Structure of flavones (13–21) given in **Fig. 7**. Structure of flavonols (22–46) given in **Fig. 8**. Structure of flavanones (47–51), (52–57) and anthocyanins is given in (58–71) **Fig. 9**⁴⁶⁻⁴⁹.

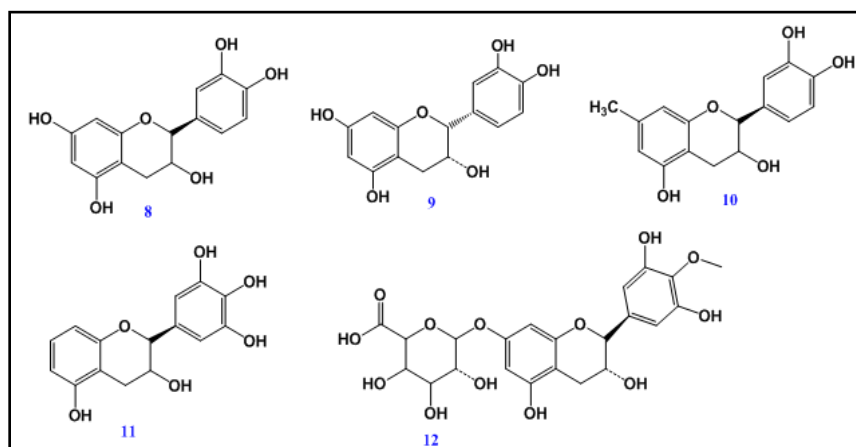


FIG. 6: STRUCTURE OF FLAVANS (8–12) ISOLATED FROM DIFFERENT PARTS OF GENUS GREWIA

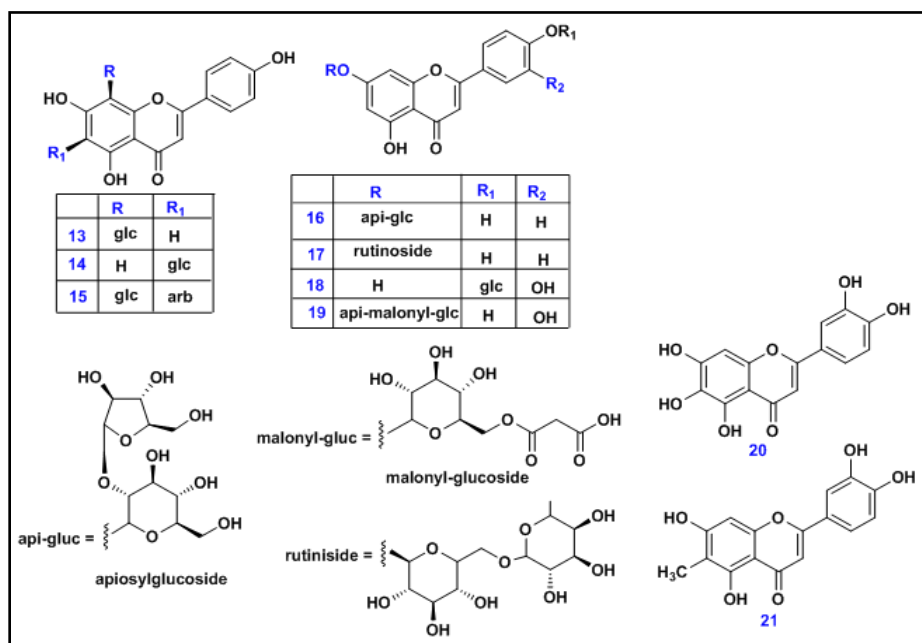


FIG. 7: STRUCTURE OF FLAVONES (13–21) ISOLATED FROM DIFFERENT PARTS OF GENUS GREWIA

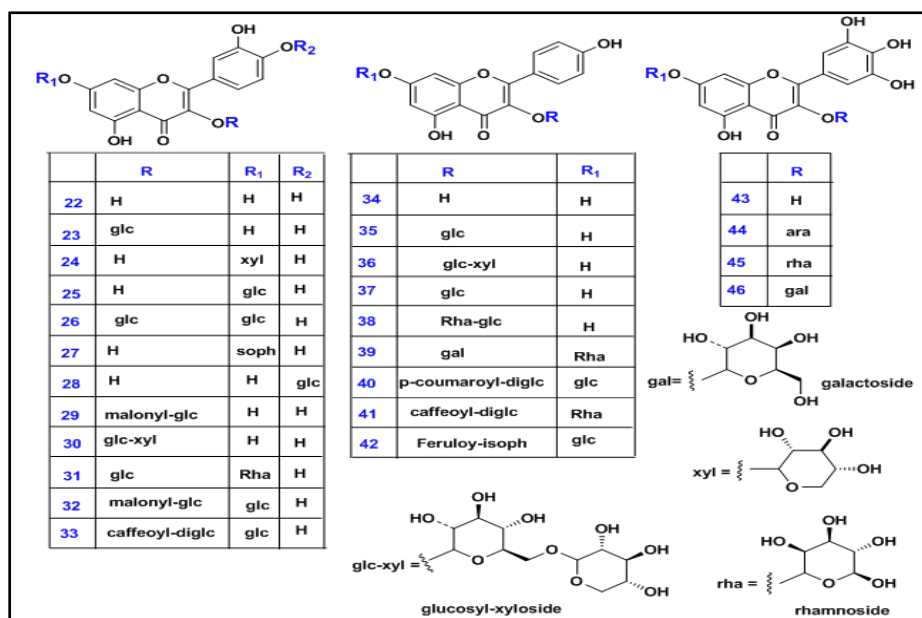


FIG. 8: STRUCTURE FLAVONOLS (22-46) ISOLATED FROM DIFFERENT PARTS OF GENUS GREWIA

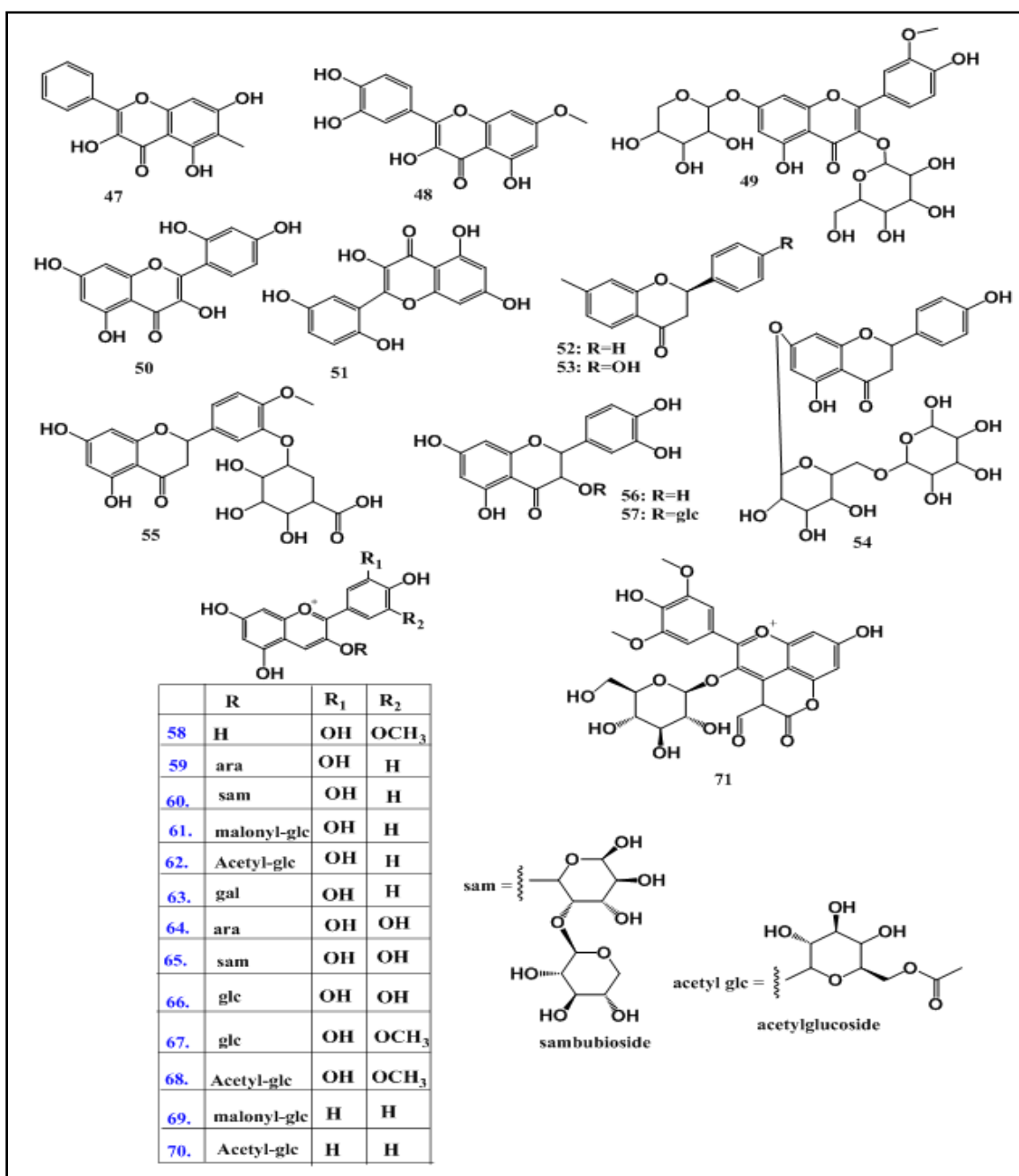


FIG. 9: THE STRUCTURE OF FLAVONOLS (47-51) FLAVANONES (52-57), AND ANTHOCYANINS (58-71) ISOLATED FROM DIFFERENT PARTS OF GENUS GREWIA

The majority of flavonoids have been published in methanolic extracts of different plant parts of *G. asiatica*^{38, 39, 41, 50, 51}. Basic structure of Flavonoids O-glycoside is derived on the flavan, flavone, flavonol and flavanone skeletons with positions C-3, C-7 and C-4' being substituted either sugar moiety or OH (8-57) whereas C-3, C-2' and C-5' positions occupied by either hydroxy (OH) or sugar moiety in anthocyanin skeleton (78-71)^{42, 47}. At positions C-6 and C-8 in the flavones skeleton, the sugar moiety (13-15) replaces the C-glycoside^{46, 52}. The Phalsa pomace flavonoid quantity was

calculated to be 12.42056 CE mg/g. The amount of flavonoids in the bark was 39.114 ± 65 mg. Another study's findings revealed that the fruit's solvent extract's phenolic content and total flavonoid concentration were, respectively, 0.13 and 5.25 GAE/MI³²⁻³⁴.

Isoflavonoids: According to Qamar *et al.*, 2020, Alcoholic extract of *G. asiatica* fruits for the first time yielded isoflavonoids (72-77). Structure of isoflavonoids represented in Fig. 10. The isoflavonoids (74-76) have been defined and

described by LC-MS/MS. The isoflavone skeleton serves as the primary basis for the construction of

isoflavones, with OH or sugar being replaced at positions C-7 and C-4' (72-77)⁴⁰⁻⁴².

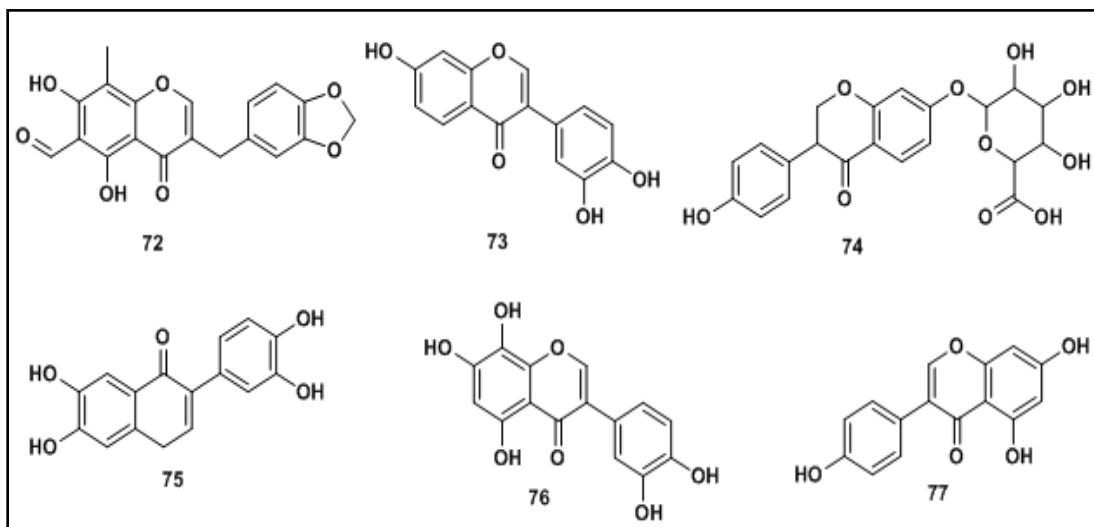


FIG. 10: THE STRUCTURE OF ISOFLAVONES (72-77)

Phenols and others: Lignans and neolignans are natural phenolic compounds metabolites that are made up of two phenylpropanoid units (oxidative coupling of phenylpropanoids)⁴⁸.

Neolignans are dimeric structures in which two phenyl propane units linked by β, β' -linkage, and have OH and methoxy (OCH₃) substitution on the aromatic moieties. Some recently developed

neolignans (78-80) isolated from methanolic extracts of *Grewia bilamellata* given in **Fig. 11**.

A new class of lignins called as Coumarinolignans that contain coumarins and phenyl propanes linked together by Dioxane Bridge. They are non-conventional lignans (81-83). In the genus *Grewia*, *neolignans* and coumarino-lignans were also found⁴⁸.

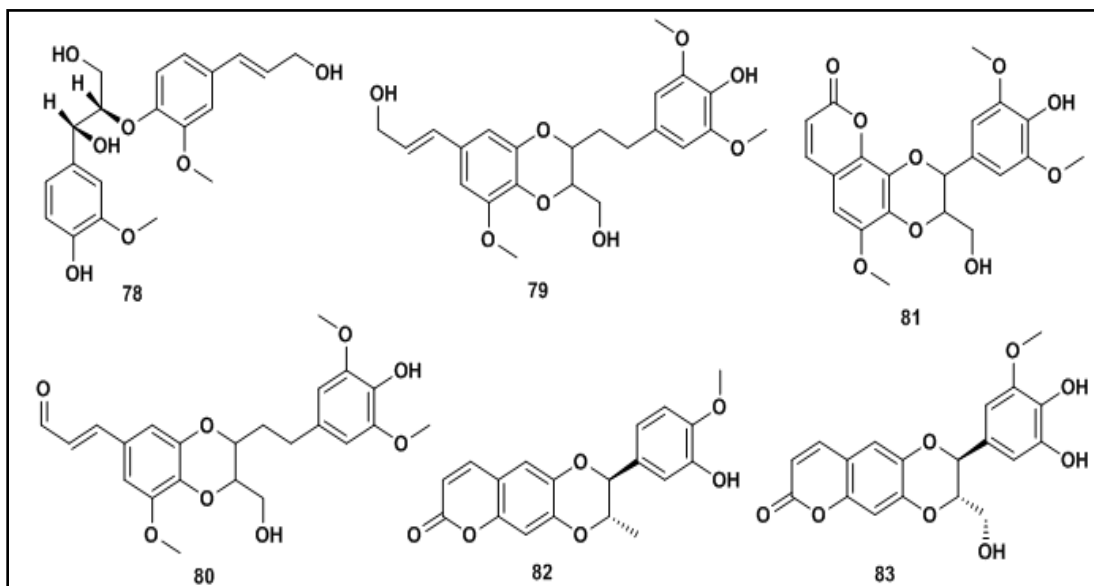


FIG. 11: STRUCTURE OF NEOLIGNANS (78-81) AND STRUCTURE OF COUMARINOLIGNANS (82 & 83)

Phenols (84-93), phenolic acids (94-96), and hydroxycinnamic acids (97-101) have been isolated in methanolic extracts of fruits, stems and roots of *G. asiatica*, *G. optiva*, *Grewia occidentalis* L., and *Grewia*. Structure of Phenols (84-93), Phenolic

acids (94-96), hydroxycinnamic acids (97-101) given in **Fig. 12**. Structure of Xanthonoid (102) and hydrolyzable tannins (103-104) and others (105-106) isolated from genus *Grewia* and shown in **Fig. 13**.

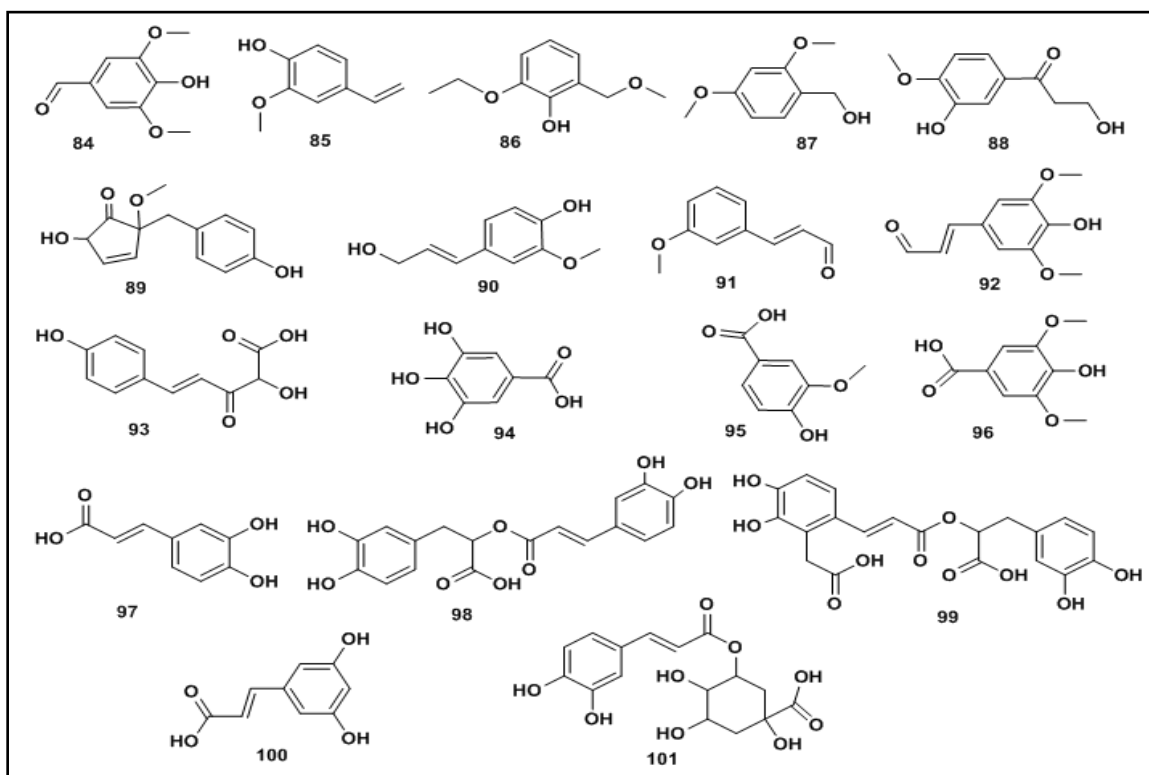


FIG. 12: PHENOLS (84-93), PHENOLIC ACIDS (94-96), HYDROXYCINNAMIC ACIDS (97-101)

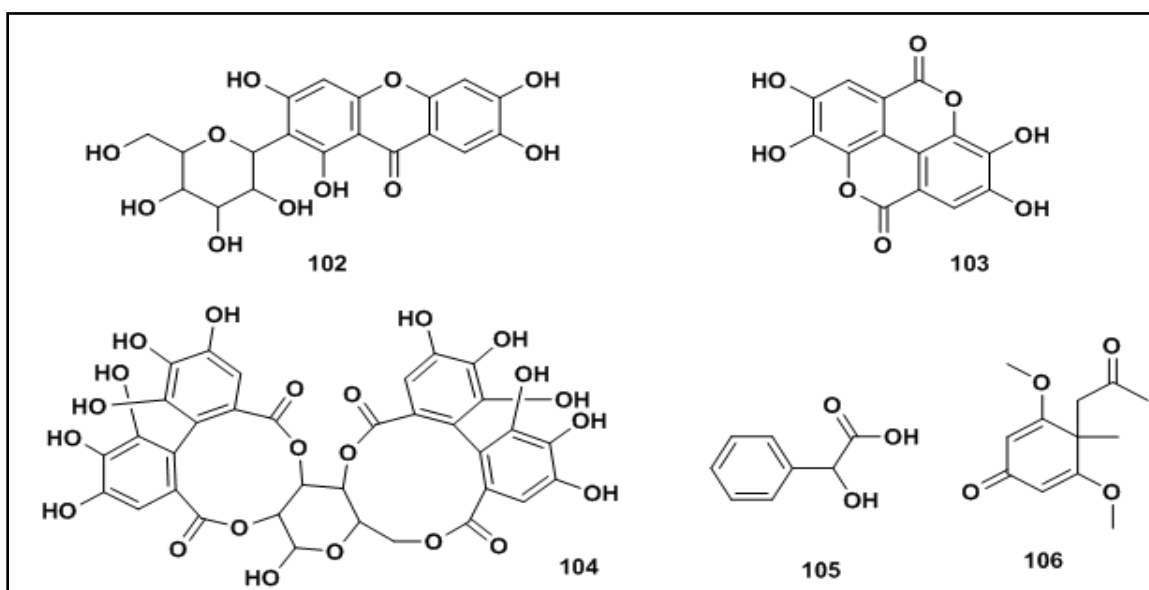


FIG. 13: XANTHONOID (102) AND HYDROLYZABLE TANNINS (103-104) AND OTHERS (105-106) ISOLATED FROM DIFFERENT PARTS OF GENUS GREWIA

Terpenoids (110-121) and Sterols: Terpenoids derived from the 5-carbon compound isoprene and its derivatives called terpenes and diterpenes. Some reported terpenoids (110-121) and sterol (122-130) isolated from aqueous, ethanolic, methanolic, n-butanol, ethyl acetate, chloroform, and hexane fractions of *G. optiva*, *G. bicolor*, *Grewia biloba* *G. Don*, *G. lasiocarpa*, *G. bilamellata*, *G. tiliaefolia*, *G. occidentalis*, *G. villosa*, *G.*

flavescens, and *G. asiatica*. Structure of terpenoidsgiven in **Fig. 14, 15**. The distinctive pharmacologically active chemical components are present in the leaves of *G. pubescens*, *G. lasiocarpa*, and *G. nervosa* are phytol and palmitic acid. Additionally, leaves of *G. lasiocarpa*, *G. nervosa*, and fruits of *G. asiatica* have been found to contain γ -tocopherol (226) and quinic acid (227) correspondingly^{53, 54}.

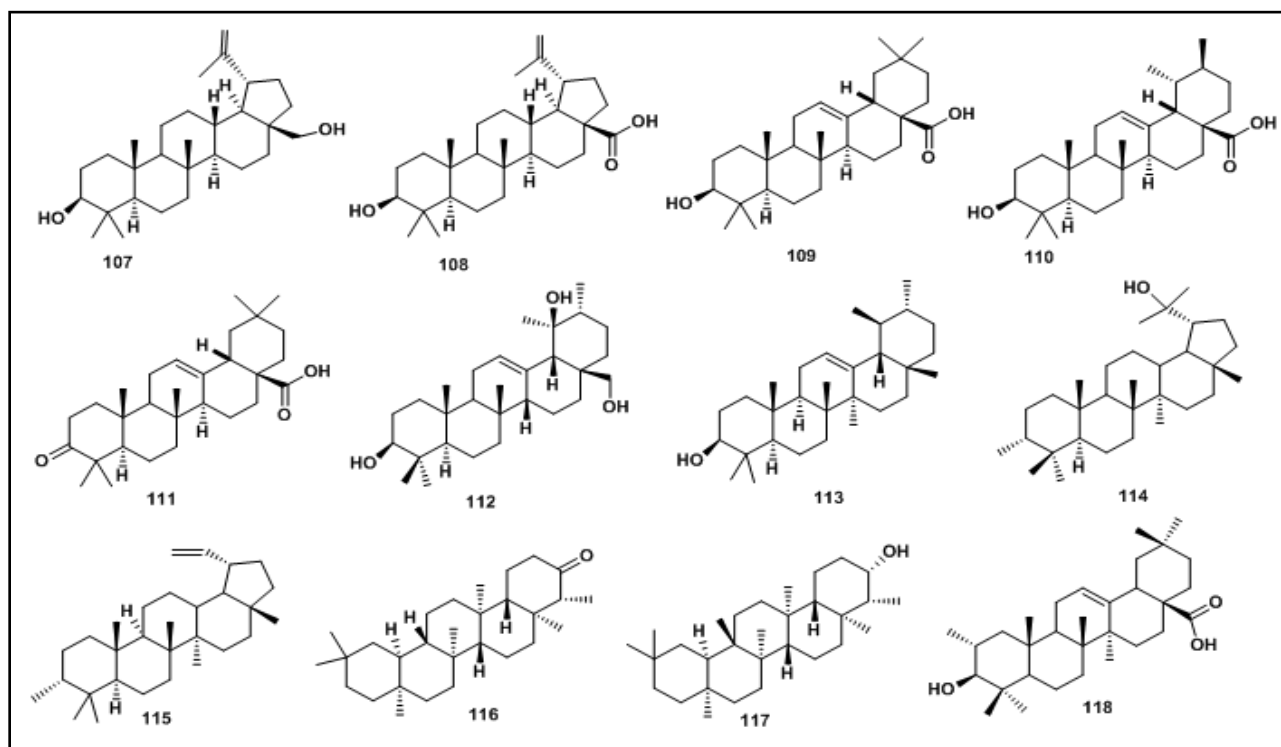


FIG. 14: THE STRUCTURE OF VOLATILE COMPOUNDS, TERPENES (107-118), OF GENUS GREWIA

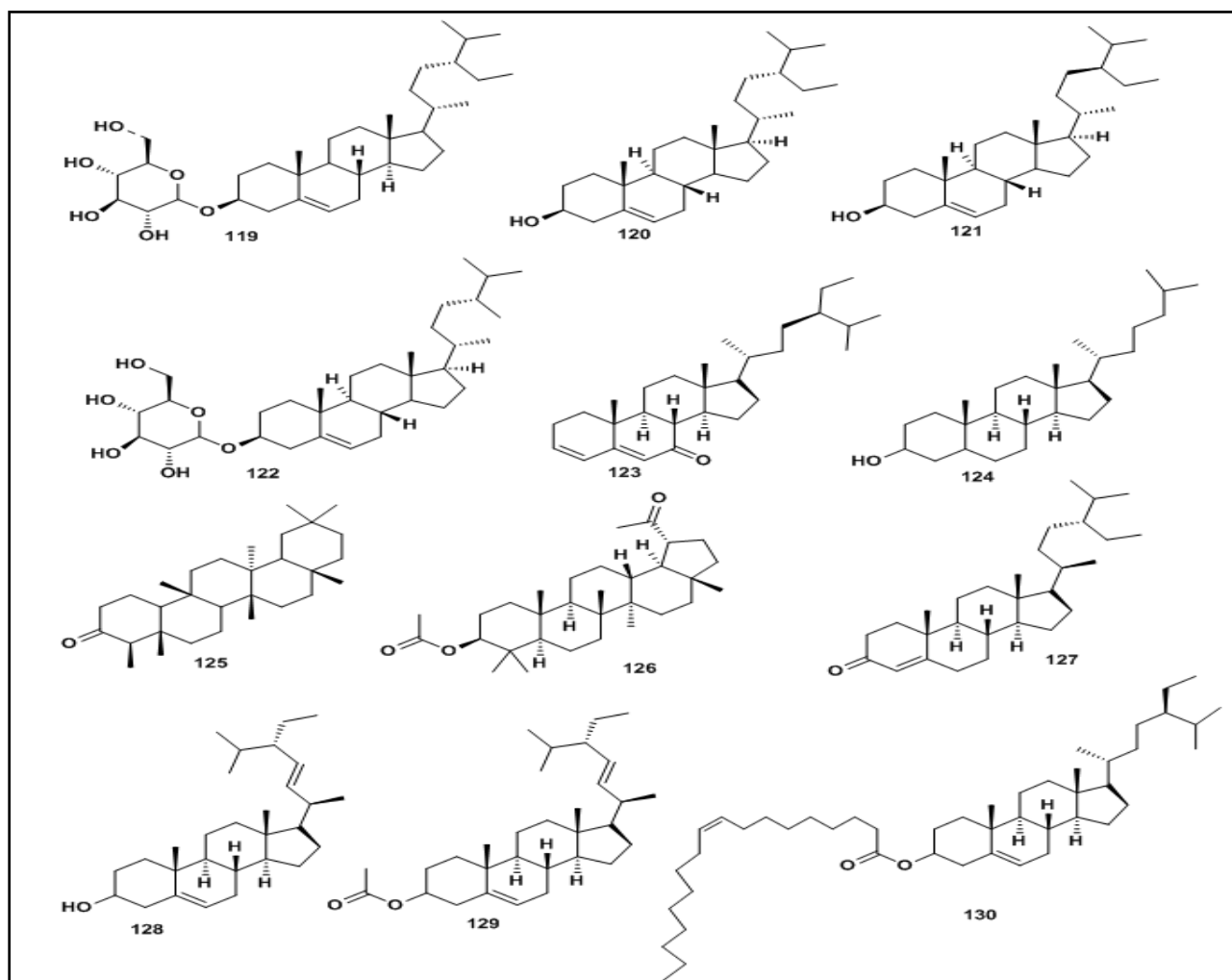


FIG. 15: THE STRUCTURE OF STEROIDS (119-130) OF GENUS GREWIA

Polyphenolic Compounds (Phenols): Polyphenols compounds contain an aromatic ring and hydroxyl groups. They have a variety of biological properties, like antibacterial, antiproliferative, antidiabetic, anti-cancer, antiviral, and anti-inflammatory properties⁵⁵. Hydroxybenzoic acid and hydroxycinnamic acid are the primary classes of phenolic acids. Compounds such as Gallic, hydroxybenzoic, ellagic, and vanillic acids are found in the first category and the second group includes caffeinic acid, ferulic acid, p-coumaric acid, and chlorogenic acid. These constituents can be found in berries, and each berry type possesses phenolic molecules with a distinct profile⁴².

Quercetin: A significant amount of quercetin, quercetin-3-O- β -D-glucoside, naringenin, and naringenin-7s-O- β -D-glucoside were present in the phalsa fruit⁵⁶.

Catechin: Catechin is polyphenol found in many plants having antioxidant properties. (+)-Catechin is a derivative of flavonoid and generally categorized into the groups; (-)-epicatechin gallate, (-)-epigallocatechin, (+)-gallocatechin, and (-)-epicatechin. It can help to prevent and protect against diseases caused by oxidative stress⁵⁶.

Anthocyanins: Anthocyanins are water-soluble pigments belonging to the phenolic group and account for the color in plant products. This fruit were possesses extensive anthocyanins content which gives a dark purple colored fruit. Specifically, research has identified the anthocyanins compounds; Cyanidin-3-glucoside, delphinidin-3-glucoside, pelargonidin-3, and 5-diglucoside are present in phalsa fruit^{56, 47}.

Tannins: Polyphenolic compound widely distributed in various parts of many food plants such as in the leaves, pomace, and wood. They are categorized in to hydrolysable and condensed tannins. Different parts of Phalsa plants like, fruit, juice leaves, stem, root, and bark contain tannins⁵⁷⁻⁵⁹. A study by Gupta, Bhatnagar, Kim, Verma, and Sharma (2014) reported that the pomace of phalsa fruit contain 0.52 ± 1.25 g/100 g dry weight basis of tannins. Various authors suggested that methanolic and acetone extract enriched with tannin and tannin-like substances inhibited the growth of several micro-organisms^{60, 61}.

CONCLUSION:

Concluding Remarks and Future Outlook: A number of bioactive substances, including anthocyanin, flavonoids, and tannins, are present in Phalsa fruit and contribute to its important functional properties. In addition, this berry fruit can be used successfully in a variety of pharmaceutical applications. According to research findings, the bioactive substances in Phalsa provide antibacterial, anticancer, radioprotective, antidiabetic, antioxidant, and anti-hyperlipidemia activities.

Although this plant has the ability to describe the physiological significance of numerous bioactive chemicals found in phalsa plants, its limited utilization is primarily due to its short shelf life of the fruit. Research has recently started to create more and more innovative, phalsa-improved products. Phalsa might not be as marketable as some other products that are produced, but that doesn't diminish its potential advantages. Nowadays, phalsa is processed on a small scale to produce a variety of edible products, including squash, juice, syrup, jam, and other drinks. However, the deficiency of the necessary equipment to fully utilize the plant's potential uses and related advantages limits the progress of phalsa-based products. Therefore, it is necessary to increase government publications and research on the phalsa plant, especially in the area of applying innovative methods to enhance its food value and quality.

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