

Review Article

Bioactive Compounds in *Ficus* Fruits, Their Bioactivities, and Associated Health Benefits: A Review

Ankita Walia,¹ Naveen Kumar ,¹ Rajat Singh ,¹ Harish Kumar ,¹ Vikas Kumar ,²
Ravinder Kaushik ,³ and Avvaru Praveen Kumar ⁴

¹Amity Institute of Biotechnology, Amity University Rajasthan, Jaipur 303002, India

²Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, Punjab, 41004, India

³University of Petroleum and Energy Studies, Dehradun 248007, Uttarakhand, India

⁴Department of Applied Chemistry, School of Applied Natural Science, Adama Science and Technology University, Po Box 1888, Adama, Ethiopia

Correspondence should be addressed to Naveen Kumar; nkft87@gmail.com and Avvaru Praveen Kumar; drkumar.kr@gmail.com

Received 1 February 2022; Accepted 12 March 2022; Published 26 April 2022

Academic Editor: Milan Stankovic

Copyright © 2022 Ankita Walia et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Bioactive compounds are secondary metabolites synthesized by plants for maintaining homeostasis; however, they also modulate metabolic processes and demonstrate valuable effects in the human body. The fig was cherished as food and for its pharmaceutical properties. The presence of a wide range of biologically active compounds such as carotenoids, flavonoids, phenols, and vitamin C is obligated for their functional properties as well as their technological capability as a dietary supplement is responsible for most health impacts. Owing to the rich and diversified composition of biologically active compounds these compounds possess different biological properties such as antioxidant, anti-inflammatory, antidiabetic, antimicrobial, and hepatoprotective activity that implies those bioactive substances might be used in the creation of novel culinary and medicinal products. Fig fruit should be widely recognized as a natural functional product. This systematic and comprehensive review gives the notion of developing figs species as a viable and innovative component for its varied food and nonfood applications as a remarkable and primitive source of medication and nourishment.

1. Introduction

Plants serve as an excellent source of food and play a vital role in sustaining human health and improving the quality of life from the beginning of humans on Earth [1]. Underutilized crops have an honest number of phytochemicals and various health benefits; hence, it is often proved as an advantage for the food and pharmaceutical industries. *Ficus* (Moraceae) encompasses 750 species of woody plants found in tropical and semitropical forests throughout the planet. The genus is notable for the wide range of habitats that its species inhabit [2]. As a seasonal fruit, figs establish a significant piece of the Mediterranean diet, either fresh or dried; figs are a particularly good source of fiber, minor elements, proteins, and carbohydrates, making them a very nutritious fruit. Fig fruit cultivars and genotypes are firmly

reliant on the concentrations of these compounds. Figs are mainstream high-value fruit because of their pleasant taste as well as their therapeutic properties [3]. A fresh fig can be consumed peeled or unpeeled. Fresh fruits usually have a short postharvest life of 7–10 days at ambient conditions; however, their shelf life is increased up to 2–3 weeks under cooler surroundings and a CO₂-advanced atmosphere. Figs are likewise extremely well known as a dried-organic product since their drying drags out their storability [4]. *Ficus* species, such as *Ficus carica*, *Ficus religiosa*, *Ficus benghalensis*, and *Ficus racemosa*, are profoundly related to spiritualism and Hindu religion and utilized for medication to treat different afflictions and irresistible sickness [5]. Fig is high in trace and macroelements, as well as a wide range of biologically active phytochemical constituents, including anthocyanins, carotenoids, flavonoids, polyphenols,

phenolic acids, triterpenoids, glycosides, polysaccharides, reducing compounds, and vitamins C, K, and E. Phytochemical components with high antioxidant potential in terms of chelating metal ions, metal reduction, and free radical scavenging can protect natural frameworks from oxidative stress. Because of their high phytochemical potential and substantial antioxidant ability, these plants exhibit a variety of biological activities such as antibacterial, hepatoprotective, antidiabetic, renal-protective, antiobesity, antidiabetic, cardioprotective, and anticancer activity. These plants are viable in the treatment of diabetes, stomachache, piles, skin diseases, inflammation, cancer [6], kidney, and spleen diseases [7].

The phytochemical investigations of *Ficus* fruit have uncovered the occurrence of ceramides, cerebrosides, steroids, pentacyclic triterpenes, flavonoids, and phenolic compounds [8,9]. The processing of figs generates many by-products. These by-products are derived from fresh figs that were abandoned owing to inadequate or excessive ripening, spoilage, or poor table fruit quality, but are still edible. If the fig coproduct is not used, it represents a considerable economic loss because it is abundant in nutrients and bioactive compounds that may be separated and used as a value-added ingredient. Fig coproducts are rich in minerals, dietary fiber, vitamins, and amino acids [4, 10]. Bioactive compounds such as anthocyanins pigments, flavonoids, and other phenolic substances with antioxidant potential have recently increased attention in fruit composition. Figs are also an incredible source of soluble crude fiber [11]. This overview summarizes research concerning the biological activities of *Ficus*, their therapeutic properties, and prospects as functional ingredients and food products.

2. Bioactive Compounds in Fresh Fig Fruit and Fruit Products

Fruits and vegetables are colorful, delightful, and nutritious additions to our diets. Because of their potential health benefits, bioactive compounds found in fruits and vegetables such as polyphenols, carotenoids, vitamins, and anthocyanins are receiving more attention. Fruit and vegetable-rich diets may help to slow down the aging process and minimize the risk of certain cancers, cardiovascular diseases, and other chronic illnesses. Vitamins, minerals, phenolics, antioxidants, and fiber appear to be responsible for these effects [12].

2.1. Ascorbic Acid. Fig fruit is an excellent source of water-soluble vitamin C, known as a natural antioxidant, and helps in preventing the nonenzymatic browning of fruits and vegetables. It is utilized as a substitute for synthetic antioxidants [13]. The vitamin plays a vital role in the immune reaction, detoxification, iron absorption, wound healing, orthogenesis, collagen biosynthesis, preventing the blood vessels from clotting, and in various metabolic processes [14]. The degrees of ascorbic acid indeed rely upon the species, ecological circumstances, harvest time, manufacturing techniques, development, and storage stages.

Different extraction strategies also affect reliability, stability, and vitamin C content [15].

Ascorbic acid has an essential function in human health including the prevention of chronic human diseases such as scurvy, oxidative stress-induced DNA mutations, certain tumors, myocardial infarction, atherosclerosis, glaucoma, and renal disease [16]. Vitamin C also invigorates the immune system of the human body. It obstructs the production of nitrosamines and prevents carcinogens from being stimulated [15]. Vitamin C is one of the most important vitamins in humans, as it is involved in many of the body's processes and functions. Collagen, or connective tissue, is the amplest tissue in the human body. Collagen protects against sicknesses and contaminations in the human body. The major function of vitamin C is to assist this animal tissue. As a result, scleroprotein has the defense mechanism against sickness and infection, and because vitamin C aids in the formation of collagen, it stands to reason that it can also be used to treat scurvy by contributing to hemoglobin synthesis. Vitamin C is required for promoting carbohydrates and integrating fats and proteins. Vitamin C is a proficient antioxidant. Even if it is used in less amount, vitamin C can protect from vitally important molecules such as amino acids, lipids, carbohydrates, nucleic acids, and other essential components against free radicals and reactive oxygen species which are produced because of exposure to toxins and pollutants (e.g., smoking). Vitamin C may also be able to resuscitate different cancer prevention agents such as vitamin E [17]. Sirajo [18] analyzed that the *Ficus carica* fruit does indeed have a relatively high ascorbic acid content (37.00 ± 1.59 mg/100 g DW). This value is higher than 7.73 ± 2.83 mg/100 g, 15.87 ± 0.91 mg/100 g, and 33.85 ± 1.92 mg/100 g recorded on a fresh weight basis for *Prunus spinosa* fruits, African star apple fruits, and Black-Berry fruits, respectively. The result revealed that fruits can be a good source of vitamin C, a water-soluble, nonenzymatic natural antioxidant that is extensively used as a substitute for chemically synthesized antioxidants [13]. Table 1 shows the Vitamin C present in the species used as both fresh fruit and spices belonging to genus *Ficus*.

2.2. Carotenoids. Carotenoids are biologically active compounds extensively located in plants, and they are liable for the color of *Ficus* species. Carotenoid molecules can serve as antioxidants, defensive cells from oxidative stress, and slow the process of aging by using reactive oxygen species [20]. Fig fruit contains a variety of health-beneficial bioactive ingredients including phenolics, anthocyanins, minerals, carotenes, and sterols. Figs are an exquisite source of crude fiber, minerals [21], phytosterols, carotenoid [22], anthocyanins [10, 23, 24], and polyphenols [23, 25]. The quality of freshly processed products is indicated by the color of the fruit. Anthocyanins give fruits and vegetables their typical red, purple, and blue hues, along with the goods produced from these materials. Similarly, typically yellow and orange hues of many foods are caused by carotenoids, a group of fat-soluble pigments. The recognition of carotenoids emerges from their precursor interest and for nutrition and defensive

TABLE 1: Ascorbic acid vitamin C present in the species used as both fresh fruit and spices belonging to genus *Ficus*.

Species	Maximum. Quantification	Extraction Solvent	References
<i>F. benghalensis</i>	203.45 mg/g	Methanol	Govindan and Shoba, [17]
<i>F. carica</i>	37.00 mg/100 g	Methanol	Sirajo [18]
	20.2 mg/100 gm		Pande and Akoh, [19]
	0.96 mg/100 gm	Ethanol	M. Viuda-Martos et al. [2]

effect against cancer and cardiovascular diseases. It has been noted that certain anthocyanins and carotenoids have entirely distinct functional characteristics [26]. Fresh figs are an excellent source of anthocyanins and carotenoids and relish growing popularity. The concentration profile of carotenoids in fig varies as per species, as shown in Table 2, considering factors such as growing circumstances, plant component, maturity stage during harvest, and postharvest management practices. Furthermore, adequate sample preparation and extraction are required to retain the optimum level of carotenoids in fruit [15]. Information about the chemical structure of figs and the number of individual anthocyanins and carotenoids is crucial [11]. Although in modest quantities, figs contain all the main carotenoids seen in plasma [22], a multitude of factors impacts carotenoid concentration in vegetables, including the type of soil, cultivar, variety, and fruit maturity. β -cryptoxanthin, α -carotene derivative, and β -carotene were carotenoids found in *Ficus carica* [28].

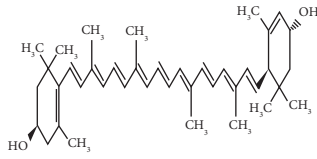
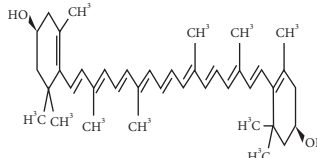
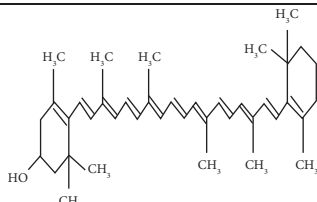
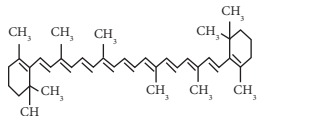
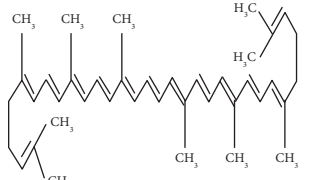
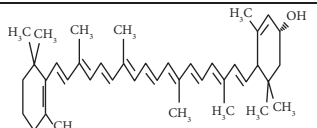
As shown in Table 2, the carotenoids in the figure are positively recognized by zeaxanthin, lutein, α -carotene, lycopene, β -carotene, and cryptoxanthin [11]. Lycopene is the carotenoid found in abundance followed by lutein, β -carotene, α -carotene, and cryptoxanthin [22]. A study of two cultivars of *F. carica* “Sarizeybek” and “Sarilop,” [11], affirmed lutein as the fundamental carotenoid recognized in fresh fig followed by zeaxanthin, β -cryptoxanthin, and β -carotene. Dry figs have far greater total carotenoid levels than apricots, dried prunes, and raisins [28]. The fruit skin is the major source of carotenoids, whereas the pulp contains only a little amount [27]. Thermal treatments expanded the extractability of these pigments, and the antioxidant potential is related to the carotenoid concentration. Mucilage present in the stems diminished the extractability of the carotenoids [29].

2.3. Phenolic Compounds. Phenolic compounds can play a significant part in protecting biological cells from hydrogen peroxide damage, protecting cells and organs from lipid peroxide damage to unsaturated fatty acids, and absorbing and neutralizing free radicals. The genus *Ficus* contains a high concentration of phenolic components [30]. In consideration of the profile of the bioactive compounds of figs, the variety of their phenolic compounds has been widely explored regarding their therapeutic properties namely the anticipation of anti-inflammatory action, tumor, and atherosclerosis [31]. It is worth mentioning that there is an interrelationship between the antioxidant activities and phenolic compounds of *Ficus* species, implying that these components are largely accountable for antioxidant capacity in figs. Phenolic compounds in fig fruits significantly

contribute to their quality especially because it has been demonstrated that their utilization can positively affect human well-being. The utilization level of phenolic compounds is not only affected by the cultivar of the fruit; however, it differs significantly from one portion to another [4].

Sirajo [18] indicated that the *Ficus carica* fruit if properly utilized can be a good source of polyphenols. Polyphenols are aromatics auxiliary plant metabolites that are widely distributed throughout the plant kingdom and are associated with color, sensory characteristics, antioxidant, and nutritional properties in food. Polyphenols may contribute to bitter taste, astringency, color, flavor, odor, and oxidative stability [32]. Dry figs have one of the highest polyphenol content levels among regularly consumed fruits and vegetables as well. Fruit skin contributed most of the phytochemicals. The total polyphenol content of fig extract is correlated well with the color of the extract. Extract of darker-colored varieties shows the highest contents of polyphenols in contrast to lighter-colored varieties [10]. Abdel-Aty et al. [33] investigated the flavonoid content and total phenolic of *Ficus sycomorus* latex extracts. Among the investigated methanol extracts, the *Ficus sycomorus* had the greatest total phenolic and flavonoid concentrations, which were about two and three times higher than *Ficus carica*, respectively. They concluded that latex from *Ficus carica* extract, and *Ficus sycamores* extract contained greater phenolic and flavonoid content than other fig sections. *Ficus sycomorus* also contains the highest tannin content and the best antiradical activity [34]. The polyphenol concentration of *Ficus deltoidea* extracts is significantly influenced by the temperature at which the extracts are extracted. Numerous plant extracts demonstrated that hot aqueous extraction of *Ficus deltoidea* yielded higher polyphenol content than cold aqueous extraction [35]. The temperature at which the extracts are extracted has a substantial impact on the polyphenol content of *F. deltoidea* extracts phenolic compounds such as gallic acid, chlorogenic acid, syringic acid, catechin, and epicatechin were identified, and rutin was present in the highest concentrations among all the phenolics analyzed as shown in Table 3. In comparison to apples, figs contain a high amount of rutin [25]. Epicatechin was found to be the most abundant component of phenol in dried fig fruits, with a level of 25.4 mg/100 g DW in cultivar “Bela Petrovka” of *Ficus carica*. Its content is up to three times that of fresh figs [36]. In contrast, research using sun-dried pear found that the drying procedure reduced monomeric catechin and epicatechin by 91 and 96%, respectively [37]. Chlorogenic acid levels in dried figs are also greater than in fresh fruits. In comparison to sun-dried fruits, oven-dried fruits have greater polyphenol levels. When compared to sun-drying,

TABLE 2: Carotenoid compounds present in the species used as both fresh fruit and species belonging to genus *Ficus*.

Carotenoid compounds	Chemical structure	Species	Maximum quantification	Extraction solvent	References
Lutein		<i>F. carica</i>	6.14 µg/gm	Methanol	Yemis et al., [11]
		<i>F. carica</i>	0.8 mg/100 gm	Methanol	Su et al. [22]; Ouchemoukh et al. [27] and Yemis et al. [11]
Zeaxanthin		<i>F. carica</i>	3.32 µgm/100 gm	Methanol	O.yemis et al., [11]
		<i>F. carica</i>	2.2 mg/100 gm	Methanol	Ouchemoukh et al., [27] and Yemis et al., [11]
β -cryptoxanthin		<i>F. carica</i>	2.04 µgm/100 gm	Methanol	Yemis et al., [11]
		<i>F. carica</i>	2.14 µgm/gm	Ethanol	Ouchemoukh et al [28]
β -carotene		<i>F. carica</i>	1.40 µgm/100 gm	Acetone	Yemis et al., [11]
		<i>F. carica</i>	0.04 mg/100 gm	Methanol	Ouchemoukh et al., [27] and Yemis et al., [11]
		<i>F. carica</i>	4.32 µgm/gm	Ethanol	Ouchemoukh et al [28]
		<i>F. carica</i>	0.2 mg/100 gm	Methanol	Su et al. [22]; Ouchemoukh et al., [27] and Yemis et al., [11]
Lycopene		<i>F. carica</i>	ND µgm/gm	Ethanol	Ouchemoukh et al., [28]
		<i>F. carica</i>	3.2 mg/100 gm	Methanol	Ouchemoukh et al., [27] and Yemis et al., [11]
α-cryptoxanthin		<i>F. carica</i>	0.1 mg/100 gm	Methanol	Su et al. [22]; Ouchemoukh et al., [27] and Yemis et al., [11]

the findings demonstrate that constant temperature can be maintained in oven-drying [36]. According to Devic and Guyot, [38] drying preserves procyanidins better than hydroxycinnamic acids or some monomeric flavanols. The two phenolic groups that follow are good substrates for enzymatic oxidation. The drying technique of fig had the same influence on flavanol concentration as it did on the other phenolic categories. In comparison to fresh figs, dried fig samples from "Bela Petrovka" contain a high concentration of kaempferol-3-glucoside, rutin, and quercetin-3-glucoside as shown in Table 3 [36]. Hassan et al. [39] investigated the total phenolic content of the methanol extracts of seven *Ficus* species (*Ficus bengalensis*, *Ficus decora*, *Ficus hawaii*, *Ficus virens*, *Ficus phatyphylla*, *Ficus retusa*, and *Ficus cycomorous*) tested by the Folin-Ciocalteu method. The phenolic content ranged from 2.50 to 7.97 mg/gm dried extract shown in Table 4. *Ficus* fruit contains phenolic

derivatives which may provide a wide variety of biological activities. Total phenols in dried fruits are considerably greater than in fresh fruits. A study by Vallejo et al. [43] found that phenolic levels in fresh and dried fruit range from 0.5 mg/100 g to 11.3 mg/100 g, with dried fruit levels ranging from 17.8 mg/100 g (Spanish genotype) to 19.2 mg/100 g (Turkish genotype). The drying procedure resulted in the loss of around 15% of the overall phenol content. Some polyphenols may be destroyed or transformed into forms that are not antioxidants. Water loss results in a 90% increase in free polyphenolic compounds when comparing fresh and dehydrated fig fruit based on fresh weight. Polyphenols are thought to be degraded or transformed into nonantioxidant forms during the aging process [37]. Meanwhile, Vinson et al. [44] found an 11% increase in total phenolic compounds because of drying. This is in accordance with previous findings on other fruit species such as strawberry,

TABLE 3: Phenolic compounds present in the species used as both fresh fruit and species belonging to genus *Ficus*.

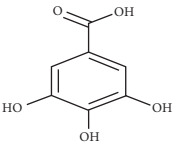
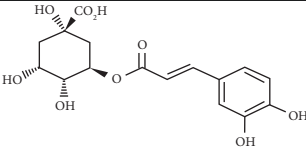
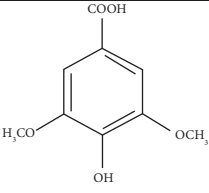
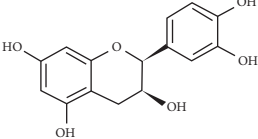
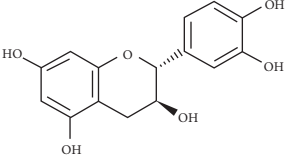
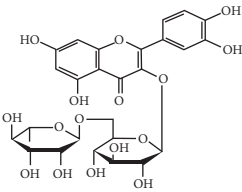
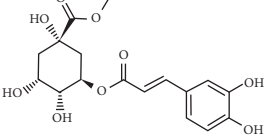
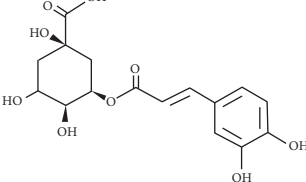
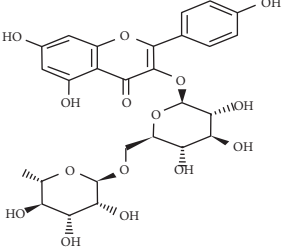
Phenolic compounds	Chemical structure	Species	Maximum quantification	Extraction solvent
Gallic acid		<i>F. carica</i>	0.15 mg/100 gm	Methanol
		<i>F. vasta</i>	76.36 mg/gm	Methanol
Chlorogenic acid		<i>F. carica</i>	0.46 mg/100 gm	Methanol
		<i>F. vasta</i>	0.73 mg/gm	Methanol
Syringic acid		<i>F. carica</i>	0.022 mg/100 gm	Methanol
Epicatechin		<i>F. carica</i>	0.34 mg/100 gm	Methanol
Catechin		<i>F. carica</i>	1.19 mg/100 gm	Methanol
Rutin		<i>F. carica</i>	4.89 mg/100 gm	Methanol
		<i>F. vasta</i>	9.33 mg/gm	Methanol
3-Caffeoylquinic acid		<i>F. carica</i>	0.32 mg/100 gm	Methanol
5-Caffeoylquinic acid		<i>F. carica</i>	1.4–32.42 mg/100 gm	Methanol
Kaempferol-3-rutinoside		<i>F. carica</i>	1.0–2.0 mg/100 gm	Methanol

TABLE 3: Continued.

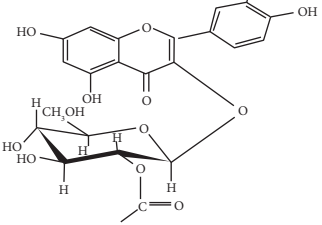
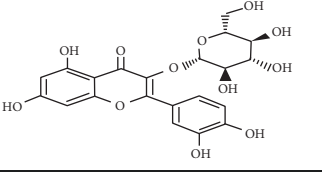
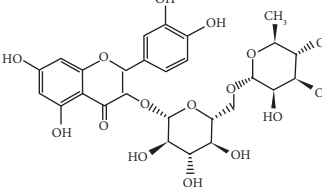
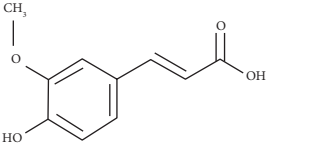
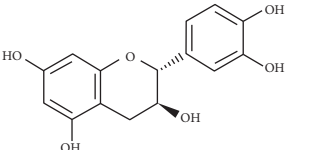
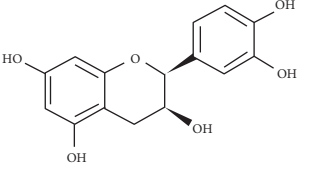
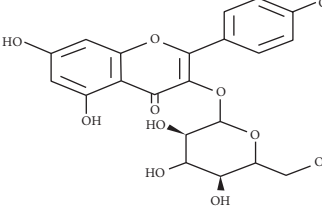
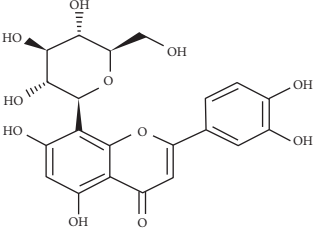
Phenolic compounds	Chemical structure	Species	Maximum quantification	Extraction solvent
Quercetin-3-acetylglycoside		<i>F. carica</i>	2.1–2.8 mg/100 gm	Methanol
Quercetin-3-glucoside		<i>F. carica</i>	0.56–3.35 mg/100 gm	Methanol
Quercetin-3-rutinoside		<i>F. carica</i>	1.38–14.62 mg/100 gm	Methanol
Ferulic acid		<i>F. carica</i>	0.92–2.05 mg/100 gm	Methanol
Catechin		<i>F. carica</i> <i>F. vasta</i>	5.88–19.75 mg/100 gm 6.53 mg/gm	Methanol
Epicatechin		<i>F. carica</i>	10.44–36.6 mg/100 gm	Methanol
Kaempferol-3-glucoside		<i>F. carica</i>	0.31–0.43 mg/100 gm	Methanol
Luteolin -8-C-glucoside		<i>F. carica</i>	0.13–0.45 mg/100 gm	Methanol

TABLE 3: Continued.

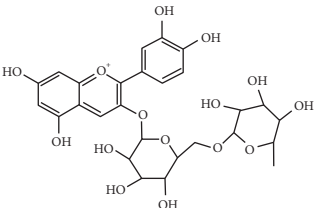
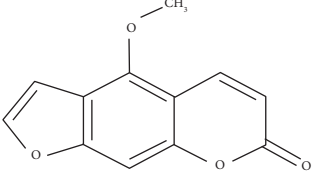
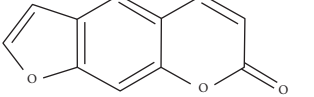
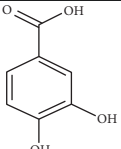
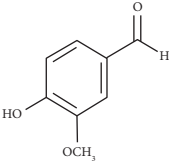
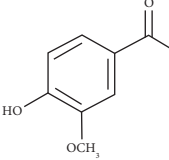
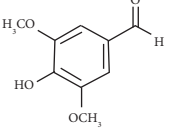
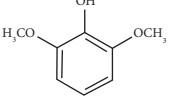
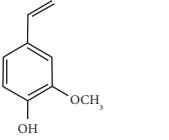
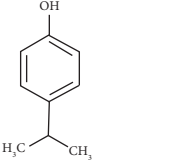
Phenolic compounds	Chemical structure	Species	Maximum quantification	Extraction solvent
Cyanidin-3-rutinoside		<i>F. carica</i>	0.12–0.31 mg/100 gm	Methanol
Bergapten		<i>F. carica</i>	2.68 mg/100 gm	Methanol
Psoralen		<i>F. carica</i>	0.26–1.84 mg/100 gm	Methanol
Protocatechnic acid		<i>F. microcapra</i>	6.6 mg/gm	Methanol
Catechol		<i>F. microcapra</i>	11.1 mg/gm	Methanol
Vanillin		<i>F. microcapra</i>	4.27 mg/gm	Methanol
Syringaldehyde		<i>F. microcapra</i>	8.96 mg/gm	Methanol
Syringol		<i>F. microcapra</i>	173 mg/gm	Methanol
P-vinyl glyaiacol		<i>F. microcapra</i>	4.40 mg/gm	Methanol
P-propyl phenol		<i>F. microcapra</i>	10.5 mg/gm	Methanol

TABLE 3: Continued.

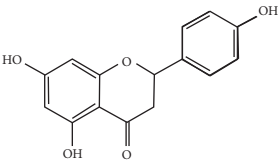
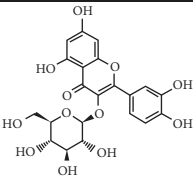
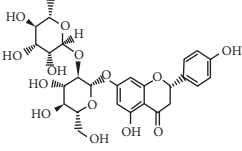
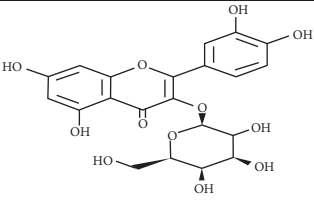
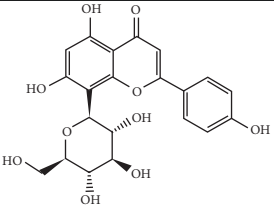
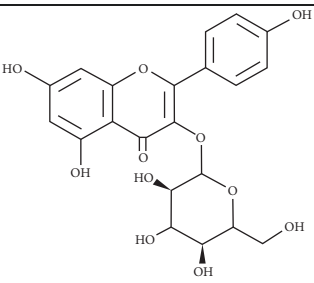
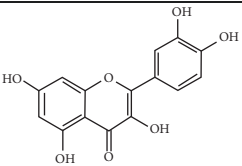
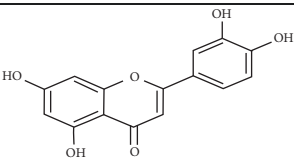
Phenolic compounds	Chemical structure	Species	Maximum quantification	Extraction solvent
Naringenin		<i>F. vasta</i>	5.84 mg/gm	Methanol
Isoquercitrin		<i>F. vasta</i>	22.50 mg/gm	Methanol
Naringin		<i>F. vasta</i>	1.20 mg/gm	Methanol
Quercetin-3galactoside		<i>F. vasta</i>	81.75 mg/gm	Methanol
Vitexin		<i>F. vasta</i>	0.64 mg/gm	Methanol
Kaempferol-3-glucoside		<i>F. vasta</i>	6.72 mg/gm	Methanol
Quercetin		<i>F. vasta</i>	0.98 mg/gm	Methanol
Luteolin		<i>F. vasta</i>	0.49 mg/gm	Methanol

TABLE 4: Total phenols present in the species used as both fresh fruit and species belonging to genus *Ficus*.

Species	Maximum quantification	Extraction solvent	References
<i>F. carica</i>	384 mg/100 gm	Methanol	Sirajo [18]
<i>F. sycomorus</i>	24700 mg TAE/gm	Chloroform, ethanol, distilled water	Ramde-Tiendrebeogo et al., [34]
<i>F. sycomorus</i>	33680 mg TAE/gm	Chloroform, ethanol, distilled water	
<i>F. deltoidea</i>	2.19 mg GAE/gm	Aqueous extract	Hakiman et al., [35]
<i>F. afzelli</i>	97.30 mg GA/gm		
<i>F. decora</i>	63.61 mg GA/gm		
<i>F. lyrata</i>	131.38 mg GA/gm		Abdel-Hameed [40]
<i>F. nitida</i>	105.38 mg GA/gm		
<i>F. sycomorus</i>	120.46 mg GA/gm		
<i>F. virnes</i>	93.50 mg GA/gm		
<i>F. sycomorus</i>	8.75 mg GAE/100 gm		Al-matani [41]
<i>F. indica</i>	218.8 mg/100 g	Methanol	Munira et al., [42]
<i>F. racemosa</i>	24.63 mg/gm		
<i>F. cycomorus</i>	7.97 mg/gm		
<i>F. decora</i>	7.60 mg/gm		
<i>F. benghalensis</i>	5.88 mg/gm		
<i>F. platyphylla</i>	4.10 mg/gm		Hassan et al., [39]
<i>F. hawaii</i>	3.91 mg/gm		
<i>F. retusa</i>	3.77 mg/gm		
<i>F. virens</i>	2.50 mg/gm		

TABLE 5: Flavonoid compounds present in the species used as both fresh fruit and species belonging to genus *Ficus*.

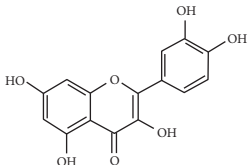
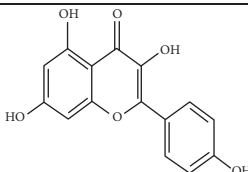
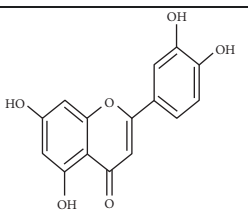
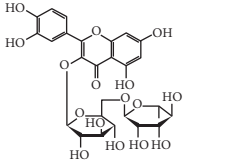
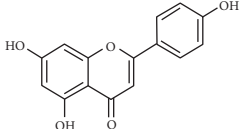
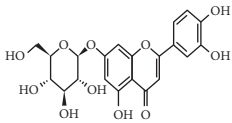
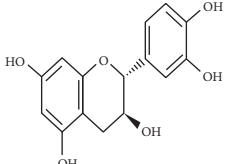
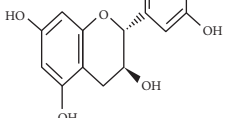
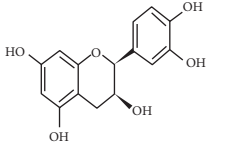
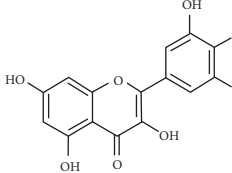
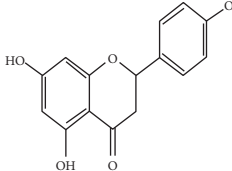
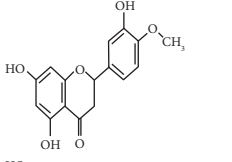
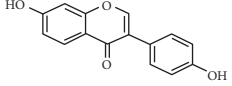
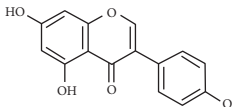
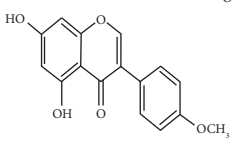
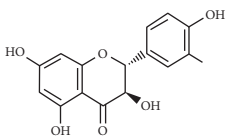
Flavonoid compounds	Chemical structure	Species	Maximum quantification	Extraction solvent	References
Quercetin		<i>F. carica</i>	63.8 mg/kg	Ethanol	Vaya and Mahamood, [48]
Kaempferol		<i>F. carica</i>	ND	Ethanol	Vaya and Mahamood, [48]
Luteolin		<i>F. carica</i>	1.07 mg/100 gm	Ethanol	Viuda-Martos et al., [2]
Rutin		<i>F. carica</i>	14.20 mg/100 gm	Ethanol	Viuda-Martos et al., [2]
Apigenin		<i>F. carica</i>	1.03 mg/100 gm	Ethanol	

TABLE 5: Continued.

Flavonoid compounds	Chemical structure	Species	Maximum quantification	Extraction solvent	References
Luteolin-7-O-glucoside		<i>F. carica</i>	2.18 mg/100 gm	Ethanol	
Catechin		<i>F. carica</i>	12.48 mg/100 gm	Ethanol	
		<i>F. carica</i>	ND	Ethanol	Vaya and Mahamood, [48]
Epicatechin		<i>F. carica</i>	2.25 mg/100 gm	Ethanol	Viuda-Martos et al., [2]
Myricetin		<i>F. carica</i>	ND	Ethanol	
Naringenin		<i>F. carica</i>	ND	Ethanol	
Hesperetin		<i>F. carica</i>	ND	Ethanol	Vaya and Mahamood, [48]
Daidzein		<i>F. carica</i>	ND	Ethanol	
Genistein		<i>F. carica</i>	ND	Ethanol	
Biochanin		<i>F. carica</i>	17.4 mg/kg	Ethanol	
Taxifolin		<i>F. carica</i>	ND	Ethanol	

apple, and peach wherein the concentrations of total phenolic content rose after drying the fresh fruit purees [45].

In many foods, pigment loss occurs mostly throughout the drying process. Some processes during the drying process, such as browning reaction enzymatic, nonenzymatic browning, and caramelization, produce color modifications in the food item, resulting in a deeper color [46].

2.4. Flavonoids. Flavonoids are compounds present in a wide range of edible plants, fruits, vegetables, and grains, and they constitute an indispensable and essential component of the human diet. Flavonoids and foodstuffs containing them (wine, tea, soybeans, and licorice) have been investigated as potential health advantages owing to their antioxidant activity and capacity to postpone or retard many disorders thought to be connected to oxidative stress (atherosclerosis, cancer, Parkinson's, and diabetes) [47]. Fig fruits are a rich source of flavonoids. The attractive color of flowers is also due to the presence of flavonoids, fruits, and leaves of *Ficus* species and possesses biological activities such as anticarcinogenic, anti-inflammatory, and antiatherosclerotic activities. The primary flavonoids found in figs are quercetin and luteolin, which have a total of 631 and 681 mg/kg, respectively, as shown in Table 5. The major flavonoid compound (nonglycosylated) in fig is found to be luteolin (187 mg/kg extract). Luteolin was shown to be the most abundant flavonoid in fig leaves. Another flavonoid found in the figure, but in lesser amounts, was biochanin A, which was found mostly as a free aglycone [18]. *Ficus ceratonia* are rich in flavonoids and also contain a high level of significant isoflavone, genistein [48]. Nawaz et al. [6] reported that *Ficus carica* contains flavonoids, alpha-tocopherol, and phenolic acids in its leaves, as well as sesquiterpenes and organic acids in its latex [49]. *Ficus deltoidea* hot and cold aqueous extracts have flavonoid contents given in mg as catechin equivalent (CE)/g of fresh weight. This study found that the total flavonoid content of hot aqueous extract ranged from 17 to 66 mg CE/g fresh weight, whereas that of cold aqueous extract was in the range of 18 to 52 mg CE/g fresh weight [35]. The absolute flavonoid content of the six cultivars of *Ficus carica* was calorimetrically measured and discovered to be altogether higher in dark varieties when compared to light-colored varieties. Most of the flavonoids are present in the fruit skin. Total flavonoid ranged from 2.1 mg/100 gm in mission variety of *Ficus carica* followed by 15.9 mg/gm in chechik, 3.6 mg/gm in Brown-Turkey, 2.7 mg/gm in Bursa, 2.3 mg/100 gm in Brunswick, and 2.1 mg/100 gm in Kadota as shown in the Table 6. Darker variety figs were substantially greater in flavonoid content than those of other varieties. So the skin is the primary tissue that adds the flavonoid content [10]. Hassan et al. [39] examined the total flavonoid content of the methanol extracts of seven *Ficus* species (*Ficus. Benghalensis*, *Ficus. Decora*, *Ficus. Hawaii*, *Ficus. Virens*, *Ficus. Phatyphylla*, *Ficus. Retusa*, and *Ficus sycomorous*) using a modified aluminum chloride colorimetric method. As shown in Table 6 the flavonoid content of dried fig species ranged from 1.85 to 12.46 mg/gm. Figs contain flavonoid derivatives which may provide a wide variety of biological activities.

3. Bioactivities of Fig Fruit

3.1. Antioxidant Activity. Antioxidants inhibit the production of reactive oxygen species. Total polyphenols, anthocyanins, flavonoids, and antioxidant capacity of fig extract is associated well with the color appearance. Extracts of darker varieties of figs had more phytochemicals than lighter color variants. When compared to fruit pulp, fruit skin contributes the greatest phytochemicals and antioxidant activity [10]. Abdel-Aty et al. [33] compared the antioxidant profile of different fig species. *Ficus carica* and *Ficus sycomorus* extracts included a variety of phytochemical substances with potential therapeutic utility, including anticancer, antiapoptotic, anti-inflammatory, and antifungal activities. Variations in the number of antioxidants found in the fig extract make it an excellent source of natural antioxidants for health. Some of these differences may be due to the kind of solvent, the phenolic concentration, and the interaction among extract components. Flavonoid glycosides in the leaves of *Ficus pumila* are powerful antioxidants that have beneficial effects on the human body. The strongest antioxidant compound rutin was extracted from *Ficus pumila* leaves using 50% of aqueous ethanol. *F. pumila* is used as herbal medicine to treat diabetes and high blood pressure [51]. The antioxidant and antibacterial activities of *Ficus microcapra* extracts were evaluated by [50]. The methanolic extracts of bark, fruits, and leaves show excellent antioxidant activities and have antibacterial activity. Shi et al. [5] studied the antioxidant effects of the edible young leaves of *Ficus virens var. Sublanceolata*, *Ficus auriculata*, *Ficus vasculosa*, *Ficus callosa*, and *Ficus racemosa* along with their total phenolic and flavonoid contents. The ethanol extracts of *Ficus virens var. Sublanceolata* and *Ficus auriculata* showed a substantial level of antioxidant potential as compared with other species that were examined, and it was stated that methanolic extract of *Ficus microcapra* stem bark contains seven distinct antioxidant chemicals, including protocatechuic acid, chlorogenic acid, catechin, and epicatechin. All the substances identified have high antioxidant properties [52].

The methanolic root extract of *Ficus hispida* and *Ficus arnottiana* has been investigated for its antiulcerogenic potential. The results have shown that the antiulcer activity is because of the antioxidant activity of the extract. Anti-inflammatory and analgesic effects have been assessed from aqueous and methanolic extracts of *Ficus benghalensis*. The considerable anti-inflammatory potential is shown by methanolic bark extract as compared to the aqueous extract. The anti-inflammatory activity is primarily because of its antioxidant and lysosomal membrane-stabilizing effects on *Ficus benghalensis*. Due to their influence on oxidative stress, the flavonoids and tannins in the methanolic extract are liable for anti-inflammatory action [53]. Sertkaya et al. [54] studied the antioxidant activities of the fig peel and pulp samples by measuring the DPPH and ABTS. It was determined that the peels of cultivars had significantly higher total antioxidant activity than the fig pulps.

Different species of fig are high in antioxidants, with phenolic compounds and flavonoids playing an indispensable part in preventing a wide range of health

TABLE 6: Flavonoids present in the species used as both fresh fruit and species belonging to genus *Ficus*.

Species	Maximum quantification	Extraction solvent	References
<i>F. carica</i>	21.63 mg QE/100gm	Methanol	Sirajo [18]
<i>F. sur</i>	120, 80 mg TAE/gm	Chloroform, ethanol, distilled water	Ramde-Tiendrebeogo et al., [34]
<i>F. sycomorus</i>	204,74 mg TAE/gm	Chloroform, ethanol, distilled water	Ramde-Tiendrebeogo et al., [34]
<i>F. deltoidea</i>	0.66 mg GA/gm	Aqueous extract	Hakimath et al., [35]
<i>F. afzelli</i>	54.30 mg GA/gm	Methanol	
<i>F. decora</i>	43.24 mg GA/gm	Methanol	
<i>F. lyrata</i>	89.12 mg GA/gm	Methanol	
<i>F. nitida</i>	47.49 mg GA/gm	Methanol	Abdel-Hameed [40]
<i>F. sycomorus</i>	72.43 mgG A/gm	Methanol	
<i>F. virnes</i>	48.85 mg GA/gm	Methanol	
<i>F. sycomorus</i>	0.527 mg GA/gm	Methanol	Al-matani [41]
<i>F. microcapra</i>	6.1 mg/gm	Methanol	Ao et al., [50]
<i>F. racemosa</i>	32.491 mg/gm	Methanol	Munira et al., [42]
<i>F. decora</i>	12.46 mg/gm	Methanol	
<i>F. bengalensis</i>	5.88 mg/gm	Methanol	
<i>F. cycomorous</i>	4.53 mg/gm	Methanol	
<i>F. hawaii</i>	3.32 mg/gm	Methanol	Hassan et al., [39]
<i>F. retusa</i>	3.20 mg/gm	Methanol	
<i>F. platyphylla</i>	2.10 mg/gm	Methanol	
<i>F. virens</i>	1.85 mg/gm	Methanol	
<i>F. carica (mission)</i>	2.1 mg/100 g	Methanol	
<i>F. carica (chechick)</i>	15.9 mg/100 g	Methanol	
<i>F. carica (Brown-Turkey)</i>	3.6 mg/100 g	Methanol	
<i>F. carica Bursa</i>	2.7 mg/100 g	Methanol	Salmon et al., [10]
<i>F. carica Brunswick</i>	2.3 mg/100 g	Methanol	
<i>F. carica Kadota</i>	2.1 mg/100 g	Methanol	

problems associated with oxidative stress, including neurodegenerative diseases, cardiovascular disease, and cancer. *Ficus* species with excellent antioxidant and physicochemical features, as well as the ability to disperse harmful free radicals, make them suitable additives in the nutraceutical and biopharmaceutical sectors [55]. The extract of *Ficus deltoidea* contains potential antioxidant activities that have contributed to total polyphenols, phenolic acids, and flavonoid compounds [35]. Abdel-Hameed [40] examined total phenolic content and free radical scavenging activity of fig. It is inferred that the existence of phenolic compounds as significant components in the six *Ficus* species is attributed to the presence of DPPH scavenging activity and phosphomolybdenum methods in these species. The phenolic content of plants is a key category of chemicals that functions as a principal antioxidant or radical terminator. Phenolic compounds such as phenolic acids, tannins, and flavonoids are viewed as the principal supporter of the antioxidant activity of fruits, vegetables, or medicinal plants. The antioxidant activity of the phenolic compounds' was ascribed to their redox characteristics, which allow them to serve as reducing agents, singlet oxygen quenchers, hydrogen donors, and metal chelators [27].

In vitro antioxidant activity of dried *Ficus carica* from the cultivar "Bela Petrovka" is double that of fresh figs [36]. When compared to fresh fruits, dehydrated fig fruits have a higher nutritional density, higher fiber content, a longer shelf life, and a substantially higher phenolic content. The antioxidant qualities of processed dried fruits are the same as those of their fresh fruits. The in vivo antioxidant impact of ingesting a

therapeutic intake of fig indicated that phenolics in dried fruit may be significant antioxidants [44]. It tends to be concluded by [42] that the antioxidant activity of crude methanolic extract of *F. racemosa* was additionally discovered as being excellent. The methanolic extracts of *F. racemosa* fruits possess substantial antioxidant properties, as well as anti-bacterial, thrombolytic, and cytotoxic properties that might be employed for the improved treatment of diseases.

3.2. Antimicrobial Activity. The phytochemical screening of fig fruit extracts revealed the presence of the same active components, notably flavonoids, tannins, and terpenoids. Each of these active chemicals has its unique mechanism, given the existence of substances with antibacterial action such as flavonoids, tannins, and terpenoids which have proven to have antimicrobial activity [56].

Mandal et al. [57] studied the antibacterial efficacy of the petroleum ether extract of *F. racemosa*. The results of the leaf on the bacteria *Bacillus pumilus* ATCC 14884, *Escherichia coli* ATCC 10536, *Bacillus pumilus* ATCC 14884, *Pseudomonas aeruginosa* ATCC 25619, and *Staphylococcus aureus* ATCC 4 are remarkably comparable with the standard. It can be inferred that the ether extract is composed of alkaloids, terpenes, coumarins, and fatty acids. The antibacterial sports are attributes of terpenoids, alkaloids; therefore, the *Ficus racemosa* has confirmed antibacterial pastime in all varieties of situations and might be actively included in ointments for infectious situations.

In-vitro and in-vivo tests have shown that an aqueous extract of figs reduces damage from bacterial pathogens

(disease incidence and disease severity). The extract exhibits *in vitro* antibacterial activity against all bacterial strains used at various concentrations ($106\text{--}108\text{ CFU mL}^{-1}$). *In vivo* tests performed on fig extract confirmed the antibacterial activity of *Pseudomonas* [58]. Ethanolic and aqueous extracts of *Ficus religiosa* leaves confirmed antibacterial impact in opposition to *Shigella dysenteriae*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella paratyphi*, *S. typhimurium*, *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella typhi*. The ethanolic extract of fig fruit confirmed an antifungal impact in opposition to *Candida albicans*. There are also antibacterial and antifungal activities from the aqueous, methanol, and chloroform extracts of *Ficus religiosa*. A huge spectrum of antibacterial pastimes with a 10–21 mm zone inhibition zone was possessed from the chloroform extract of *Ficus religiosa*. The methanolic extracts possessed a slight antibacterial activity in opposition to some bacterial strains. There is much less antibacterial activity or none in any respect for the usage of aqueous extracts. The extracts of *Ficus religiosa* had been discovered to be active in opposition to *Aspergillus niger* and *Penicillium notatum*. The extracts from the leaves exhibited tremendous and variable inhibitory effects in opposition to the maximum of the microorganisms tested [59].

The antibacterial potency of petroleum ether extract of *Ficus racemosa* Lin. leaves against bacteria *E. coli* ATCC 10536, *Bacillus pumilis* ATCC 14884, *Bacillus subtilis* ATCC 6633, *Pseudomonas aeruginosa* ATCC 25619, and *Staphylococcus aureus* ATCC 29737 were quite significant. The results were significantly comparable to standard chloramphenicol. It could be inferred that ether extract consists of alkaloids, terpenoids, coumarins, and fatty acids. The antibacterial activities that are attributes of terpenoids, alkaloids of *F. racemosa* Lin. has confirmed antibacterial activity in all sorts of conditions and can be actively incorporated into ointments for infectious conditions [60]. Antibacterial activity has been demonstrated in *Ficus hispida* extract. *Ficus hispida* leaf extracts in water, methanol, and ethyl acetate inhibit Gram-positive *Staphylococcus aureus* and Gram-negative *E. coli* with inhibition areas greater than 13 mm. The ethyl acetate extract was found to be more sensitive than the conventional antibiotics chloramphenicol (30 mcg/disc) and streptomycin (10 mcg/disc). *Ficus hispida* fruit suppresses Gram-positive *Staphylococcus aureus* and Gram-negative *E. coli* with inhibitory areas greater than 13 mm. The ethyl acetate extract was found to be more susceptible than the conventional antibiotics streptomycin (10 mcg/disc) and chloramphenicol (30 mcg/disc). When analyzed for antifungal efficacy against *Aspergillus niger*, the extract likewise demonstrated an inhibitory effect [51]. Wu et al. [61] discovered a significant relationship between the hydrophobicity and antibacterial activity for its action on Gram-negative bacteria membranes.

The compounds listed above could provide new leads for the development of pharmaceutically acceptable antibacterial agents. However, more research is needed to determine the mechanism of antibacterial action.

3.3. Antidiabetic Activity. Diabetes mellitus, characterized by hyperglycemia and insulin resistance, is occurring in a very important form, and is causing epidemic progress in many regions of the world [62]. The global prevalence of type 2 diabetes (T2D) is rapidly increasing, with a projected global prevalence of 552 million by 2030 [63]. Fruits and vegetables are both nutritional vital components of a healthy diet, and they are considered to have an important role in the prevention of T2D. Higher fruit intake -associated gut microbiota and metabolic changes were linked to a reduced incidence of T2D, lending credence to the public dietary guideline of eating more fruits for T2D prevention [64].

Fruit of figs has potential antidiabetic and anti-obesogenic effects as compared to the leaves and stem bark. Fig pulp may be used as an effective treatment to regulate abnormal carbohydrate metabolism associated with diabetes and hyperglycemia [65]. Tannins from *Ficus racemosa* were investigated for their ability to protect the lipid profile and antioxidant parameters in rats that were fed a high-fat diet and streptozotocin-induced hypercholesterolemia-associated diabetes. The *Ficus racemosa* tannin fraction successfully reversed the increased hyperglycemia, cholesterol levels, triglycerides, low-density lipoprotein, and significantly restored serum triglyceride levels. Furthermore, tannins significantly restored the activity of antioxidative enzymes peroxidase and catalase while decreasing glutathione peroxidase and glutathione, restoring the antioxidant state of the organs to normal levels [66]. The aqueous decoction of fig leaves has been shown to reduce total cholesterol and the total cholesterol/HDL cholesterol ratio, indicating that fig extract has a clear hypoglycemic effect. Because such an effect cannot be facilitated by steadily increasing insulin secretion, an undefined insulin-like peripheral effect may be recommended [67]. The addition of fig to the diet of insulin diabetes mellitus patients may aid in the control of postprandial glycemia [68].

Ficus religiosa extract at 50 and 100 mg/kg showed significant reductions in blood glucose levels in normal glucose-loaded hyperglycemic and streptozotocin (STZ)-induced diabetic rats, and its effects were compared to glibenclamide, an established hypoglycemic medication. When a phytosterol isolated from *Ficus religiosa* root bark was administered orally to fasting rabbits at a dosage of 25 mg/kg, it generated a maximum drop in blood sugar level comparable to 81 percent of the tolbutamide stand after 4 hours [1].

Although several *in vivo* models have been successfully introduced to evaluate the antidiabetic effects of isolated compounds, due to the differences in the system, these compounds may not be effectively evaluated. There may be lower blood glucose levels in diabetic patients. Therefore, detailed studies of these active ingredients are still warranted to identify diabetes drugs that are more effective with mild or no side effects [69].

3.4. Anti-Inflammatory Activity. Inflammation usually develops when infectious microorganisms, such as bacteria or viruses, enter the body, are present in certain tissues, or

circulate through the blood [70]. Inflammation can develop in response to a variety of activities, including tissue injury, cell death, tumor, and ischemia degeneration. In most situations, both innate and adaptive immune responses contribute to inflammation development [71]. The 300 mg of ethanol extract and 600 mg/kg/day petroleum ether extracts of figs substantially exceeded carrageenan-induced rat paw edema ($P < 0.05$). Ethanol and petrol have anti-inflammatory effects found in the hydroalcoholic extract of *Ficus carica*. This anti-inflammatory activity of the fig fruit could be due to the presence of steroids and phytochemicals. The phytochemicals showed the presence of anti-inflammatory effects in fig [72]. The anti-inflammatory activity of *Ficus racemosa* is studied by [57] in a model of rat hind leg edema induced by histamine, serotonin, dextran, and carrageenan. At the doses of 200 and 400 mg/kg, the extract showed anti-inflammatory activity. The effect produced by the extract is equivalent to that of phenylbutazone extract that show anti-inflammatory activity at doses of 200 and 400 mg/kg, and the results were found to be significantly equivalent to phenylbutazone, a prototype of a nonsteroidal anti-inflammatory agent and the ether extract show great anti-inflammatory effects as compared with standard drug indomethacin. The results show that the ethanol extract of the banyan tree showed more significant activity than petroleum ether in treating inflammation [73]. Various extracts (ethyl acetate, petroleum ether, ethanol, and chloroform) of *Ficus lacor* aerial root have significant anti-inflammatory activity comparable to standard drugs (indomethacin and pyrillamine) using carrageenan, histamine, and serotonin-induced paw edema in animal models. The ethanol extract (100 mg/kg) show significant anti-inflammatory activity of 75.40, 68.72, and 74.01% with carrageenan, serotonin, and histamine-induced rat paw edema, respectively [74].

3.5. Hepatoprotective Activity. The liver is the first major organ to be exposed to ingested toxins due to its portal blood supply and toxins may be, at least partially, cleared from the circulation during the first pass, protecting other organs while increasing the likelihood of hepatic damage [70]. With CCl₄ administration, the methanolic and petroleum ether extract of *Ficus racemosa* stem bark induced a significant decrease in serum total protein, albumin, urea, and a significant increase in total bilirubin, as well as a marked increase in the activities of aspartate, aminotransferase, alanine, aminotransferase, and alkaline phosphatase. In nearly normal mice, pretreatment with petroleum ether extract and methanolic extract of *Ficus racemosa* resulted in significant recovery of total protein and albumin [75].

Channabasavaraj et al. [76] studied the hepatoprotective activity of methanolic extract evaluated in rats at doses of 250 and 500 mg/kg to prevent liver damage caused by carbon tetrachloride, with silymarin as a standard. Compared to control rats in serum, liver, and kidney treated with carbon tetrachloride, it showed that all biochemical parameters were significantly reversed. In acute toxicity tests, the methanol extract of the bark was

shown to be safe up to 5,000 mg/kg body weight. As a result of its safety and powerful action, it is good to use this extract in the herbal preparations owing to its hepatoprotective and antioxidant qualities, as well as its active components that must be isolated. Methanol extracts of *Ficus hispida* leaves, given orally at 400 mg/kg, can prevent paracetaminduid hepatotoxicity by lowering blood levels of transaminase, bilirubin, and alkaline phosphatase. Histological profiles in paracetamol-treated mice revealed centrilobular necrosis in the liver, including infiltration of lymphocytes and Kupffer cells, fatty alterations, and ballooning degeneration. *Ficus hispida* leaves can help avoid paracetaminduid liver toxicity by decreasing bilirubin, transaminase, and alkaline phosphatase levels in the blood. Histological profiles of paracetamol-treated mice revealed centrilobular necrosis in the liver, including lymphocyte and Kupffer cell invasion, inflating degeneration, and fatty alterations. On the other hand, these effects were mitigated by *Ficus hispida* leaves extract [77]. Although the pharmacological antioxidative activity of these agents has indeed been evaluated in animal studies, additional research into the potential mechanism of hepatoprotective intervention is required.

4. Health Benefits

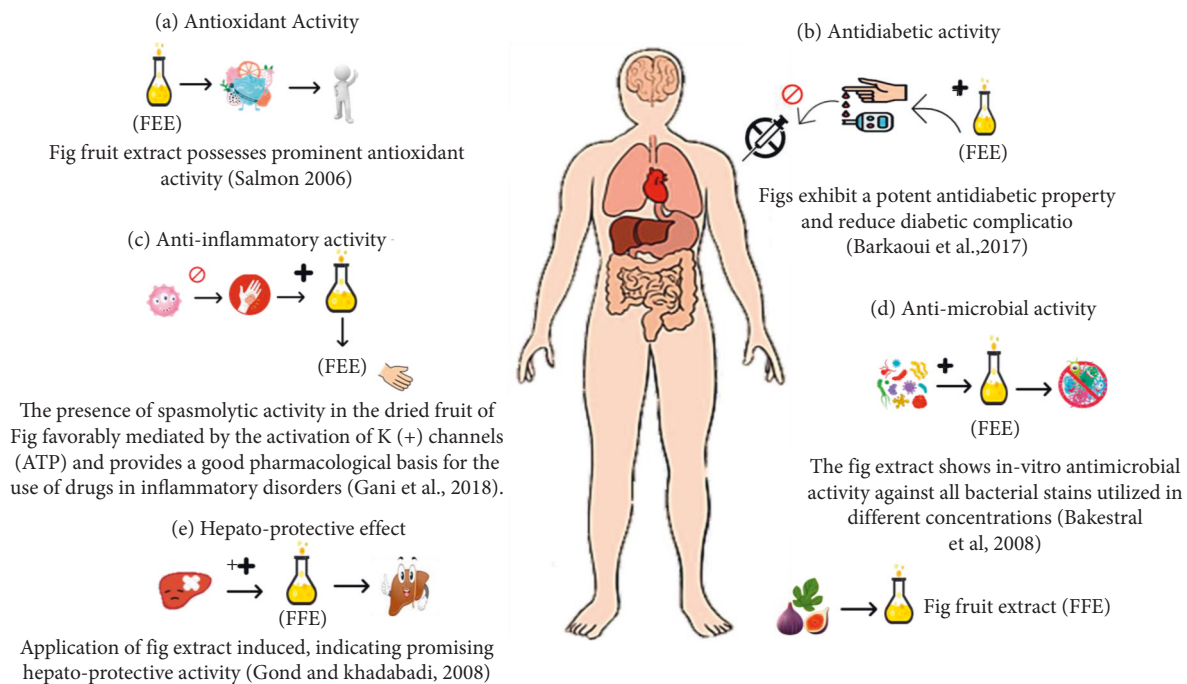
Ficus species have been used in traditional medicine for a wide range of ailments in varied geographical locations. The health benefits of fig and its various bioactive compounds are listed below in Table 7 and Figure 1. *Ficus carica* fruits, when utilized properly, can serve as a source of flavonoids, dietary polyphenols, tocopherols, and ascorbic acids, all of which are good sources of antioxidants with a wide range of biological advantages, and thus their consumption should be stimulated [18]. *Ficus sycomorus* extract can offer scientific support for its traditional use for the treatment of sickle cell disease [34]. Figs have health-promoting potential due to their high phenolic content [84]. The latex of fresh fig could treat warts, toothache, hemorrhoids, cough, and be used externally or internally for cancer and other tumors treatment [33, 85].

The *Ficus benghalensis* plant has a high nutritional value and mineral content, indicating that it has therapeutic potential and extracts that may be utilized in pharmaceutical formulations. These plant seeds might be investigated as a feasible supplement and quick supply of dietary minerals in human meals to combat a variety of illness [17]. *Ficus carica* may be utilized as nutraceutical food with good nutrition and therapeutic benefits due to its high antioxidant potential [86].

The fruits of *Ficus sycomorus* are utilized as a significant medicinal herb and food which is employed to cure fungal infections, jaundice, and dysentery. Besides, it is appropriate for the treatment of cough, skin infections, stomach disorders, helminthiasis, liver disease, epilepsy, lactation disorders, *tuberculosis*, infertility, and sterility. Figs are a good source of calcium and potassium. These minerals can work together to improve bone density which presents osteoporosis [41]. Figs are fat-free, sodium-free, and like other plant

TABLE 7: Health benefits of bioactive compounds present in *Ficus* species.

Compound	Use and health benefits	References
Kaempferol	Antioxidant defense against free radicals decreases the risk of persistent diseases, particularly cancer	Villejo et al., [43], El-Moatafa et al., [78]
Myricetin	Cytoprotective and antioxidative effects against cancer-causing activities, antiviral, and anti-microbial properties	Vaya and Mahamood, [48]
Quercetin	Antioxidants improve normal cell endurance, antibacterial, anti-inflammatory, and muscle relaxing properties	Taviano et al., [79]
Luteolin	Natural and pharmacological activities include the anti-inflammatory, antioxidant possible value in treating atherosclerosis	Taviano et al., [79]
Iso-hemnetin	Intermediate quercetin antioxidant, the antitumor activity of human hepatocellular cancer cells, prevents endothelial cell injuries brought about by oxidized low thickness lipoprotein	El-Mostafa et al., [78]
Chlorogenic acid	Antioxidant, anti-inflammatory, cardioprotective, antiobesity properties	Taviano et al., [79], Veberic et al., [4]
Lutein	Nonprovitamin-A carotenoid antioxidant in the retina, shielding the eye from irritation and oxidative stress	Flores et al., [29]
Zeaxanthin	Strong antioxidant and prooxidant conduct as well as anti-inflammatory effects, suppresses oxidative stress in the retinal tissue	Ouchemoukh et al., [27], and Yemis et al., [11]
β -cryptoxanthin	The antecedent of vitamin A may help to prevent free radical damage to biomolecules, and prevention, and treatment of certain tumors	Ouchenoukh et al., [28]
Rutin	Rutin can help strengthen and increase flexibility in blood vessels, can prevent the formation of blood clots, can help lower LDL cholesterol, and reduce arthritis pain	(Viuda-martos et al., [2])

FIGURE 1: Bioactivities of *Ficus* species [80–83].

foods cholesterol-free. Diabetes and high blood pressure can be treated with *Ficus pumila*, which works as herbal medicine and is also used for different kinds of beverages [51]. *Ficus racemosa* phytochemical screening revealed that the methanolic extract contains biologically active constituents such as saponins, phenols, tannins, saponins, flavonoids, phenols, flavonoids, and terpenoids with high medicinal value. The methanolic extract also seems to have cytotoxic activity and it might be a better treatment for tumors and cancer [42].

Crude extracts and phytochemical components from numerous *Ficus* species have been demonstrated in recent research to have antidiabetic effects in a range of in vitro and in vivo systems. The streptozotocin- and alloxan-induced diabetic mice compounds isolated from *Ficus* species substantially decreased all diabetes-related issues. Some of the most important antidiabetic actions of *Ficus* species have been shown to improve insulin sensitivity, stimulate insulin secretion, promote hepatic glycogen synthesis, reduce carbohydrate absorption, regulate enzymatic activity in the

intestinal tract, increase hepatic glucose production, and improve antioxidant capacity [87].

Ficus religiosa (Family; Moraceae) is utilized in the conventional system of medication for the treatment of various disorders. It is an herb that is determined in the old sacred writings of Homeopathy Siddha, Ayurveda, and Unani. Different parts of fig trees such as bark, root, leaf, fruits, and latex are appropriate for the treatment of different kinds of diseases such as astringent, diarrhea, diabetes, hemoptysis, carminative, vermifuge, and antidyentery. It is likewise utilized as a remedy for inordinate hunger. It is used topically to treat skin wounds, lymphadenitis, sprains, and fibrositis [1] Hence, this review provides a logical premise for additional investigations in relationship with the advancement of viable pharmacological drugs from the *Ficus* species.

5. Application in the Food Industry

Fig is extremely sweet, squishy, succulent, luscious, and fleshy, and the fruit paste used as a natural sweetener is a healthier option than corn syrup or sucrose. It can be made into delectable jams. Fig fruits can be prepared in various ways either peeled or unpeeled, relying on the cooking procedure. Puddings, cakes, fig pies, smoothies, milkshakes, custards, or other bakery products are easily prepared from fig. Fig fruits also can be used in frozen dessert mixtures. Home producers preserve entire fruit in syrup or prepare them as fig paste (with added wheat and corn flour, whey, syrup, oils, and other ingredients), jam, and marmalade, which are used as a tempting filling in different bakery products [88].

Due to the functional properties associated with these compounds, fig fruit coproducts are rich in polyphenolic compounds that may be reused by food enterprises as a distinguishing feature for the conception and formulation of functional foods [2]. Dried figs are accessible in various consumer and industrial products, including pasta, nuggets, powder, concentrate, and diced forms. Ice cream, yogurt, desserts, and porridge can all be topped with dried fig puree [84]. Fermented and unfermented different ranges of food products can be prepared by using fig fruit. In fermented food products, it can be utilized to produce wine and vinegar whereas, it tends to be utilized in its raw form or dried form in non-fermented food products [89].

6. Conclusion and Future Prospects

Fig is a primitive food that accompanies man from previous times. Either wild or cultivated, the different species of figs continue to provide nourishment to people around the world. *Ficus* species include a variety of bioactive substances with functional characteristics of industrial relevance, including carotenoids, phenolic compounds, flavonoids, vitamins, and antioxidant activity. The research has shown that fig fruit additionally reveals an extremely good composition of bioactive compounds. In vivo and in vitro experiments on human molecular strains together with the

animal version the usage of fig fruit/leaves extract has proved its useful impact as anticancer, antidiabetic, antioxidant, antimicrobial, and anti-inflammatory. Based on the dietary bioactivities, this evaluation additionally highlighted the capacity utilization of fig fruit. The multidisciplinary research interventions have facilitated the conversion of underutilized fig fruit into healthy ingredients in the food sector. However, further research is needed to understand the biologically active molecular mechanisms of fig fruits. More exploration for the pharmacological activity and safety of certain fig compounds of fig fruit for food and plasma applications is required. Clinical trials of fig-based products on humans increase the potential of the food, pharmaceutical, and cosmetics industries. We strongly believe that the detailed information presented in this review of the various therapeutic effects of the constituents can provide detailed evidence of the use of the plant in various drugs. The fig fruits, if properly utilized, can be a potential source of bioactive compounds that are significant for human utilization and therefore their consumption should be stimulated. Figs establish a magnificent alternative as dried fruits or as food in several forms.

- (i) Figs are underutilized crops, have a low shelf life, and are rich in nutrients; hence, by applying the food processing techniques they can be used for the preparation of many value-added products.
- (ii) Figs also help in managing various skin conditions as it has a moisturizing effect which helps in reducing hyperpigmentation, acne, and wrinkles. It can help in making beauty products and figs can also be used for strengthening and improving hair quality.
- (iii) Figs can be used as a staple ingredient in preparing smoothies, juices, and jams in the food industry.

Data Availability

All data pertaining to this work are provided in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Supplementary Materials

Supplementary Graphical abstract: *Ficus* fruit species, extraction of bioactive compounds from *Ficus* fruit, health benefits associated *Ficus* fruit, and possible industrial applications of fig as a valuable source of functional ingredients. (*Supplementary Materials*)

References

- [1] R. K. Jangde, "Plant profile officus religosa: a review," *Research Journal of Science and Technology*, vol. 7, no. 4, p. 193, 2015.

- [2] M. Viuda-Martos, X. Barber, J. A. Pérez-Álvarez, and J. Fernández-López, "Assessment of chemical, physico-chemical, techno-functional and antioxidant properties of fig (*Ficus carica* L.) powder co-products," *Industrial Crops and Products*, vol. 69, pp. 472–479, 2015.
- [3] S. Ercisli, M. Tosun, H. Karlidag, A. Dzubur, S. Hadziabulic, and Y. Aliman, "Color and antioxidant characteristics of some fresh fig (*Ficus carica* L.) genotypes from northeastern Turkey," *Plant Foods for Human Nutrition*, vol. 67, no. 3, pp. 271–276, 2012.
- [4] R. Veberic, M. Colaric, and F. Stampar, "Phenolic acids and flavonoids of fig fruit (*Ficus carica* L.) in the northern Mediterranean region," *Food Chemistry*, vol. 106, no. 1, pp. 153–157, 2008.
- [5] Y.-X. Shi, Y.-K. Xu, H.-B. Hu, Z. Na, and W.-H. Wang, "Preliminary assessment of antioxidant activity of young edible leaves of seven *Ficus* species in the ethnic diet in Xishuangbanna, Southwest China," *Food Chemistry*, vol. 128, no. 4, pp. 889–894, 2011.
- [6] H. Nawaz, R. Waheed, and M. Nawaz, "Phytochemical composition, antioxidant potential, and medicinal significance of *Ficus*," *Modern Fruit Industry*, vol. 1–20, 2020.
- [7] P. Deep, K. A. Singh, M. T. Ansari, and P. Raghav, "Pharmacological potentials of *Ficus racemosa* – a review," *International Journal of Pharmaceutical Sciences Review and Research*, vol. 22, no. 1, pp. 29–34, 2013.
- [8] J. J. K. Bankeu, R. Khayala, B. N. Lenta et al., "Isoflavone dimers and other bioactive constituents from the figs of *Ficus mucosa*," *Journal of Natural Products*, vol. 74, no. 6, pp. 1370–1378, 2011.
- [9] B. Moraceae, Q. Yannick, S. F. Fongang et al., "Phytochemistry Letters Flavonoids and other bioactive constituents from *Ficus thonningii*," *Phytochemistry Letters*, vol. 1–7, 2014.
- [10] A. Solomon, S. Golubowicz, Z. Yablowicz et al., "Antioxidant activities and anthocyanin content of fresh fruits of common fig (*Ficus carica* L.)," *Journal of Agricultural and Food Chemistry*, vol. 54, no. 20, pp. 7717–7723, 2006.
- [11] O. Yemiş, E. Bakkalbaşı, and N. Artik, "Changes in pigment profile and surface colour of fig (*Ficus carica* L.) during drying," *International Journal of Food Science and Technology*, vol. 47, no. 8, pp. 1710–1719, 2012.
- [12] B. R. Sharma, V. Kumar, S. Kumar, and P. S. Panesar, "Microwave assisted extraction of phytochemicals from *Ficus racemosa*," *Current Research in Green and Sustainable Chemistry*, vol. 3, no. September, Article ID 100020, 2020.
- [13] C. F. Fasakin, C. C. Udenigwe, and R. E. Aluko, "Antioxidant properties of chlorophyll-enriched and chlorophyll-depleted polyphenolic fractions from leaves of *vernonia amygdalina* and *gongronema latifolium*," *Food Research International*, vol. 44, no. 8, pp. 2435–2441, 2011.
- [14] I. N. Tomita, A. Manzoli, F. L. Fertonani, and H. Yamanaka, "Amperometric biosensor for ascorbic acid," *Eclética Química*, vol. 30, no. 2, pp. 37–43, 2005.
- [15] A. V. Carvalho, R. de Andrade Mattietto, A. de Oliveira Rios, R. de Almeida Maciel, K. S. Moresco, and T. C. de Souza Oliveira, "Bioactive compounds and antioxidant activity of pepper (*Capsicum* sp.) genotypes," *Journal of Food Science & Technology*, vol. 52, no. 11, pp. 7457–7464, 2015.
- [16] M. Rodríguez-Ruiz, R. M. Mateos, V. Codesido, F. J. Corpas, and J. M. Palma, "Characterization of the galactono-1,4-lactone dehydrogenase from pepper fruits and its modulation in the ascorbate biosynthesis. Role of nitric oxide," *Redox Biology*, vol. 12, pp. 171–181, 2017.
- [17] V. Govindan and F. G. Shoba, "Determination of nutritive value and mineral elements of *Ficus benghalensis* linn. seed," *Asian Journal of Pharmaceutical and Clinical Research*, vol. 8, no. 4, pp. 156–159, 2015.
- [18] M. Sirajo, "Ascorbic acid, total polyphenols and antioxidant activity of *Ficus carica* fruits," *Journal of Food Chemistry and Nutrition*, vol. 6, no. 1, pp. 21–27, 2018.
- [19] G. Pande and C. C. Akoh, "Organic acids, antioxidant capacity, phenolic content and lipid characterisation of Georgia-grown underutilized fruit crops," *Food Chemistry*, vol. 120, no. 4, pp. 1067–1075, 2010.
- [20] M. R. S. Campos, K. R. Gómez, Y. M. Ordoñez, and D. B. Ancona, "Polyphenols, ascorbic acid and carotenoids contents and antioxidant properties of habanero pepper (*capsicum chinense*) fruit," *Food and Nutrition Sciences*, vol. 04, no. 08, pp. 47–54, 2013.
- [21] C. F. Adams and M. Richardson, "Nutritive Value of Foods (No. 72)," *Department of Agriculture, Agricultural Research Service, Consumer and Food Economics Institute, Washington D.C., USA*, p. 72, 1977.
- [22] Q. Su, K. Rowley, C. Itsiopoulos, and K. O'Dea, "Identification and quantitation of major carotenoids in selected components of the Mediterranean diet: green leafy vegetables, figs and olive oil," *European Journal of Clinical Nutrition*, vol. 56, no. 11, pp. 1149–1154, 2002.
- [23] A. Del Caro and A. Piga, "Polyphenol composition of peel and pulp of two Italian fresh fig fruits cultivars (*Ficus carica* L.)," *European Food Research and Technology*, vol. 226, no. 4, pp. 715–719, 2008.
- [24] M. Dueñas, J. J. Pérez-Alonso, C. Santos-Buelga, and T. Escribano-Bailón, "Anthocyanin composition in fig (*Ficus carica* L.)," *Journal of Food Composition and Analysis*, vol. 21, no. 2, pp. 107–115, 2008.
- [25] R. Veberic and M. Mikulic-Petkovsek, "Phytochemical composition of common fig (*Ficus carica* L.) cultivars," in *Nutritional Composition of Fruit Cultivars* Elsevier, Amsterdam, Netherlands, 2015.
- [26] F. C. Stintzing and R. Carle, "Functional properties of anthocyanins and betalains in plants, food, and in human nutrition," *Trends in Food Science & Technology*, vol. 15, no. 1, pp. 19–38, 2004.
- [27] S. Ouchemoukh, S. Hachoud, H. Boudraham, A. Mokrani, and H. Louaileche, "Antioxidant activities of some dried fruits consumed in Algeria," *Lebensmittel-Wissenschaft und -Technologie- Food Science and Technology*, vol. 49, no. 2, pp. 329–332, 2012.
- [28] N. Amessis-Ouchemoukh, S. Ouchemoukh, N. Meziant et al., "Bioactive metabolites involved in the antioxidant, anticancer and anticalpain activities of *Ficus carica* L., *Ceratonia siliqua* L. and *Quercus ilex* L. extracts," *Industrial Crops and Products*, vol. 95, pp. 6–17, 2017.
- [29] M. E. Jaramillo-Flores, L. González-Cruz, M. Cornejo-Mazón, L. Dorantes-álvarez, G. F. Gutiérrez-López, and H. Hernández-Sánchez, "Effect of thermal treatment on the antioxidant activity and content of carotenoids and phenolic compounds of cactus pear cladodes (*opuntia ficus-indica*)," *Food Science and Technology International*, vol. 9, no. 4, pp. 271–278, 2003.
- [30] I. Juárez, I. A. Ludwig, E. Huarte et al., "Influence of heat treatment on antioxidant capacity and (poly)phenolic compounds of selected vegetables," *Food Chemistry*, vol. 197, pp. 466–473, 2016.
- [31] A. L. B. Dias, C. S. Arroio Sergio, P. Santos, G. F. Barbero, C. A. Rezende, and J. Martínez, "Effect of ultrasound on the

- supercritical CO₂ extraction of bioactive compounds from dedo de moça pepper (*Capsicum baccatum* L. var. pendulum),” *Ultrasonics Sonochemistry*, vol. 31, pp. 284–294, 2016.
- [32] H. Kelebek and S. Selli, “Characterization of phenolic compounds in strawberry fruits by RP-HPLC-DAD and investigation of their antioxidant capacity,” *Journal of Liquid Chromatography & Related Technologies*, vol. 34, no. 20, pp. 2495–2504, 2011.
- [33] A. M. Abdel-Aty, M. B. Hamed, W. H. Salama, M. M. Ali, A. S. Fahmy, and S. A. Mohamed, “Ficus carica, Ficus sycomorus and Euphorbia tirucalli latex extracts: phytochemical screening, antioxidant and cytotoxic properties,” *Biocatalysis and Agricultural Biotechnology*, vol. 20, no. June, Article ID 101199, 2019.
- [34] A. Ramde-Tiendrebeogo, A. Tibiri, A. Hilou et al., “Antioxidative and antibacterial activities of phenolic compounds from Ficus sur Forssk. and Ficus sycomorus L. (Moraceae): potential for sickle cell disease treatment in Burkina Faso,” *International Journal of Brain and Cognitive Sciences*, vol. 6, no. 1, pp. 328–336, 2012.
- [35] M. Hakimian, M. A. Syed, A. Syahida, and M. Maziah, “Total antioxidant, polyphenol, phenolic acid, and flavonoid content in Ficus deltoidea varieties,” 2016.
- [36] A. Slatnar, U. Klančar, F. Stampar, and R. Veberic, “Effect of drying of figs (*Ficus carica* L.) on the contents of sugars, organic acids, and phenolic compounds,” *Journal of Agricultural and Food Chemistry*, vol. 59, no. 21, pp. 11696–11702, 2011.
- [37] D. U. F. Erreira, S. Y. G. Uyot, N. A. M. Arnet et al., “Composition of phenolic compounds in a Portuguese pear (*pyrus communis* L. Var. S. Bartolomeu) and changes after sun-drying,” , 2002.
- [38] E. Devic, S. Guyot, J.-D. Daudin, and C. Bonazzi, “Kinetics of polyphenol losses during soaking and drying of cider apples,” *Food and Bioprocess Technology*, vol. 3, no. 6, pp. 867–877, 2010.
- [39] h. Hassan, E. Attia, S. Desoukey, K. Mohamed, and M. Kamel, “Quantitative analysis of total phenolic and total flavonoid constituents of some *Ficus* species,” *Journal of Advanced Biomedical and Pharmaceutical Sciences*, vol. 2, no. 1, pp. 38–40, 2019.
- [40] E.-S. S. Abdel-Hameed, “Total phenolic contents and free radical scavenging activity of certain Egyptian *Ficus* species leaf samples,” *Food Chemistry*, vol. 114, no. 4, pp. 1271–1277, 2009.
- [41] S. K. Al-matani, R. N. S. Al-Wahaibi, and M. A. Hossain, “In vitro evaluation of the total phenolic and flavonoid contents and the antimicrobial and cytotoxicity activities of crude fruit extracts with different polarities from *Ficus sycomorus*,” *Pacific Science Review A: Natural Science and Engineering*, vol. 17, no. 3, pp. 103–108, 2015.
- [42] M. Munira, M. Uddin, M. Islam, K. Aktar, and A. Muhit, “Evaluation of antioxidant, cytotoxic, antibacterial and thrombolytic activity of the methanolic extracts of *Ficus racemosa* fruits,” *Journal of Complementary and Alternative Medical Research*, vol. 5, no. 2, pp. 1–13, 2018.
- [43] F. Vallejo, J. G. Marin, and F. A. Tomás-Barberán, “Phenolic compound content of fresh and dried figs (*Ficus carica* L.),” *Food Chemistry*, vol. 130, no. 3, pp. 485–492, 2012.
- [44] J. A. Vinson, L. Zubik, P. Bose et al., “Dried fruits: excellent in vitro and in vivo antioxidants dried fruits: excellent in vitro and in vivo antioxidants,” *Journal of the American College of Nutrition*, vol. 24, 2013.
- [45] F. Chem, “Effect of ascorbic acid and dehydration on concentrations of total phenolics, antioxidant capacity , anthocyanins , and color in fruits,” pp. 4444–4447, 2005.
- [46] K. S. Jayaraman and D. K. Das Gupta, “Drying of fruits and vegetables,” *Handbook of Industrial Drying* pp. 611–636, CRC Press, Boca Raton, FL, USA, 2014, <https://doi.org/10.1201/b17208>, Fourth edition.
- [47] J. A. Ross and C. M. Kasum, “Dietary flavonoids: bioavailability, metabolic effects, and safety,” *Annual Review of Nutrition*, vol. 22, no. 1, pp. 19–34, 2002.
- [48] J. Vaya and S. Mahmood, “Flavonoid content in leaf extracts of the fig (*Ficus carica* L.), carob (*Ceratonia siliqua* L.) and pistachio (*Pistacia lentiscus* L.),” *BioFactors*, vol. 28, no. 3-4, pp. 169–175, 2006.
- [49] A. P. Oliveira, L. R. Silva, F. Ferreres et al., “Chemical assessment and in vitro antioxidant capacity of *Ficus carica* latex,” *Journal of Agricultural and Food Chemistry*, vol. 58, no. 6, pp. 3393–3398, 2010.
- [50] C. Ao, A. Li, A. A. Elzaawely, T. D. Xuan, and S. Tawata, “Evaluation of antioxidant and antibacterial activities of *Ficus microcarpa* L. fil. extract,” *Food Control*, vol. 19, no. 10, pp. 940–948, 2008.
- [51] C. N. A. Leong, M. Tako, I. Hanashiro, and H. Tamaki, “Antioxidant flavonoid glycosides from the leaves of *Ficus pumila* L.,” *Food Chemistry*, vol. 109, no. 2, pp. 415–420, 2008.
- [52] C. V. Rao, A. R. Verma, M. Vijayakumar, and S. Rastogi, “Gastroprotective effect of standardized extract of *Ficus glomerata* fruit on experimental gastric ulcers in rats,” *Journal of Ethnopharmacology*, vol. 115, no. 2, pp. 323–326, 2008.
- [53] M. Gregory, K. P. Vithalrao, G. Franklin, and V. Kalaichela, “Anti-ulcer (Ulcer-Preventive) activity of *Ficus arnottiana* miq. (Moraceae) leaf methanolic extract,” *American Journal of Pharmacology and Toxicology*, vol. 4, no. 3, pp. 89–93, 2009.
- [54] M. Sertkaya, G. Guclu, O. K. Buyukkurt, H. Kelebek, and S. Selli, “GC-MS-Olfactometric screening of potent aroma compounds in pulps and peels of two popular Turkish fig (*Ficus carica* L.) cultivars by application of aroma extract dilution analysis,” *Food Analytical Methods*, vol. 14, no. 11, pp. 2357–2366, 2021.
- [55] C. M. Chetty, *Antioxidant Properties of Ficus Species—A Review*, vol. 2, no. 4, pp. 2174–2182, 2010.
- [56] S. Benmagnhia, “Phytochemical analysis, antioxidant and antimicrobial activities of three samples of dried figs (*Ficus carica* L.) from the region of mascara,” *Journal of Microbiology, Biotechnology and Food Sciences*, vol. 9, no. 2, pp. 208–215, 2019.
- [57] S. C. Mandal, T. K. Maity, J. Das, B. P. Saba, and M. Pal, “Anti-inflammatory evaluation of *Ficus racemosa* Linn. leaf extract,” *Journal of Ethnopharmacology*, vol. 72, no. 1–2, pp. 87–92, 2000.
- [58] G. M. Balestra, A. Rossetti, and A. Quattrucci, “Biological control of kiwifruit and tomato bacterial pathogens,” in *Proceedings of the 16th IFOAM Organic World Congress*, Modena, Italy, June 2008.
- [59] S. Chandrasekar, M. Bhanumathy, A. Pawar, and T. Somasundaram, “Phytopharmacology of *Ficus religiosa*,” *Pharmacognosy Reviews*, vol. 4, no. 8, pp. 195–199, 2010.
- [60] P. K. Dubey, P. Yaduwanshi, and V. Gouttam, “*Ficus racemosa* linn- cooler A review,” *World Journal of Pharmaceutical Research*, vol. 7, no. 23, pp. 325–341, 2018.
- [61] T. Wu, M. He, X. Zang et al., “A structure-activity relationship study of flavonoids as inhibitors of *E. coli* by membrane interaction effect,” *Biochimica et Biophysica Acta (BBA) - Biomembranes*, vol. 1828, no. 11, pp. 2751–2756, 2013.

- [62] X. Qian, X. Liu, Z. Mao et al., "Fruit and vegetable intake modifies the associations between suppressor of cytokine signaling 3 genetic variants and type 2 diabetes," *European Journal of Nutrition*, vol. 59, no. 8, pp. 3441–3449, 2020.
- [63] D. R. Whiting, L. Guariguata, C. Weil, and J. Shaw, "IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030," *Diabetes Research and Clinical Practice*, vol. 94, no. 3, pp. 311–321, 2011.
- [64] Z. Jiang, T. Y. Sun, Y. He et al., "Dietary fruit and vegetable intake, gut microbiota, and type 2 diabetes: results from two large human cohort studies," *BMC Medicine*, vol. 18, no. 1, pp. 371–411, 2020.
- [65] M. Barkaoui, A. Katiri, H. Boubaker, and F. Msanda, "Ethnobotanical survey of medicinal plants used in the traditional treatment of diabetes in Chtouka Ait Baha and Tiznit (Western Anti-Atlas), Morocco," *Journal of Ethnopharmacology*, vol. 198, pp. 338–350, 2017.
- [66] R. Velayutham, N. Sankaradoss, and K. N. Ahamed, "Protective effect of tannins from *Ficus racemosa* in hypercholesterolemia and diabetes induced vascular tissue damage in rats," *Asian Pacific Journal of Tropical Medicine*, vol. 5, no. 5, pp. 367–373, 2012.
- [67] P. M. Guarrera, "Traditional phytotherapy in Central Italy (marche, abruzzo, and latium)," *Fitoterapia*, vol. 76, no. 1, pp. 1–25, 2005.
- [68] G. Gani, T. Fatima, T. Qadri, N. Jan, and O. Bashir, "Phytochemistry and pharmacological activities of fig (*Ficus carica*): a review," *International Journal of Research in Pharmacy and Pharmaceutical Sciences*, vol. 3, no. 2, pp. 80–82, 2018.
- [69] M. Devansh, "Review on *Ficus racemosa* *Ficus racemosa* linn.—a review on experimental lead approach," *International Journal of Pharmaceutical Sciences Review and Research*, vol. 22, 2018.
- [70] D. Artis and H. Spits, "The biology of innate lymphoid cells," *Nature*, vol. 1–9, 2015.
- [71] S. M. Lucas, N. J. Rothwell, and R. M. Gibson, "The role of inflammation in CNS injury and disease," *British Journal of Pharmacology*, vol. 147, no. SUPPL. 1, pp. 232–240, 2006.
- [72] V. V. Patil and V. R. Patil, "Evaluation of anti-inflammatory activity of *Ficus carica* Linn. leaves," *Indian Journal of Natural Products and Resources*, vol. 2, no. 2, pp. 151–155, 2011.
- [73] S. T. Gopukumar and P. K. Praseetha, "*Ficus benghalensis* Linn – the sacred Indian medicinal tree with potent pharmacological remedies," *International Journal of Pharmaceutical Sciences Review and Research*, vol. 32, no. 1, pp. 223–227, 2015.
- [74] P. Ghimire, S. Pandey, A. C. Shrestha, and A. Chandra Shrestha, "A comprehensive review on phytochemical, pharmacognostical properties and pharmacological activities of *Ficus lacor* L. (Moraceae)," *International Journal of Herbal Medicine*, vol. 8, no. 5, pp. 96–102, 2020.
- [75] F. Ahmed and A. Urooj, "Hepatoprotective effects of *Ficus racemosastem* bark against carbon tetrachloride-induced hepatic damage in albino rats," *Pharmaceutical Biology*, vol. 48, no. 2, pp. 210–216, 2010.
- [76] K. P. Channabasavaraj, S. Badami, and S. Bhojraj, "Hepatoprotective and antioxidant activity of methanol extract of *Ficus glomerata*," *Journal of Natural Medicines*, vol. 62, no. 3, pp. 379–383, 2008.
- [77] S. C. Mandal and C. K. Ashok Kumar, "Studies on anti-diarrhoeal activity of *Ficus hispida*. Leaf extract in rats," *Fitoterapia*, vol. 73, no. 7–8, pp. 663–667, 2002.
- [78] M. B. Bey, H. Louaileche, and S. Zemouri, "Optimization of phenolic compound recovery and antioxidant activity of light and dark dried fig (*Ficus carica* L.) varieties," *Food Science and Biotechnology*, vol. 22, no. 6, pp. 1613–1619, 2013.
- [79] M. F. Taviano, K. Rashed, A. Filocamo et al., "Phenolic profile and biological properties of the leaves of *Ficus vasta* Forssk. (Moraceae) growing in Egypt," *BMC Complementary and Alternative Medicine*, vol. 18, no. 1, pp. 161–211, 2018.
- [80] M. Ali and N. Chaudhary, "*Ficus hispida* Linn.: a review of its pharmacognostic and ethnomedicinal properties," *Pharmacognosy Reviews*, vol. 5, no. 9, pp. 96–102, 2011.
- [81] M. A. Farag, I. E. Sallam, M. I. Fekry, S. S. Zaghoul, and R. S. El-Dine, "Metabolite profiling of three *Opuntia ficus-indica* fruit cultivars using UPLC-QTOF-MS in relation to their antioxidant potential," *Food Bioscience*, vol. 36, Article ID 100673, 2020.
- [82] N. Gond and S. Khadabadi, "Hepatoprotective activity of *Ficus carica* leaf extract on rifampicin-induced hepatic damage in rats," *Indian Journal of Pharmaceutical Sciences*, vol. 70, no. 3, pp. 364–366, 2008.
- [83] M. S. A. Khan, S. A. Hussain, A. M. M. Jais, Z. A. Zakaria, and M. Khan, "Anti-ulcer activity of *Ficus religiosa* stem bark ethanolic extract in rats," *Journal of Medicinal Plants Research*, vol. 5, no. 3, pp. 354–359, 2011.
- [84] M. I. Barolo, N. Ruiz Mostacero, and S. N. López, "*Ficus carica* L. (Moraceae): an ancient source of food and health," *Food Chemistry*, vol. 164, no. April, pp. 119–127, 2014.
- [85] M. L. C. Caxito, C. P. Victório, H. B. Costa, R. M. Kuster, and C. R. Gattass, "Antiproliferative activity of extracts of *Euphorbia tirucalli* L. (Euphorbiaceae) from three regions of Brazil," *Tropical Journal of Pharmaceutical Research*, vol. 16, no. May, pp. 1013–1020, 2017.
- [86] N. Soni, S. Mehta, G. Satpathy, and R. K. Gupta, "Estimation of nutritional, phytochemical, antioxidant and antibacterial activity of dried fig (*Ficus carica*)," *Journal of Pharmacognosy and Phytochemistry*, vol. 3, no. 2, pp. 158–165, 2014.
- [87] P. Deepa, K. Sowndhararajan, S. Kim, and S. J. Park, "A role of *Ficus* species in the management of diabetes mellitus: a review," *Journal of Ethnopharmacology*, vol. 215, pp. 210–232, 2018.
- [88] I. J. Pharm, P. Res, and P. Aspects, "*Ficus carica* Linn.: a review on its pharmacognostic, phytochemical and pharmacological aspects," *International Journal of Pharmaceutical and Phytopharmacological Research*, vol. 1, no. 4, pp. 215–232, 2012.
- [89] G. K. Chaware, V. Kumar, S. Kumar, and P. Kumar, "Bioactive compounds, pharmacological activity and food application of *Ficus racemosa*: a critical review," *International Journal of Fruit Science*, vol. 20, no. S2, pp. S969–S986, 2020.