



African Journal of Biological Sciences



Bioactive Compounds in Different Fruits and Fruit products- their role and medicinal benefits

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Abstract

This review paper explores the roles and medicinal benefits of diverse bioactive compounds found in various fruits and fruit products. Fruits are abundant sources of phytochemicals such as polyphenols, flavonoids, carotenoids, vitamins, and minerals, which contribute significantly to their nutritional value and health-promoting properties. The bioactive compounds present in fruits exhibit antioxidant, anti-inflammatory, anti-cancer, anti-diabetic, and cardiovascular protective effects, among others. This paper discusses the specific bioactive compounds present in different fruits and fruit products, highlighting their mechanisms of action and potential therapeutic applications. Furthermore, the review emphasizes the importance of consuming a diverse range of fruits to harness the collective benefits of these bioactive compounds for overall health and disease prevention. By elucidating the roles and medicinal benefits of bioactive compounds in fruits, this paper aims to contribute to the growing body of knowledge on functional foods and their implications for human health and wellness.

Keywords: Bioactive compounds, flavonoids, medicinal benefits, phytochemicals, polyphenols

Introduction

Food contains critical life nutrients and bioactive chemicals that promote health and illness prevention. Our dietary recommendations include a high consumption of plant-based diets, such as 400 g or more of fruits and vegetables daily. Fruit intake is growing in the daily diet because fruits contain high quantities of physiologically engaged substances that provide health care advantages beyond basic nutrition, such as a decreased chance of stroke, cardiac problems in the coronary heart, and Certain forms of cancer. Fruits include a range of micronutrients and non-nutrient bioactive components, including vitamins, phytochemicals such as nutrients such as potassium and dietary fiber, calcium, magnesium, polyphenolic chemicals and carotenoids. More than 5,000 different while many phytochemicals are yet unknown, some have been found in fruits, vegetables, and grains. (Liu, 2013). Fruit eating has become more than simply a question of taste and personal choice; it has also become a health issue owing to the vital nutrients included in fruits. In addition to necessary components, most fruits include enormous amounts of micronutrients as example of minerals, fiber, vitamins, and secondary phenolic compounds. Bioactive compounds tend to accumulate within the fruit and vegetable skins and leaves because light triggers their production (Bernhoft *et al.*, 2010). About half of the production of tropical and subtropical fruits is sold in the fresh fruit market, with the remaining portion going into a variety of processed forms like wines, desserts, nectars, compotes, marmalades, sauces, syrups, and nibbles, with tropical fruit beverages being the most significant. (Sayago-Ayerdi *et al.*, 2021). When consumed by humans, antioxidants may in addition to acting as agents that are anti-inflammatory, anti-tumor, anti-carcinogenic, immune-stimulating, antifungal, antibacterial, cholesterol-lowering, antiviral, or anti-thrombotic, they also assist in controlling blood pressure and blood sugar levels. Fruit juice consumption affects the antioxidative state, immunological status, and DNA damage. (Bub *et al.*, 2003). Papaya, pineapple, guava, banana and mango are the most popular tropical fruits worldwide because of their brilliant color, peculiar aroma and nutritional content those kinds of fruits are shipped from subtropical and tropical regions to the United States and Europe as a result of increased demand. Customers in these marketplaces are increasingly incorporating more exotic and tropical fruits into their diets, and the excellent nutritional value of these fresh produce is another method used by producers to grow their markets. Fruit processing produces co-products that may equal or

surpass the quantity of processed products. Co-products in papaya, mango, and pineapple may account for as much as sixty percent of the fruit's total weight (Gomes *et al.*, 2018).

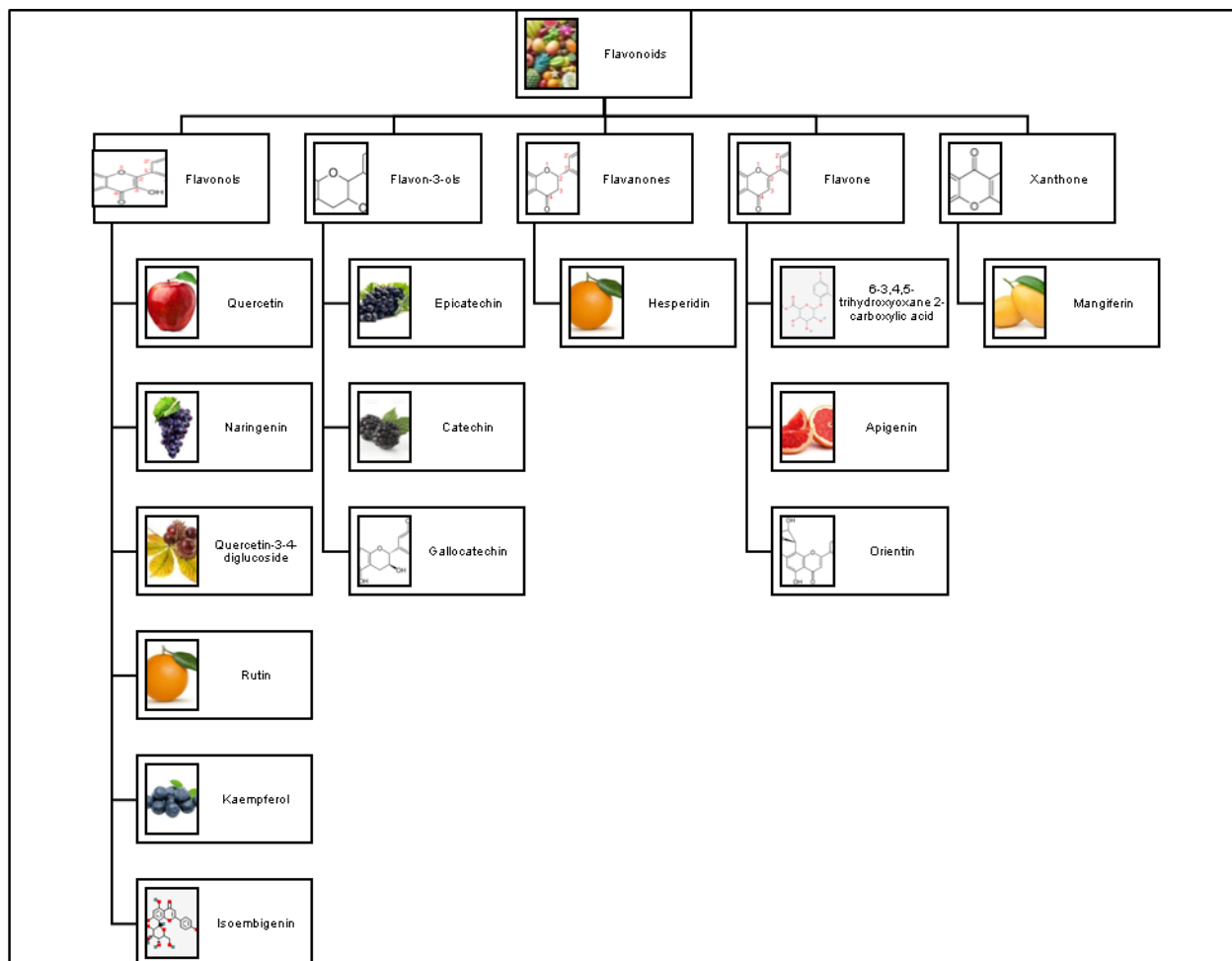


Table 1. Under Flavonoids, this table clearly displays (Flavonols, Flavon-3-ols, Flavanones, Flavone, Xanthone) along with photos.

1. Mango

Flavonoids discovered included quercetin, mangiferin, epicatechin, and catechin. In contrast, The ratio of flavonoid components in peel samples was higher compared to equivalent pulp mango cultivars, with Xiao Tainong peel and pulp having the highest fisetin level. Aozhou had the highest mangiferin level in the pulp samples according to the current weight. Shuixian peel has the greatest catechin concentration. Peel and pulp samples have different quantities of epicatechin than Fresh Weight, respectively. Various cultivars' peels Xiao Tainong, Guifei, and

Xiangya contained the highest quercetin. The pulp samples with the highest concentration of quercetin were those from the Lvsong cultivar Fresh Weight (Abbasi *et al.*, 2017).

Phenolic compounds, which are mostly present in the peels and seeds of mango fruit, are the most significant bioactive substances. The greatest levels of total phenolic flavonoids, antioxidant capacity indicated by TE, and antioxidant capacity expressed by DPPH EC50 were found in Tommy Atkins. The seed followed by peel had the highest values of all the parameters that were looked at Haden and Ataulfo (Vega *et al.*, 2013). The primary phenolic substances present in mangos include quercitrin, epicatechin, leucocyanidin, epicatechin, and chlorogenic acid (Berardini *et al.*, 2005; Schieber *et al.*, 2000). Guifei had the least amount of TP, while Tainong 1 had the most, next to Mallika, Xiaoji, Fengshunwuhe, Ao, Jinhuang, and Irwin (Ma *et al.*, 2011).

Bioactive substances include ascorbic and dehydroascorbic acids. β -carotene in flesh the flesh contain other carotenoids like Z-carotene, violaxanthin, luteoxanthin, mutatoxanthin, auroxanthin, and mutato-Flesh chrome Polyphenols include quercetin, peel, leaves, twigs, kaempferol, anthocyanins, isomangiferin, ferin, homomangiferin, and mangiferin. Phenolic acids are found in pulp, peel, seeds, coumaric, ellagic, gallic, protocatechuic, and kernel Acids (4-caffeoylquinic acids) derived from caffeine. Serpentine $Mg_3Si_2O_5(OH)_4$, D-Limonene, (Z)-Ocimene, (E)-Ocimene, α , β Terpinene, camphene, β -guaiene, β -humulene, fenchene and other compounds like Oxo-lactones are examples of terpenoids. Mineral antioxidants include potassium, pulp, peel, seed, Cu, Zn, Mn, Ferrum and Outer bark Se. Provitamin A, Epoxy-carotenoid, β -Cryptoxanthin, Neochrome, Lutein-5,6-epoxide, Zeaxanthin-3, β -diol are among the carotenoids found in mango flesh. (Ribeiro & Schieber, 2010).

2. Guava

Flavonoids, carotenoids, triterpenes, Guaiacic Acid, Guaiac Acid, Quercetin 3-O-beta-D-(6"-acetyl)glucopyranoside, Quercetin 3-O-beta-D-glucopyranoside as well as other bioactive substances, are found in guava. (-)-Epicatechin, 3,5,7,3',4'-Pentahydroxyflavone, and its Isoquercetin were discovered in Leaf, Peel, Fruit of white guava. Only the white guava leaves and peel contained quercetin-glucoside. White Guava Leaf Flavanoid and White Guava Peel Flavanoid's major groups were quercetin-pentoside. Several plant-derived substances, including rutin, naringenin, guaijaverin, isoflavonoids, gallic acid, galactose-specific lecithins, catechin,

epicatechin, and quercetin. Guava is frequently utilized for its culinary and nutritional properties. (Wanjun *et al.* 2018) published a paper titled ' Guava has bioactive chemicals in five different sections (Leaves,Flesh, Seed ,Bark,Skin). Polyphenols, Isoflavanones,3,4,5-Trihydroxybenzoic Acid,(-)-Epicatechin,Quercetin-3-rutinoside,Naringin and Kaempferide are all present in the leaves. Carotecoids and Vitamin A in pulp Isoprenoids, Phenolic compounds, Glycones are found in seeds. Bark and skin contain phenolic compounds. (Parvez *et al.*, 2018).

The High concentration of ascorbic acid, myricetin, and apigenin acid in the Fresh guava fruit makes it a strong source of antioxidants. Flavonoids, notably quercetin, are abundant in guava leaves.

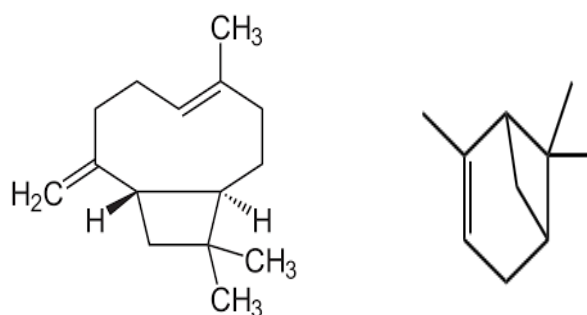


Figure 1. a) Caryophyllene

b) Pinene (Parvez *et al* 2018).

Total Phenolic Compound and Total Flavonoid Compound levels were highest in peel, then pulp extracts and seed extracts. However, the total phenolic content of peel was much higher than byproducts of guava. Furthermore, guava peels contained three times as many bioactive compounds as other portions, suggesting that they are outstanding sources of phenolics for possible beneficial processing of coproducts. 69 phenolic compounds and other polar substances in total were discovered. It was determined which phenolic chemical subclasses included Flavanols, Procyanidins, Gallotannins, Flavon-3-ols, Isoflavones, Diphenylmethanones and derivatives of Polyphenolic acids (Liu *et al.*, 2018). The fruit's roots include Flavonols,Guajaverin,3,3',4',5,7-Pentahydroxyflavone,Lyxoglucoside,Araboglucoside,Oleanic Acid, Sapogenins. Additionally, roots include sterols, 3,4,5-Trihydroxybenzoic acid and leukocyanidins. (Naseer *et al.*, 2018).

3. Papaya:

In fresh papaya, nine phenolic compounds were discovered. Gallic acid (2.41 mg 100 g1 D.M) was the only substance detected. Several studies have shown that papaya fruit contains trace amounts or low levels of phenolic compounds, however they have only recognized substances as myricetin, apigenin, coumaric acid, ferulic acid, quercetin, and kaempferol without measuring them. It's important to note that tyrosol was the predominant phenolic component detected throughout each sample of dried papaya examined, with amounts ranging from 8.55-21.01 mg 100 g1. (Gálvez *et al.*, 2019). Papaya has a lot of bioactive compounds such amines, phenolic and flavonoid molecules (Silva *et al.*, 2011). Papaya fresh pulp, spray-dried powders were shown to contain 5 Polyphenols: 3,4-Dihydroxybenzoic Acid,4-Hydroxy-3-methoxybenzoic Acid,4-Hydroxy-3-methoxycinnamicAcid,3,4-DihydroxycinnamicAcid,3,5-Diprenyl-4 hydroxycinnamic Acid .In Papaya, the main phenolic components found "Maradol" pulp were found to be 4-hydroxy-3-methoxycinnamic acid and 3,4-dihydroxycinnamic acid by (Sancho *et al.*, 2011), (Gomes *et al.*, 2018) Significant no of byproducts, mainly Peels and Seeds, are produced and discharged into the surroundings during the processing of papaya, resulting in organic pollution. Isothiocyanates and phenolic compounds, for example, are bioactive substances found in papaya seeds that may be used in nutraceutical supplements, nutritional additives, creative cuisine, and medicinal goods. (Parniakov *et al.*, 2015). The incorporation of papaya leaf flavonoids was proven to be beneficial for both improving product shelf life and retaining the nutritional characteristics of the final RTS product. (Vignesh *et al.*, 2019).

4. Lemon:

There were fifteen phenolic components in the lemon juice, with hesperidin, eriocitrin, chlorogenic acid, and neoeriocitrin being the most common. Natural cloudy lemon juice had four different types of carotenoid components: lutein, zeaxanthin, beta-carotene, and beta-cryptoxanthin. A. (Ucan *et al.*, 2016). According to (Xu *et al.*, 2008) Other studies reported that eriodictyol 7-rutinoside was the most predominant bioflavonoid in the fruit (Tripoli *et al.*, 2007). Five carotenoid components (beta-carotene, alpha-carotene, xanthophylls) were studied in inherently turbid lemon juices. Xanthophyll (lutein) and pro-vitamin A carotenoid were discovered to be the prevalent tetraterpenoid components in juice of lemon. The antioxidant beta-carotenoid pigment was not discovered in juices. (Uçan *et al.*, 2016). (*C. limon*) lemon fruit (L.)

Burn. f. contains a variety of key elemental chemicals found naturally, including polyphenols (flavones) and nutrients, in addition to alternative nutrients and Micronutrients, Phytonutrients, Volatile oils. Citrus sp. contains around 60 different flavonoids, the majority of which are classified as flavanones, flavones, or flavanols. Citrus species also include extra polyphenols. Citrus flavonoids were found as glycosides or aglycones. Therefore, flavonoids are usually present in juices as glycosides. Among the glycosyl derivatives, 2 kinds of diglucosides, or 1-rhamnosyld- glycosides, are classified flavonoid glycosides (Tripoli *et al.*, 2007).

Table 2. Exploring the Rich Tapestry of Nature: Crops and their Diverse Array of Bioactive Compounds

S.NO	Crops	Bioactive Compounds	Reference
1	Mango	Catechin, epicatechin, chlorogenic acid, quercitrin, and quercetin, Leucocyanidin	(Berardini <i>et al.</i> , 2005; Schieber <i>et al.</i> , 2000).
2	Guava	Flavonoids, triterpenes, guayavolic acid, guavanoic acid, guajadial, guajaverin, carotenoids, terpenoids.	Zhang, <i>et al</i> (2018)
3	Papaya	Amines, phenolic (protocatechuic acid, vanillic acid, ferulic acid, caffeic acid, and artepillin C) and flavonoid chemicals	Santiago <i>et al.</i> (2011),Sancho <i>et al.</i> (2011)
4	Lemon	Hesperidin, eriocitrin, chlorogenic acid, and neoeriocitrin and carotenoid compounds: beta-carotene, beta-cryptoxanthin, lutein, and zeaxanthin.	Uçan <i>et al.</i> ,(2016).

Miyake *et al.*, found two C-glucosides of flavones from the fruit in 1997: diosmetin diglucoside" and "diosmetin monoglucoside. Chrysoeriol diglucoside and 7-O-glucoside of apigenin (Gil *et al.*, 2004). However, diosmetin diglucoside is among the three flavones most found identified in lemon peels. (Baldi *et al.*, 1997). Rutin and myricetin are the two flavanols found in the greatest amounts in lemon juice. Kawaii *et al.*, (1999). Miyake *et al.*, (2007) found Feruloyl glucoside and Sinapoyl glucoside in lemon juice (Molina *et al.*, 2010). According to (Astell *et al.*, 2013), citrus fresh fruits and peels have large quantity of Phenolics and Bioflavonoids. The bulk of these bioactive substances, including Phenol compounds, Tetraterpenoids, Nitrogenous compounds, offer an antioxidant defense system. (Abeyasinghe *et al.*, 2007). Citrus fruit peels contain a greater than normal flavonoid concentration in contrast to other fruits sections (Sharif *et al.*, 2021).

Biological Effects:

Nutrition plays a major role in the prevention and treatment of many illnesses, and consumers, academics, and the food industry have all recently shown a growing interest in the possible health advantages of food items (Martos *et al.*, 2013). Numerous studies have shown a correlation between the consumption of fresh fruit and vegetables and a lower risk of socially significant illnesses as Alzheimer's disease, cancer, and cardiovascular disease. (Denev *et al.*, 2014). Food and nutrition are becoming more crucial in the preservation of health and the prevention of chronic illnesses. The demand for foods with specific health-promoting properties is steadily rising. The food industry is exploring for new raw materials to employ as bioactive ingredient sources for meals and nutraceuticals. (Yang & Liu, 2014)

Mango

The mango is the most popular and important tropical fruit in terms of commerce. It is a member of the Anarcadiceae family, which has over 70 species. In many places of the world, mangos are an important source of food. This tropical fruit has been known as the "king of fruits" because of how much consumers value its succulence, sweetness, and unique flavor (Ribeiro & Schieber, 2010). The primary product of mangos is the ripe whole fruit, which may be eaten raw or

processed into a wide range of goods. This guarantees a year-round supply of mangos and the advantages that go along with them. Green mango fruit is used to make chutney, pickles, curries, dehydrated products like dried pieces/slices, amchoor (raw mango powder), and panna (green mango beverage), while ripe fruits are used to make canned and frozen slices, pulp, concentrate, juices, nectar, jam, leather, puree, mango cereal flakes, and mango toffee, among other dried products. (Masibo and He, 2009). This trash may be handled as a specialist material due to the high concentrations of residual phenolics. It was discovered that the dietary fiber content of several mango peel varieties was 16–28% soluble, 29–50% insoluble, and 45-78% total.(Ajila *et al.*, 2007). Numerous studies on mangiferin and extracts from mango leaves, bark, and flowers have demonstrated a broad variety of pharmacological effects, including antioxidant, anticancer, antibacterial, antiatherosclerotic, antiallergenic, anti-inflammatory, analgesic, and immunomodulatory activity (Masibo and He, 2008).

Guava:

The delicious tropical fruit known as the guava (*Psidium guajava*) is often eaten uncooked. The type of the fruit is berry. A seed chamber with a mushy pericarp, soft pulp, and many tiny seeds. A projection puts the world's guava production at 500,000 metric tons. South America's leading guava-producing nations include Venezuela, Brazil, Colombia, and Mexico. Beverages, syrup, ice cream, jams, jellies, cheese, and toffee are just a few of the processed goods made from guava. (Escrig *et al.*, 2001).

For a variety of pharmacological actions, including anti-inflammatory, cough alleviation, anti-diabetic, antibacterial, hepatoprotective, anti-diarrheal, contractile, anti-hypertensive, and so forth, different sections of the plant or fruit are utilized. both analgesic and anti-inflammatory properties, characteristics that cure plaque, including anti-cancer, anti-hypertensive, anti-fungal, anti-proliferative, and antipyretic effects. antimalarial activity, spermatoprotective effect, immunomodulatory function, and spasmolytic effect (Parvez *et al.*,2018). In addition to being applied locally to heal wounds, ulcers, and skin sores, the bark infusion or decoction can be taken orally to cure dysentery and diarrhea. In addition to treating bad breath and bleeding gums, chewing the delicate leaves is said to help prevent hangovers. An oral infusion or decoction of the leaves can be used to treat a variety of conditions, including vertigo, diarrhea, dysentery, stomach disturbances, vomiting, colic, colds, fevers, headaches, dental pain, whooping cough,

cough, mouth and throat sores, and bleeding gums (Medina & Herrero 2016). Leaf extracts were also discovered to exhibit anticancer action, as well as anti-inflammatory effects, including a possible cytotoxic impact on human cervical cancer cell lines. Other characteristics have been identified, such as insecticidal and repellent properties. (Joseph and Priya, 2011).

Papaya:

Papaya is considered one of the most significant fruits because of its high concentration of antioxidants such as carotenes, vitamin C, and flavonoids, along with B vitamins like folate and pantothenic acid, minerals like potassium and magnesium, and fiber. Papain, a digestive enzyme found in papayas, is also utilized in medicines, cosmetics, beer, and beauty products. (Evans & Ballen, 2012).

Papaya skin is frequently utilized in cosmetics. Skin damage may be repaired and renewed with the aid of vitamin A. SPF and a calming obedient. To cure dandruff, massage papaya vinegar and lemon juice into the scalp for 20 minutes before showering. Papaya leaf use has a number of benefits. Therapy for Dengue Fever Papaya leaf juice has several benefits, including more platelets and white blood cells, better clotting, and liver healing. Recent studies have demonstrated that papaya leaf tea extract inhibits the growth of cancer cells. Papaya leaves are used to prepare tea that has antimalarial and antiplasmodial properties to treat malaria. The method, however, is not obvious and has not been properly validated. A phytoalexin called danielone has been discovered in papaya fruit. When tested against the papaya pathogen *Colletotrichum gloeosporioides*, this substance demonstrated significant antifungal efficacy. Indigestion The green, ripe fruit's creamy juice contains papain, an enzyme that is utilized in many gastrointestinal treatments. Eating papayas can help reduce heart attacks and strokes because they contain folic acid, which is necessary for homocysteine to be converted into amino acids like cysteine or methionine. Homocysteine can directly harm blood vessel walls if it is not transformed, which increases the chance of having a heart attack or stroke. It contains several immunostimulants and antioxidants. Because maintaining chronic non-healing ulcers is difficult and creates various clinical challenges, its pulp is used in African hospitals to treat wounds and cure burns. It has been shown that enzymatic wound debridement using a papain-urea combination is efficient. Papaya latex, according to Reed, is highly helpful in treating dyspepsia

and may be used topically to burns and scalds. It also treats whooping cough, bleeding hemorrhoids, and diarrhea. Papaya juice helps to cure colon infections by removing mucus, pus, and inflammation. Mature fruit is carminative, diuretic, expectorant, sedative, and possesses anti-dysentery, anti-skin disease, anti-psoriasis, and anti-ringworm properties. Papaya has anti-inflammatory properties as well, which may be beneficial for a variety of medical conditions. Impotence and ulcers are treated with underripe fruit. (Saeed *et al.*, 2014).

Lemon:

Every citrus-producing location on the earth has commercial lemon (*Citrus limon* L. Burm.) cultivation. With 1.08 million hectares of cultivated land, the world produced 17.35 million tons of lemon and lime fruit, with India, Mexico, China, Argentina, and Brazil accounting for 61.32% of the total production. (Sun *et al.*, 2019), Lemon fruit is frequently used to flavor and decorate food as well as to create enticing beverages and cordials since it is abundant in minerals, flavonoids, vitamin C, citric acid, and other beneficial substances. (Molina *et al.*, 2010). Lemon was used to cure the plague, and its juice is used to make a syrup known as acridine citri, which is used to quench someone's thirst while also being battled over. (Uduak *et al.*, 2014). Vitamin C, folate, dietary fiber, and other bioactive substances including carotenoids and flavonoids that are thought to prevent cancer and degenerative illnesses are all found in citrus limonene.(Tripoli *et al.*, 2007) Citrus fruits have the highest antioxidant content. High quantities of ascorbic acid (vitamin C) in various fruits may function as an antioxidant. Carotenoids, flavonoids, glutathione, and other enzyme systems are among phytoconstituents that may also have an antioxidant effect. (Oikeh *et al.*, 2016)

Lemon and its derivatives have been demonstrated to be a rich source of therapeutic chemicals for treating several maladies, including antiulcer disorders, in Indian medicinal plants. Lemons contain an organic compound called polyphenols, which is concentrated in the peel. Citrus peel possesses anti-diabetic and antioxidant effects owing to its high total polyphenol content. An organic acid-rich fresh red chicory extract was tested for its ability to fight against predontopathic bacteria such Actinomyces and Streptococcus mutant. (Rafique *et al.*, 2020).

Table 3. Crops and Their Health-Boosting Bioactive Compounds: A Comprehensive Overview

S.NO	Crops	Health Benefits	References
1	Mango	Antioxidant, anticancer, antibacterial, antiatherosclerotic, anti-allergenic, anti-inflammatory, analgesic, and immunomodulatory activity	Masibo, M., and Q. He (2008).
2	Guava	Anti-cancer, anti-hypertensive, anti-fungal, anti-proliferative, and antipyretic effects. antimalarial activity, spermatoprotective effect, immunomodulatory function, and spasmolytic effect	Parvez <i>et al.</i> , 2018
3	Papaya	Juice helps to cure colon infections by removing mucus, pus, and inflammation. Mature fruit is carminative, diuretic, expectorant, sedative, and possesses anti-dysentery, anti-skin disease, anti-psoriasis, and anti-ringworm properties.	Saeed <i>et al.</i> , (2014).
4	Lemon	Citrus fruits have the highest antioxidant content, Used to cure the plague, prevent cancer and degenerative illnesses.	Uduak <i>et al.</i> , 2014, (Oikeh <i>et al.</i> , 2016)

Conclusion:

Fruits are considered as important and Necessary source of Nutrition, Minerals and Bio-Active Compounds. Many Doctors, Researcher's and Health Organization recommended consuming fruits in daily basis increases immune system and health in human life. These Fruits are also used to prevent various diseases and Anti-aging factor, anti-cancer, antiinflammation and Etc., So, The awareness of the Chemical Compound Present in fruits and their Uses should be spread through these kind of Research work. This Research work can Develop general idea of Bio-active compounds and their role to bridge the generation gap, further study has to be done on the issue of bioactive chemicals in fruits.

Acknowledgements

We would like to express our sincere gratitude to all those who contributed to the completion of this manuscript. Their support and expertise were invaluable throughout the reviewing and writing process.

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