IJP (2025), Vol. 12, Issue 7 **(Review Article)**

Received on 03 July 2025; received in revised form, 29 July 2025; accepted, 30 July 2025; published 31 July 2025

FRUITS PHYTOCHEMICALS: A COMPREHENSIVE REVIEW OF THEIR NUTRACEUTICAL BENEFITS

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Keywords:

Flavonoids, Phenolic extraction, Alkaloids, Nutrients, Anthocyanins

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ABSTRACT: Plants create bioactive substances called phytochemicals to defend themselves. Consuming phytochemicals including carotenoids, polyphenols, isoprenoids, phytosterols, saponins, dietary Fibers, polysaccharides, *etc*. has been linked to certain health outcomes, according to recent scientific research. This article lists a few of these well-known fruits, such as *Persea americana*, *Selenicereus undatus*, *Morus*, *Psidium guajava*, *Mallus domestica*, and *Vaccinium macrocarpon*, that may offer new sources of health-promoting substances. Additionally, this web page lists a few of these popular fruits that could deliver fresh supplies of substances that enhance health. A diet rich in fruits has been linked to a lower risk of noncommunicable diseases because they contain a variety of compounds that, in addition to vitamins and minerals, offer health-protective qualities. many have therefore chosen to enhance their overall standard of life through increasing their fruit intake, taking dietary supplements or nutraceuticals, or using nutritional therapy or phytotherapy in place of prescription medications. The development of specific horticulture models for the production of nutritional fruits may offer an interesting opportunity to obtain an extremely standardized raw material for fresh or derived products. This article examines the function of phytochemicals in the diet and emphasizes how crucial it is for humanitarians to develop a habit of eating fruits from an early age.

INTRODUCTION: Humans have depended on plants for survival and health advantages since the beginning of time. This pattern has persisted to this day, with almost 80% of people worldwide depending on medications derived from plants. Fruits and other horticultural plants are particularly significant in the plant kingdom.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.IJP.12(7).562-75

Article can be accessed online on: www.ijpjournal.com

DOI link: https://doi.org/10.13040/IJPSR.0975-8232.IJP.12(7).562-75

Fruit groups have nutritional components including sugars, essential oils, carotenoids, vitamins, and minerals that enhance their overall medicinal characteristics, as well as bioactive components like flavonoids, phenolics, anthocyanins, and phenolic acids, in emerging nations like India, the biggest problems are growing populations, insufficient food, hunger, and a variety of diseases.

Usually, we use drugs to seek a treatment or to avoid all of these uncertainties. However, as people's health has become more important to them, they are choosing natural resources, such as nutraceuticals, to prevent and treat illness. The article presents a summary of the research-based

knowledge concerning the nutritional value of phytochemicals that exist in fruits such *Mallus domestica, Persea americana* and Morus.

Avocado: The avocado, or *Persea americana*, is a fruit that comes from the evergreen avocado tree, which is native to Mesoamerica and it belongs to the Lauraceae family [1]. The cultivar Fuerte from Mexico; Bacon, Zutano and Hass from California; Booth selection from Florida; Sharwil from Australia and Ettinger from Israel are said to be encouraging. The cultivars, Pollock and Waldin of West Indian race; Nabal and Linda of Guatemalan race; Puyevla and Gott Froid of Mexican race [2].

The family includes more than 3000 blooming plant species over more than 50 genera globe. Its inflammation reducing, seizure suppressant, antihyperglycemic and arterial relaxant properties have been demonstrated. An American missionary who lived in Bangalore from 1906 to 1914 brought avocado from the Royal Botanical Gardens in Ceylon. During their frequent travels in India between 1912 and 1940, American missionaries also transported a few seedlings of their preferred types from their own country.

This explains why over a dozen different types of Avocadoes are produced throughout this area and in hill stations like Kallar, which is close to Nilgris, Pulney Hills, Kodaikanal, Shreveroy Hills, Yercaud, Coorg, *etc*. The fruit is berry-like and consists of a single large seed covered in a buttery pulp. The fully grown fruit may be reddish, purple, black, or green, depending on the diversity. The leaves are 7–41 cm long and have elliptic, oval, and lanceolate shapes. The yellowish green flowers have a diameter of 1 to 1.3 cm. Fruits can be spherical or pyriform in shape and weigh up to 2.3 kg [4].

Collection: The avocado fruits utilized in this study, all of the Hass variety, were harvested from an orchard near Faro (Latitude: 37.019°, Longitude: -7.926°). There were one hundred fruits at the beginning of ripening, which were chosen at random based on their firmness, lack of mechanical damage, and obvious Volume 1 of Current Studies in Agricultural and Food Science. Organic Sources of Phytochemical Compounds, Nutrients, and Their efficient Traits in Avocado and Its Co-products 85 decline. The fruits were washed and processed in accordance with the specifications of the intended analysis as soon as they were harvested.

They were preserved at 4^{o}C after being sliced open to separate the palatable and unpalatable sections (pulp, skin, and seeds, respectively). For every sample, six duplicates were chosen and examined. After harvest, all analyses were completed within a maximum of two weeks. According to each type's season Mature avocado fruits of the Margarida, Breda, and Geada varieties were collected by the State Logistic Hub (Latitude: -10.91610000 and Longitude: -37.06080000) in the state of Aracaju/SE between October 2017 and July 2018.

The fruit was then cleaned, dried, and manually ground into pulp in order to extract the desired portions (peel, pulp, and seed). The peels, pulp, and seeds of several avocado kinds were thinly minced, put in glass flasks, and maintained cold at 7°C for further physicochemical analysis and extractions[2].

Cultivation: Propagation: In India, avocado trees can reproduce asexually as well as sexually. Planted plants are now commonly utilized for planting, whereas seed propagation was the most popular technique a few years ago. The seedlings are primarily used as rootstocks [4]. Field Preparation and Planting Care had to be taken when choosing the cultivars for the avocado plantation in this relatively new area. It is necessary to choose types from both the A and B groups, and their flowering times must coincide. There might be a 1:1 or 2:1 ratio between the A and B group variants. Avocados are planted six to twelve meters apart, depending on the variety's Vigor and growth habit. Varieties with spreading growth, such as Fuerte, should be spaced farther apart. Avocados can't tolerate standing water; therefore, they should be planted on mounds in locations that get a lot of it.

Nutrient Management: Avocados require a lot of manuring, with nitrogen application being the most important. In general, older avocado trees should receive a 2:1:2 ratio of N, P2O5, and K2O, whereas younger trees should receive a 1:1:1 ratio. Iron deficiency symptoms can arise at pH values higher than 7, and iron chelate is charged at a cost of 35g/tree to remedy this. Avocado output, nutrient uptake, and tree growth are all significantly

impacted by multiple micronutrients (Fe, Zn, and B). Avocado is recommended to have integrated nutrition management using inorganic fertilizer and organic manuring as a supplement.

Flowering, pollination and fruiting: The individual flowers are physically bisexual and possess both fertile male and female organs. However, they have dichogamy, in which the female and male organs mature at distinct times, preventing a single flower from being self-pollinated. Fruit harvesting and yield: While grafted avocado plants begin to yield in three to four years, plants raised from seeds begin to give fruit five to six years after planting.

When purple kinds reach maturity, their color turns crimson, while green species mature fruits turn greenish-yellow. When the seed coat inside the fruit turns from yellowish white to dark brown, the fruit is ready to be harvested. A fruit's maturity occurs six to 10 days after harvest.

For as long as they are on the trees, the fruits are hard; they only become soft after harvest. Avoiding harvesting when it's raining and leaving fruits outside in the sun. Braces should be avoided as they can accelerate the decomposing process of the skin. Each tree produces between 100 and 500 fruits annually [4].

Geographical Distribution: The commercial avocado crop is made up of three of the eight distinct geographical eco-types that make up the Lauraceae family, which is a commercially significant plant family. These horticultural races are the Guatemalan (*P. americana* var. nubigena), the Mexican (*P. nubigena* var. nubigena and *P. nubigena* var. guatemalensis), and the Western zone of India (*P. americana* var. americana) [5].

The tropical zones of North and Central America are home to 70 of the 150 kinds in the genus Persea. Its other entire species are cultivated throughout East and Southeast Asia [6]. Tropical America is the native home of the avocado (*Persia americana*), when it initially came in Mexico and Central America, it may have sprung from many non-domesticated species.

As a result, more than a dozen distinct types of Avocadoes are grown in this area, including in mountainous areas like Kallar, which is close to Nilgris, Pulney Hill sides in Kodaikanal, Shreveroy Foothills in Yercaud, Coorg, etc [4].

Extraction: Traditional, aqueous separation extraction method.

TABLE 1: AQUEOUS EXTRACTION -A BRIEF DESCRIPTION OF AVOCADO OIL EXTRACTION METHODOLOGIES (JOS) [7]

Procedure	Outcomes	Inference
Enzyme-aided sedimentation: The process involves combining fresh avocado flesh with paste + diluted paste +Biocatalytic reaction + sedimentation and raw oil to create a final product.	The extraction yield under ideal conditions was almost 78%.1% α-amylase, 1 hour of enzymatic reaction duration, 65°C temperature, and 1:5 dilution rate	The use of an enzyme-treated paste significantly enhances oil extraction yield compared to the control paste.
Microwave-assisted squeezing: Crude oil is extracted by pressing or squeezing avocado pulp after it has been prepared by microwave treatment.	Using microwave treatment, squeezing/pressing, and crude oil extraction at a microwave power of 1.8 KJ/g and an subjective period of 11 minutes, the study obtained an extraction yield of 65.2% from pulp.	Different extraction techniques prompted the avocado oil's chemical and physical properties to change.
Supercritical fluid extraction: Slices of avocado are first dried in the oven, then ground, extracted using a supercritical fluid extractor, and finally the crude oil gets turned into a finished product.	At 37°C and 3.5×107 Pa, the oil yield from supercritical carbon dioxide (SC-CO2) extraction (6 g/kg fruit weight on a dry basis) was attained.	Under experimental conditions, SC-CO2 might be more selective, resulting in less thorough extraction and lower oil yields.
Hexane extraction (Soxhlet method) Ultrasound water bath extraction: Hexane was used to sonicate the dried avocado samples for an hour in a water bath set at 60°C.	The most reliable findings have been found by Soxhlet extraction (6.5±0.24 g/kg for Hass avocados and 6.4±0.20 g/kg dry weight for Fuerte avocados).	Since the solvent-free nature of the process, SC-CO2 is more advantageous than conventional oils for the food and pharmaceutical industries.

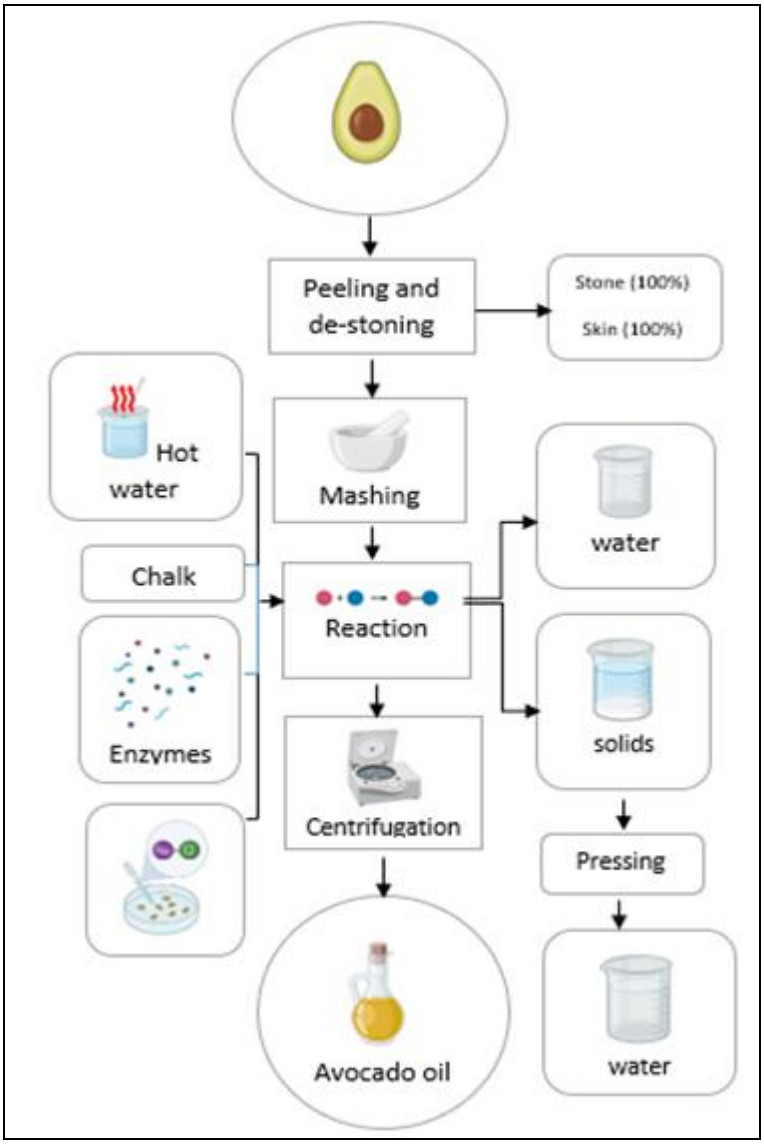

FIG. 1: FLOW DIAGRAM FOR THE CONVENTIONAL MECHANICAL EXTRACTION PROCESS USED TO PRODUCE AVOCADO OIL [8]

Avocado Phytochemicals: Avocado's "rich supply of minerals and vitamins" helps in weight control. The entire nutritional value of a food in relation to human needs is more significant than its calorie amount. Nutrients per calorie is an effective metric. Results from several analyses of avocados have been a little inconsistent Their statistics show that halved a Hass avocado (approximately 80 grams of consumable fruit) can be part of the daily diet of a child between 7 and 10 years old (for adults, iron is usually lower, especially for women) **Table 2**. Avocados contain small amounts of cobalamin and calcium ion, less zinc ion and less phosphate. The riboflavin and thiamine quotas in half of the fruit for minor are about 9.5% and 8% sequentially, i.e. approximately identical to their caloric ratio. What's remarkable, though, is that a whopping eight vital elements appear to be present in roughly a 2:1 calorie ratio. Avocados are thought to have twice as many calories as all three of the extra nutrients potassium, copper, and pantothenic acid. The avocado is incredibly nutrient-dense for its calorie count. A) Although protein cultivars differ slightly, the predominant 'Hass' has roughly 2.4% polypeptide based on fresh mass. This is a seed-bearing structure abnormally high number. All nine of the essential amino acids are present in avocados, making them a "complete food" in terms of protein, albeit not in the optimal amounts. B) Research on Fiber indicates that it has emerged as a crucial component for combating chronic illnesses. Consuming a lot of Fiber reduces the risk of excessive body fat, blood sugar disorder, increased blood pressure, heart disease, and certain

malignancies. It seems that a combination of soluble and insoluble Fiber is best for some conditions. Another analysis of the avocado's Fiber content revealed that it contained significant levels of both dissolvable and dissolvable Fiber (having 2.1% and 2.7% by fresh mass, sequentially) [6].

TABLE 2: HALF AN AVOCADO CAN MEET A YOUNGSTER AGED 7 TO 10'S DAILY NUTRITIONAL NEEDS [6]

Nutritional substance	% provided
Folic acid	16
Nicotinic acid	13
Pyridoxine	15
Ferrous	15
Energy	7
Retinol	18
Ascorbic acid	17
Tocopherol	13
Magnesium ion	20

Phytochemicals of Avocado Peel: Avocado peels are high in phytochemicals; **Table 1** shows that the overall phenol levels of fresh avocado peels extent from 0.6 to 6.8 mg gallicinper gram equivalent pattern (mg GAE/g pattern), and for dried avocado peels with inter-varietal alterations, it ranges from 4.3 to 120.3 mg GAE/g. And other studies have revealed increased phenolic content and antioxidant interest in the peel, which makes up approximately 18% of the total clean weight. The fresh peel of the avocado fruit has the very best flavonoid content material and the dried peel has the very best total phenolic content whilst in contrast to other equatorial fruit peels (banana, muskmelon, *Passiflora edulis, Carica papaya*, pineapple, and *Citrullus lantus*). Moreover, when as compared to the peels of other culminations, driedavocado peel has the best antioxidant activity (FRAP assay). Because avocado peel has a high level of antioxidant activity, its phenolic content is several times higher than that of fresh blueberries [9].

Chemical Components of Avocado Seeds: Numerous the very best flavonoid content material and the dried peel has the very best total phenolic content whilst as compared to other tropical fruit peels (banana, melon, passion fruit, papaya, pineapple, and watermelon). Moreover, when as compared to the peels of other culmination, proanthocyanidins (PAC) and other polyphenols, have been found by phytochemical studies conducted on avocado seeds **Table 3.**

The quantity of these substances fluctuates based on the avocado variety, development environment, as well as maturation stage of the seeds. The experiment's extraction technique has an impact on the measured levels as well [5].

TABLE 3: THE PHYTOCHEMICAL CONTENT OF SEEDS FROM AVOCADOS [5]

Phytochemicals	(mg/100g)
Oxalic acid	4.40±0.30
Phytic acid	0.44±0.01
Bioactive amines	5.40±0.00
Bioflavonoids	20.33±0.01
Tannic acid	0.76±017
Glycosides	0.52±0.42

Chlorophyll and carotenoids Margarida, Geada, and Breda avocado extracts' total carotenoids and total chlorophyll contents are displayed in **Table 4**.

There was no discernible difference between the kinds, however the peels contained larger quantities of both carotene (5.24 ± 0.57 to 5.92 ± 0.21 mg/g β-carotene) and chlorophyll (9.43 ± 1.08 to 11.01 ± 0.10 mg/g. The pulps, on the other hand, showed the highest levels of both carotenoids (4.79 ± 0.33 mg/g β-carotene) and total chlorophyll (8.08 ± 0.32 mg/g) in the Breda variety.

Wang *et al.* (2010) found that, when compared to the other sections of the fruit under analysis, the peel of the eight avocado varieties they examined had an overall carotenoid content that was eight times higher and a total amount of chlorophyll that was increased by nine times than that of the seed and flesh. The idea that such peel has the highest amounts of these phytoconstituents is supported by these results [10].

Phenolics and flavonoids in total Margarida, Geada, and Breda avocado peel, pulp, and seed samples' total phenolic concentrations are shown in **Table 3.** It is clear that the seed has the largest total phenolic content (33.03 to 83.38 mg GAE/g), regardless of the avocado type, followed by the peels (23.06 to 55.57 mg GAE/g) and pulps (0.22 to 0.40 mg GAE/g), with a meaning variation ($p < 0.05$). Wang and colleagues validate the findings of this study, who tested eight different avocado types and found that each variety had a larger polyphenolic concentration in the seed. The whole phenolic content material of the Margarida variety's seed (83.38 mg GAE/g) was found to be higher by

the Folin-Ciocalteu method than that of the Hass and Fuerte varieties' seeds (60.82 and 69.12 mg GAE/g). Because it represents a superior origin of phenol derivatives compared to the primary avocado varieties utilized for commercialization, this finding stimulates interest in the Margarida variety. Previous studies (Wang *et al.*, 2010; Vinha *et al.*, 2013; Daiuto *et al.*, 2014) found that the Hass (51.60 mg GAE/g), Algarvia (704.0 mg/100g), and Hass Brasileira (57.30 mg GAE/g) varieties had higher levels of total phenolics compared to a portion of the pulp. Epicarp avocado extracts had 44.00 mg GAE g-1 of phenolic compounds, according to Contreras *et al.* (2021). Flavonoids were present in avocado extracts at total values between 0.15 ± 0.04 also 6.90 ± 0.23 mg QE/g. The highest concentrations of avocado components and variations had been determined The Geada (6.90 mg QE/g) and Breda (4.57 ± 0.85 mg QE/g) peels contain this substance. Furthermore, the seed of the Breda range (3.38 ± 0.03 mg QE/g) and the pomace of the Margarida range (1.03 ± 0.18 QE/g) both showed enhanced composition than the other alternative samples. Avocado peels from the Algarvia cultivar had a flavonoid content of 0.44 mg QE/g, according to Vinha *et al.* (2013). In general, simple phenolic compounds make up a significantly larger portion of the phenolic makeup of avocado varieties than flavonoids do [5].

TABLE 4: CONTENT OF CAROTENOIDS, TOTAL CHLOROPHYLL, TOTAL PHENOLICS AND FLAVONOIDS CONTENTS OF AVOCADO VARIETIES MARGARIDA, GEADA AND BREDA [10]

Sample/Procedure	Pomace	Peel	Seed
Overall carotenoids (mg/g β-carotene)			
Breda	4.79 ± 0.33bA	5.92 ± 0.21aA	3.96 ± 0.52bA
Margarida	4.02 ± 0.03bAB	5.98 ± 0.05aA	2.95 ± 0.06cB
Geada	3.07 ± 0.67bB	5.24 ± 0.57aA	2.55 ± 0.32bB
Overall chlorophyll (mg/g)			
Breda	8.08 ± 0.32bA	10.74 ± 0.46aA	6.34 ± 1.30bA
Margarida	6.09 ± 0.14bB	11.01 ± 0.10aA	2.92 ± 0.07cB
Geada	5.38 ± 1.05bB	9.43 ± 1.08aA	1.50 ± 0.23cB
Overall phenolics (mg GAE/g)			
Breda	0.39 ± 0.03cA	23.06 ± 0.77bC	33.03 ± 0.08aC
Margarida	0.40 ± 0.05cA	42.84 ± 1.76bB	83.38 ± 2.46aA
Geada	0.22 ± 0.01cB	55.57 ± 1.23bA	74.04 ± 1.48aB
Overall flavonoids (mg QE/g)			
Margarida	1.03 ± 0.18bA	1.31 ± 0.13bC	2.71 ± 0.08aA
Geada	0.15 ± 0.04cB	6.90 ± 0.23aA	1.46 ± 0.12bB
Breda	0.23 ± 0.01bB	4.57 ± 0.85aB	3.38 ± 0.03aA

Mulberry: The Moraceae family of plants includes the genus Morus, which includes mulberries. The three most common types of mulberry trees are the indigenous crimson mulberry (*Morus rubra*), the Chinese white mulberry (*Morus alba*), and the southwest Asian black mulberry (*Morus nigra*) [11]. Mulberry is generally referred "Kalpa Vruksha," due to the utilization of all plant parts in different applications. The fruit is referred to as toot and shahtoot (King's or "advanced" mulberry). The Shah toot is seemed extraordinary for its great taste and appealing color, which is utilized in marmalades, juices, liquors, natural dyes, and cosmetics. Mulberries are small, deciduous trees with deep roots that grow into woody perennial plants that are 10–13 m tall. It is tough to clean, alter, stipulate, petiolate, entire, or lobed leaves that are 10–20 cm long and 6–10 cm wide (up to 23 cm on vigorous stems). Such leaves are downy on the underside. flowers hung on quick, inexperienced, pendulous catkins that appear within the axils. The flower cluster is catkin with sex-specific flora yielding a hanging peduncle [12].

Collection: Core collection development process grouping concept development procedures included the following: the overall sample fraction, within group sampling ration, and the specimen picking strategy inside the group. In terms of conventional classification based on morphological traits, the grouping principle was applied. The eight businesses, or ecotypes, that comprise Atropurprea Roxb., *M. alba* L., *M. alba* var. macrophylla Loud., *M. nigra* L., *M. australis* Poir., *M. multicaulis* Perr., *M. wittorum* Handelb-Mazett., and *M. bombycis* Koidz, might be formed from all of the

accessions. There has been a contrast of six sample ratios in overall: 5, 10, 15, 20, 25, and 30% Within each group, there were four different sample proportions:

Genetic variety (G strategy), square root (L strategy), logarithm (S strategy), and constant proportion (P strategy). The Euclidean distance became used because the clustering distance, even as the Un weighted Pair institution approach with arithmetic imply changed into the clustering approach. Stepwise clustering and least distance stepwise clustering have been the 2 sampling techniques used inside the group. In order to determine which core collection would be best, 48 potential core collections were created. From each group, at least one accession ought to be selected [13]. Following the founding of the CSGRC at Hosur, Tamil Nadu, India, in 1993, a systematic collection of mulberry germplasm from natural sources was initiated. The current study was conducted as a part of survey and exploration in order to gather mulberry germplasm resources from North West India, specifically from Uttaranchal, Himachal Pradesh, and Jammu & Kashmir. This paper has focused on biodiversity, its geographic distribution, conservation, and use [14].

Cultivation: Planting 1,172 ha of densely planted fields made up the 14,884 ha of mulberry gardens, according to statistical data on Japanese sericulture from 1996. In terms of mulberry garden planting density, it is typical to plant 600–1,000 plants per 10a. More than 2,500 plants/10 ha are employed in densely planted fields with the goal of early high yield and machine harvesting. In alluvial soil, 30 kilograms of N, 14 kg of phosphoric acid salt, and 12 kilos of potassium/10a are normally carried out as chemical fertilizer to mulberry gardens; in volcanic ash soil, 30 kilos of N, 16 kilos of phosphate, and 20 kilos of Mulberry Breeding, Cultivation and utilization in Japan 8 potassium/10a are implemented. Making use of no less than 1,500 kg of compost in step 10a is recommended in each scenario [15].

One of the tropical fruits that India produces insufficiently is the mulberry. Mulberries are found in the tropics of both the southern and northern hemispheres, and they grow in a variety of soil types, topographies, and temperatures. While mulberry growing is more common in temperate and tropical climates, 26 °C is the ideal temperature for mulberry cultivation [12].

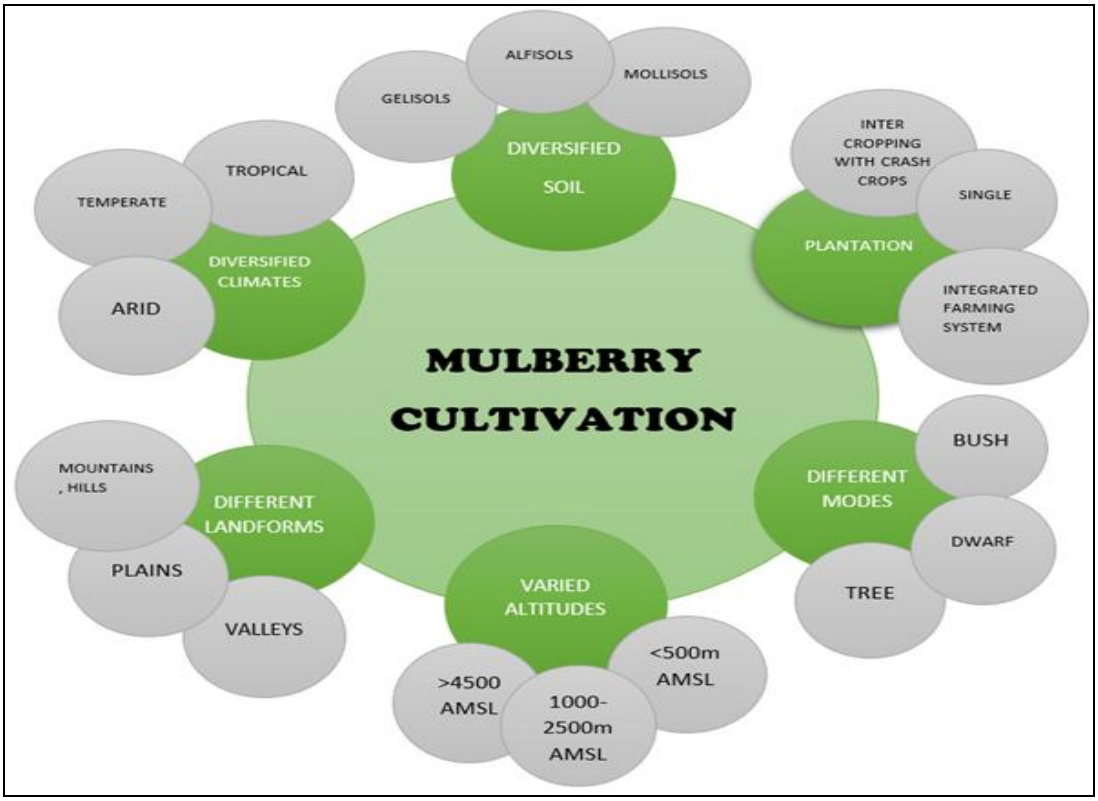

FIG. 2: MULBERRY CULTIVATION UNDER DIVERSIFIED CLIMATES, SOIL CONDITIONS, LANDFORMS AND AT DIFFERENT ALTITUDES [16]

Geographic Distribution: Mulberry is found in parts of Africa, southern Europe, north-western South America, southern North America, and east, west, and Southeast Asia. Mulberry grows in a wide variety of temperatures, including tropical, subarctic, temperate, and subtropical. *Morus alba* is a moderate-sized mulberry tree that grows quickly, reaching heights of 10–20 meters, originated in China and are now widely domesticated and naturalized across the globe [17].

Extraction:

Procedures for Isolating Bioactive Ingredients from White Mulberry Leaf: Bioactive chemicals found in white mulberry leaves can be extracted from either fresh or dried plant material. Prior to extraction, the leaves may undergo pretreatments such as washing, drying, and size reduction in order to produce homogeneous samples. Plant materials like white mulberry leaf are frequently extracted using techniques like maceration and Soxhlet. Advantages of non-conventional techniques include shorter extraction times, environmental friendliness, and lower energy consumption. Demonstrations of these methods are microwave both ultrasound-aided extraction (UAE) and assisted separation (MAE). TPC and TFC mean for total phenolic and flavonoid sections, etc. are the two bioactive chemicals that are the subject of this section's comparison of extraction techniques [18].

Method of Extraction: maceration three distinct aqueous mixes containing organic solvents at three percentage points were used to carry out conventional solid-liquid extraction. Aqueous solutions of methyl alcohol, ethyl alcohol, and propanone at varying ratios of organic solvent: and water (100:0, 75:25, and 50:50 v/v, respectively) were employed to determine the best solvent for the extraction of various phytochemicals. In alluvial soil, 30 kilos of N, 14 kilos of phosphoric acid salt, and 12 kilos of potassium/10a are normally carried out as chemical fertilizer to mulberry gardens; in volcanic ash soil, 30 kilos of N, 16 kilos of phosphate, and 20 kilos of Mulberry Breeding, Cultivation and utilization in Japan 8 potassium/10a are implemented. Making use of no less than 1,500 kg of compost in step with 10a is recommended in each scenario. After that, all extracts were centrifuged for 15 minutes at 7000 rpm. Following that, a BuchiLabo Technik was used to collect and evaporate the supernatants. Rotary evaporator system model R-200 connected to a heated immersion bath type B-490. The arid leftover material was rebuilt [19].

CSE of mulberry polysaccharides in an HH-6 water bath, conventional solvent extraction was performed. In a flask with a circular bottom, 10.0 g of the powdered powder was combined with distilled water. The conditions listed in Table 1a were followed when extractions were performed. Centrifugation was used to get rid of polysaccharide extract debris particles. Four litres of 95% (V/V) ethanol were used to precipitate the polysaccharide solution after it had been concentrated using a rotary evaporator for 48 hours at 4 C. Crude polysaccharides were produced by using centrifugation (6000 r/min, 30 min) of the precipitates, observed via an acetone wash and a discount in pressure drying at 40^{o}C [20].

Phytochemicals:

Phytochemical and Nutritional Composition of White Mulberry Leaf: white mulberry leaves are categorized as edible, rich in vitamins, and nutraceutical. Several in advance studies reported that the white mulberry leaf is rich in bioactive compounds in the form of secondary metabolites, like alkaloids, anthraquinone, anthocyanin, benzofurans, coumarins, chalcones, flavonoids, glycosides, phenolic acids, saponins, steroids, stilbenes, tannic acids, and so on [18].

TABLE 5: THE PERCENTAGE DISTRIBUTION OF SECONDARY METABOLITES IN WHITE MULBERRY LEAF [18]

Compound	Amount in white mulberry leaf (%)
Alkaloid	0.825-0.830
Tannins	2.905-3.455
Saponin	4.915-5.005
Oxalate	2.775-2.905
Phenolics	2.560-2.600
Flavonoids	2.400-2.815
Phytate	2.915-3.050
Trypsin inhibitor	1.525-1.695

Aside from phytochemical composition, the white mulberry leaf additionally incorporates complete nutraceutical composition, such as is excessive in protein, accompanied with the aid of carbs, Dietary Fiber, nutrients, and reduced fat content, which makes it an appropriate food element.

Nutraceutical Value of Mulberries: Nutraceuticals are substances derived from food sources that provide extra health benefits beyond the essential nutritional content of food. Mulberries are an essential source of nutraceutical goods, including nitrogen containing compound, carbs, lipids **Table 6,** micronutrients, trace elements **Table 6**, and phytonutrients, according to several studies. The Amino Acids Mulberries have essential nitrogen containing compounds (EAA) such as isoleucine, leucine, lysine, methionine, cysteine, phenylalanine, tyrosine, threonine, tryptophan, valine, and histidine, as well as non-essential amino acids like alanine, arginine, aspartic acid, glutamic acid, glycine, proline, and serine. Contrary to protein meals made of milk and fish, mulberries have a higher overall amino acids ratio (TAA). Mulberry fruits include monosaccharides (fructose and glucose) and a moderate quantity of overall phenolic concentration material. Additionally, the study revealed that mulberry culmination might be utilized as a nourishment due to the existence of an uncommon carbohydrate called prebiotic Fiber. When the saccharide content of purple (*M. rubra*) and black (*M. nigra*) mulberries was examined, it was found that 48% fructose and 52% glucose were present.

Vitamins and Minerals: Folic acid, nicotinic acid, Pyridoxine, Riboflavin, Retinol, Ascorbic acid, Tocopherol, and Phylloquinone, mineral ions such as sodium and potassium, minerals such as calcium, copper, ferric, magnesium, zinc, as well as selenium, phytonutrients, and provitamin A, carotene, α, and xanthophyll are all abundant in mulberry culmination.

Anthocyanins: An enjoyable source of anthocyanins is mulberries. Mulberries contain significant anthocyanins, notably cyanidin-3-O-glycoside and cyanidin-3-O-rutinoside (determine 2). Polyphenolic Acids and Alkaloids compounds: These hydroxycinnamic acid derivatives include Polyhydroxy benzoic acid (determine 2e), clinic acid (determine 2), syringic acid (parent 2), Dihydroxybenzoic acid isomer (determine 2), p-hydroxybenzoic acid, and Caffeoylquinic acid (discern 2), caffeic acid, Coumaroyl (parent 2), o-coumaric (discern 2), and. Methoxylated Cinnamic acid.

Aromatic as well as Volatile Compounds: Mulberries have been found to contain a number of potent fragrance chemicals, including benzene carbaldehyde, ethyl butyrate, (E)-2-nominal, beta Mercaptothion, and hexan-1-ol. A small number of volatile chemicals, including Hexanoic acid methyl ester, methyl hexanoate, Citrus terpene, 1-octanol, and ethyl caproate, were additionally noticeable in the culmination of black and white mulberries.

Flavanols and Flavanols: Mulberries, which have biological activity against a variety of illnesses, include these essential nutritional elements. Kaempferol-O-hexoxide, kaempferol diglycosidic, kaempferol rhamnosylhexoside, morin, quercetin (determine 2), quercetin glucoronide, quercetin hexoside, and quercetin hexosylhexoside are a few flavonols that have been identified and isolated from mulberry berries [21].

Mulberries are also known to contain alkaloids, which may be important chemicals with nitrogen that have pharmacological properties (S1262 V. k. RAMAPPA ET AL.). NMR Spectroscopy has identified five pyrrole-based alkaloids (morrole B, C, D, E, and F) in white mulberry (*M. alba*) [22].

TABLE 6: NUTRITIONAL COMPONENT AND NUTRITIONAL VALUE OF MULBERRY [21]

Dietary Element	Type of Compound	Nutritional value		
		M. alba	***M. nigra***	***M. rubra***
Carbo	_	14.21 g	9.80 g	_
Polypeptide	_	1.55 g	1.44 g	_
Cholesterol	_	0 mg	0 mg	_
Vitamins	Folic acid,	-	6 µg	-
	Nicotinic acid, Vitamin	3.10 mg	0.620 mg	-
	B6 -Riboflavin Retinol	-	0.050 mg	-
	Ascorbic acid	0.088 mg	0.101 mg	-
	Tocopherol	0 IU	25 IU	-
		22.4 mg	21.8 mg	19.4 mg
		-	0.87 mg	-

Mulberry Nutrition: It has been reported that the final mulberry has 7.55% of all saturated lipids, 87.5% Polyunsaturated FA, and the maximum concentration of Omega-6-fatty acid (seventy 9.4%), which is accompanied by hexadecenoic acid (8.6%) and oleic acid (7.5%).34. Palmitic acid (22.4%) and total lipids (57.3%) are the constituents of Turkish mulberry culmination. Polyunsaturated fatty acids are more abundant in mulberry fruit than monounsaturated and saturated fatty acids. Mulberry fruit contains linoleic acid, a vital polyunsaturated fatty acid that is essential for human growth, fitness promotion, and disorder prevention among people. The anthocyanin pigment concentration is what causes variation in fruit color. One type of berry that grows on bushes is the mulberry. It is susceptible to storage because of its high moisture content. Fruit's acidity is what gives it its tartness. Malic acids are greater in mulberries than citric acids. Morin, quercetin, and rutin are the most common flavonoids. Mulberries have sufficient amounts of vitamin C in addition to the many B-complex vitamins, which include vitamin E (tocopherol), vitamin K (phylloquinone), vitamins B2, B3, B6, and B9. These kinds of nutrients function as cofactors in the body's metabolism of fats and proteins [23].

Apple: Apples, a perennial tree in the rose family, are grown worldwide in over 7,500 varieties, including *Malus domestica*, M. frutescens, *M. paradisiaca*, and *Pyrus dioica* [24]. The plant has ovate to oblong leaves with serrate margins, glabrous above and tomentose beneath, a 1-layered epidermis, and a young, oval to spherical stem [25]. The global history of a fruit from Kazakhstan's mountains, which has become a favourite worldwide due to its cultural and culinary significance [24].

Collection: Apple juice was prepared from apple cultivars from Bilate Charicho district, Duguna-*Fango woreda, Wolaita area*, South Ethiopia, using Golden Scrumptious, Fuji, and Granny Smith varieties. The apple was reduced into slices and juice was prepared using a juicer, and samples were stored at -20°C for further analysis [26].

Cultivation: Apple fruit is one of the most intensively grown and extensively cultivated fruit crops within the temperate areas around the arena [26]. Apple fruit, also known as *Malus domestica*, is a candy made from an apple tree grown in Ethiopia's tropical climate. A trial was conducted at the Lithuanian Institute of Horticulture from 2005-2008, using one-12 months-old nursery bushes of tested apple cultivars and choices, with a 4x2 m planting scheme. The experiment involved four random blocks with four bushes, with the orchard floor transformed into cultivated soil, and bioinsecticide Bio shower applied after 12 months [27]. The apple tree is cultivated internationally and the maximum widely grown species within the genus Malus [24].

Geographic Distribution: The Latin name for the apple tree is *Malus domestica*, and its descendants, originating from Central Asia, share most of the genome of *Malus sylvestris* [24]. Jammu and Kashmir was chosen for the study due to its significant manufacturing presence, with 35.92% and 58.8% of the US overall area and 50% of apple production coming from south Kashmir, particularly Spain, which is known for its fine apples [28].

Extraction:

Pectin Extraction: The study involved extracting pectin from apple flour using a condensation system at 97°C for 30 minutes, acidifying water with citric acid, and using apple flour as raw cloth. The pool was then categorized using steel sieves to separate it into five distinct particle sizes. Three batches and crude dried pomace were used to examine the impact of particle size on pectin yield. The extraction of pectin was conducted using apple pomace from various varieties under similar conditions and under reflux at 97oC for 30 minutes [29].

The study used a fractionation method to extract phenolic compounds from freeze-dried and ground samples. The method was adjusted based on the sample's characteristics and study goal. The water extracts were filtered and combined, and the extracted mixtures were then analyzed. The pomace was reconstituted in methanol and stirred, followed by acetone extraction, using acidic conditions to prevent phenolic compound oxidation, with glacial acetic acid added at 5 mL/L [30]. The extraction process involved loading the extraction cell into an oven, filling it with solvent up to 1500 psi, heating up time, static extraction,

rinsed with 60% solvent, purged with N2 gasoline, and depressurized. A rinse was performed between extractions to prevent extract transfer. The extracted extracts were freeze-dried, freeze-dried, and stored at -20°C until analysis [31]. The study involved extracting apple juice from a 500mL conical flask, dissolving it in methanol, and storing it in an orbital shaker for 12 hours. A rotary evaporator was next utilized to filter and evaporate the extracts under suction at 50°C. Until more research was carried out, the ensuing extracts were preserved at 4°C[26].

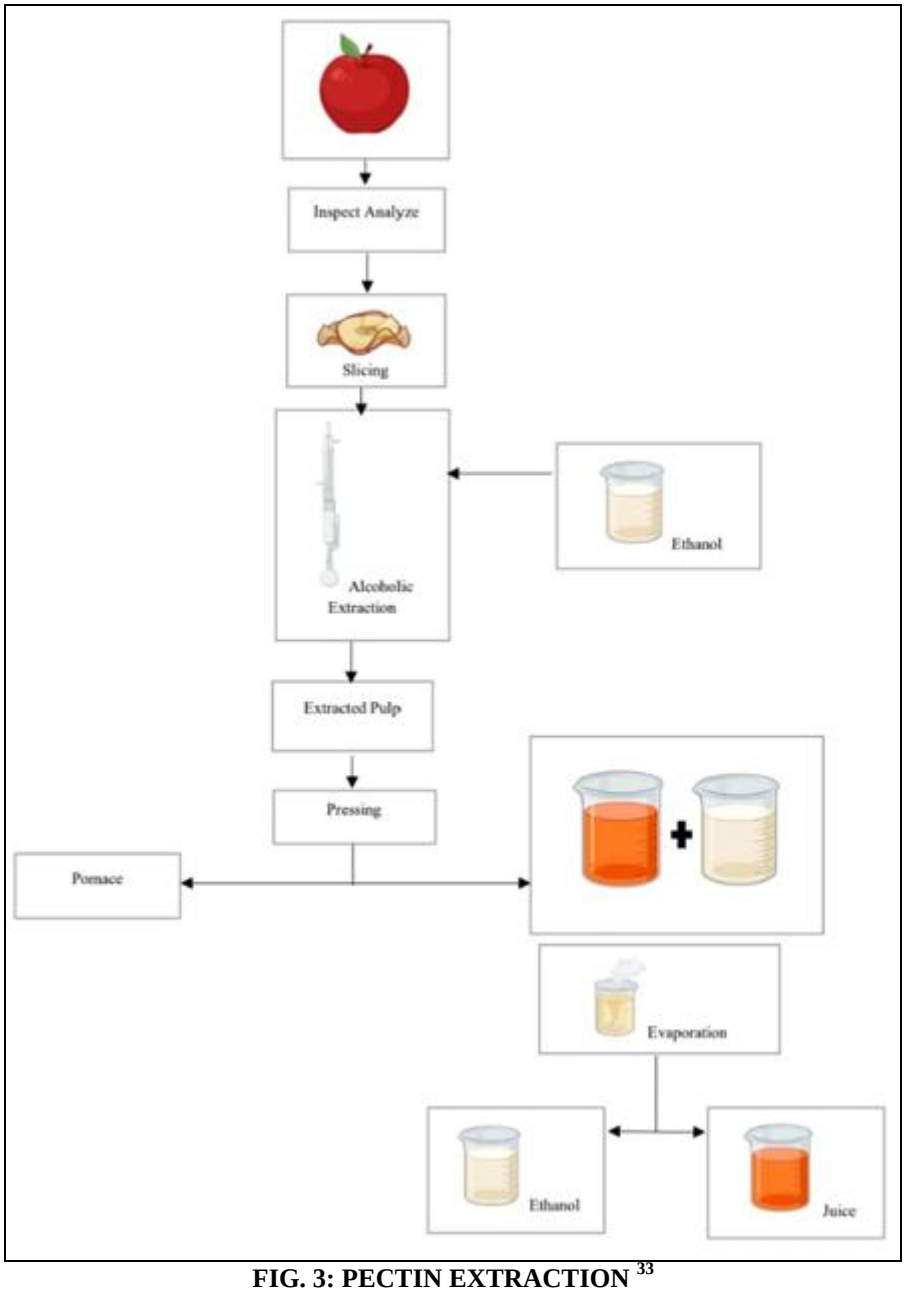

FIG. 3: PECTIN EXTRACTION [33]

Phytochemicals: Apples are rich in flavonoids and other phytochemicals, which are impacted by elements like harvest, processing, storage, and cultivars. Peels and meat have distinct levels of comprehension of these phytochemicals. Procyanidins, epicatechin, catechin, chlorogenic acid, phlorizin, and quercetin conjugates are the most prominent features in peels; in flesh, these compounds exist in fewer quantities. Procyanidins, epicatechin, catechin, chlorogenic acid, phlorizin, and quercetin combinations are all identified in apple peels. Such substances are found in flesh, albeit in fewer proportions. Based on recent studies, peels have up to a few times as many flavonoids and up to six times as many phenolic constituents as meat [32].

Fibers: Apples are a rich source of Fiber with a balanced soluble and insoluble fraction, and their bioactive compounds, including flavonoids, polyphenols, and carotenes, contribute to their nutritional value. Numerous studies have explored their *in-vivo* effects on lipid metabolism. Polyphenols in apples, including flavanols, dihydrochalcones, flavan-3-ols, and phenolic acids, are similar in concentrations but have different structural lessons, including quercetin, kaempferol, and rutin [33].

TABLE 7: VITAMIN C, TOTAL FLAVONOID CONTENTS (TFC), AND TOTAL PHENOLIC CONTENTS (TPC) ACROSS DIFFERENT KINDS OF APPLES [26]

Samples	TPC (mg GAE/g) *	TFC (mg CE/g) **	Vitamin C (mg/100 g)
Granny smith	71.88 ± 2.30b	21.78 ± 1.87b	14.97 ± 1.28a
Golden delicious	66.94 ± 1.62a	15.59 ± 0.23a	31.48 ± 2.18b
Fuji rose	70.90 ± 2.74b	21.91 ± 2.55b	28.83 ± 2.80b

Pursuant to a redox titration implementing an iodine solution, vitamin C (ascorbic acid) is a crucial antioxidant in the tissues of humans. Ascorbic acid, an antioxidant that can be found in apple juice, is transformed to iodide ions and oxidized to dehydroascorbic acid. Apple juice's median level of vitamin C is determined in milligrams per 100 grams [34].

The high levels of Fiber, potassium, vitamin C, and phytochemical secondary nutrients make apples a vital part of a balanced diet. Due to its antioxidant abilities, these polyphenols and secondary metabolites guard against oxidative damage. Known as nutraceuticals, these antioxidant phytochemical substances deliver extra wellness benefits. Numerous omics techniques, such as transcriptomics, metabolomics, genomic selection, genetics, and genomics, are being utilized to accelerate the study of apple nutritive content. In this emerging discipline, it is imperative to acknowledge the intricate interplay among environmental variables, gene expression, and nutraceutical content [35].

RESULT AND DISCUSSION: Fruits and their constituent parts, such as the peel, seed, and leaves, were found to be rich in phenols, flavonoids, tannins, alkaloids, saponins, and triterpenes by phytochemical examination. The usage of phytochemicals in commercial formulations, which were extremely advantageous for health, was also mentioned in this review. Many have therefore attempted to enhance their quality of life by increasing their fruit intake, taking dietary supplements or nutraceuticals, or using nutritional therapy or phytotherapy in place of prescription drugs. Beyond the realm of plants, there are also nutritious options that aren't typically thought of as such, such as protein, fat, and carbohydrate components. Examples of recent studies on particular phytonutrients and their potential associations with particular diseases are briefly discussed in this article. Information on the universe of health-promoting ingredients and advantageous nutrients has been included in the review. The food business has tremendous prospects to develop new food products in the future thanks to nutraceuticals derived from both plants and animals.

In addition to marketing the products to attract consumers' attention and, perhaps most importantly, satisfy their tastes, the food business must persuade investors of the possible financial gains from investing in the value of nutraceuticals.

CONCLUSION: The percentage of people with various ailments has increased in recent years. Environmental factors and bad dietary habits are the causes of the percentage increase. Fruits can help prevent and treat a number of illnesses because of their nutritious importance. In order to improve their health and prevent ailments, individuals are currently growing increasingly health conscious and favouring functional foods and phytonutraceuticals over medications. Because they have less negative side effects than manufactured pharmaceuticals, people from all over the world rely on medicinal plants that contain phytochemicals for their medical requirements. Nowadays, improving one's health and quality of life is a top priority for everyone, whether that be through the use of synthetic chemical medications like multivitamins or through the use of supplemental foods or dietary supplements.

ACKNOWLEDGEMENT: We would like to take this opportunity to thank everyone who has contributed to the success of this review article. With their dedication, blessings, and sincere support, numerous people have made significant contributions. I want to thank our mentors, Harshal Chavan and Kartiki Bhandari, for their constant support, encouragement, expertise, insight, and positive attitude in resolving any problem. Additionally, they supplied the infrastructure needed to support our study work. We appreciate the thoughtful conversations and recommendations from our peers and colleagues that deepen our comprehension of the subject.

CONFLICT OF INTEREST: NA

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How to cite this article:
Janhavi GV, Sneha PK, Yash CS, Harshal CP, Kartiki BM and Sunil AV: Fruits phytochemicals: a comprehensive review of their nutraceutical benefits. Int J Pharmacognosy 2025; 12(7): 562-75. doi link: http://dx.doi.org/10.13040/IJPSR.0975-8232.IJP.12(7).562-75.