

PHYTOCHEMISTRY, NUTRITIONAL AND MEDICINAL VALUE OF KIWI FRUIT

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Summary: Current studies were performed to review the phytochemistry, nutritional and medicinal value of kiwi (*Actinidia deliciosa*). Kiwi is one of the richest sources of vitamin C, vitamin E along with folate, phenolic compounds, dietary fibers, and sufficient amount of essential minerals including zinc, copper, potassium so rate as a, highly healthy food. Having immense amount of vitamin C, it is highly recommended for bones and teeth issues, also to heart patients to avoid narrowing of arteries. For having much antioxidant, antitumor and anti-inflammatory properties kiwis are pointed for a promising treatment of catastrophic diseases involving cancer, heart disease, gastrointestinal issues and nervous disorders. For having strontium, biotin and collagen fibers, kiwis are considered an excellent fruit for sleep regulation, for healthy nails, hairs and teeth. However, processing of its extracts may affect the physiochemical and biological properties of kiwifruit derives ingredients. Allergens, mycotoxin, pesticides and heavy metals are the chemical hazards of kiwifruit.

Keywords: kiwi, phytochemicals, nutrients, disease treatment

INTRODUCTION

Kiwifruit (**Fig. 1**) belongs to genus *Actinidia* and its known to all over the world especially due to its health-promoting effects and delicious taste [28]. The fruit has a unique look and flavor along with rich amount of vitamin C [10]. Kiwi got its name from the land of New Zealand. The plant was originated in Chang Kiang valley (Yang Tao) of northern China [11]. It is also called Macaque peach, Mihoutau, and Chinese gooseberry [50]. Kiwi fruit is approximately 3 inches long with a weight of four ounces [63]. There are about 50 types of kiwi fruit, each has different characteristics, frost tolerance, and flavor [30]. Kiwi fruit is also consumed as fresh, as dried and frozen fruit, marmalade, juice, as jam, as jelly and nectar, etc. Its juice is traditionally used as a meat tenderizer in some cultures [21].



FIGURE 1. Kiwi fruit

<https://plantinstructions.com/tropical-fruit/how-to-grow-kiwi-in-a-pot/>

Kiwi holds its great position in highly nutritious, low-calorie fruits having a potential to deliver great benefits to health [75]. The content of soluble dietary fiber maintain issues of hunger, for having negligible calories it is helpful to lose weight and extra fat from body [60]. The kiwi fruit is also known for its medicinal use in China [27] as it find applications in reduction of irritability, relieving rheumatism, curing of hemorrhoids, prevention of kidney or urinary tract stone, prevention of the premature greying of hairs and also aids in digestion [9].

Current studies were performed to overview the phytochemistry, nutritional and medicinal value of kiwi fruit.

PHYTOCHEMISTRY OF KIWI

The green color of kiwifruit is due to the presence of Chlorophyll [70]. The study of aroma active components and their profile in kiwi fruit are done by Multidimensional Gas Chromatography olfactometry (GC/GC-O) and Gas chromatography- Mass Spectro-photometry (GC-MS) [88]. The chemical composition of kiwifruit in their roots, peel and pulp are discussed below.

PHYTOCHEMICALS IN ROOTS

There are a total twelve compounds (β -Sitosterol, *n*-stearic acid, Iso-scopoletin, Dimethyl chromancarboxylic acid, Fraxetin, Aesculetin, Umbelliferon, Va-

nillic acid, Protocatechuic acid, Vanillic acid 4-*O*- β -D-glucopyranoside, 5, 7-dihydroxychromone, Tachioside) that are present in the roots of *Actinidia* [24, 83]:

β -Sitosterol: Its chemical structure is similar to that of cholesterol. It has characteristic odour and are of white waxy powder, one of the components of the food additive E499 and studied for its potential to reduce benign prostatic hyperplasia [51], and blood cholesterol levels [77].

***n*-stearic acid:** It has a waxy solid appearance and is mainly used in the production of cosmetics, in detergents, and in soaps, such as shampoos and shaving cream products [1].

Iso-scopoletin: It shows substantial inhibition against the cell proliferation, and multidrug resistant subline and also shows inhibitory activity against HBV replication [55].

Dimethyl chromancarboxylic acid: It used in the preparation of copolymers such as polyamides and polyesters, most widely used in the industry is adipic acid, which is a precursor used in the production of nylons [42].

Fraxetin: It has a role as an Arabidopsis thaliana metabolite, an antimicrobial agent, an apoptosis inhibitor, an apoptosis inducer, an antioxidant, an anti-inflammatory agent, a hepatoprotective agent, an antibacterial agent and a hypoglycemic agent [90].

Aesculetin; Aesculin is used as a vasoprotective agent, and in laboratory to aid in the identification of bacterial species [13].

Umbelliferon: also known as 7-hydroxycoumarin, Umbelliferon is a fluorescing compound used as a sunscreen agent [61].

Vanillic acid: is used as a flavoring agent. It is an oxidized form of vanillin [54].

Protocatechuic acid: (PCA) dihydroxybenzoic acid, type of phenolic acid. It is an antioxidant polyphenol present in the metabolite of green tea. PCA shows particularly mixed effects on both normal and cancer cells [47].

Vanillic acid 4-*O*- β -D-glucopyranoside: It is belonging to a compound known as hydrolyzable tannins which is phytotoxic against different species, but not for human but for veterinary use [49].

5, 7-dihydroxychromone: is a natural antioxidant extracted from plants [66].

Tachioside: Tachioside has antioxidant and α -glucosidase inhibitory activities, decreases lipid content in adipocytes by inhibiting lipogenesis, shows anti-obesity activities, inhibit nitric oxide production in lipopolysaccharides [24, 83].

PYTOCHEMICALS IN PEEL

The analysis of crude extract from the peel of kiwi led to the isolation of **vitamin E, alpha- and delta-tocopherol** and **2, 8-dimethyl-2- chroman-6-ol**, natural antioxidants that inhibit oxidation of the lipid in biological systems by the stabilization of hydroperoxyl and other free radicals [12]. Tocopherol oil stability in-

creases due to its antioxidant activity [39]. **7 sterols, triterpene ursolic acid** and chlorogenic **acid** are the esters of caffeic and quinic acid, act as an intermediate in biosynthesis of lignin, Kiwifruit contains phenolic compounds: flavonoids and anthocyanins. Antioxidant is the primary function of flavonoid. Studies show that in the skin of kiwi there may be more concentration of phenolic compounds [70].

PHYTOCHEMICALS IN PULP

Two caffeic acid **coumarin glucosydes** and **glucosyl derivatives** are isolated by the chemical fraction of pulp crude extract which is used as a flavoring agent profusely in pharmaceutical preparations. Besides the three vitamin E, beta-sit sterol, stigma sterol, and chlorogenic acid, Delta (7) isomer, camp sterol, and some flavone and its molecules are also present in it [71, 88, 99].

AROMATICITY

The aroma in kiwi fresh puree and its aqueous essence are due to of 35 total components contribution which include; methyl-butanol, ethyl furan, cyclohexanone, hexanol, methyl-2-butenal, 3-methyl-2-butanone, 2-methyl-1-butanol, 2,6-nonadienal, 3-methyl 3-buten-2-one, and octane, hexyl hexanoate, 3-methyl-1-butanol, diethyl succinate, 3-hydroxy-2-butanone, 3-penton-2-ol [44].

Researchers believe that the defense systems may be able to reduce the risk of developing some catastrophic illnesses due to phytochemicals and natural components of plants [70]. These phytochemicals can help to stimulate the enzyme secretion that deactivate carcinogens (cancer-causing chemicals). They also decrease the risk of developing heart and cancer disease. Kiwifruit contains carotenoids: carotenes (primarily beta carotene), Lutein, and xanthophyll's. Diet high in foods containing carotenoids reduced the risk of cancer, heart disease, cataracts, and muscular degeneration [24].

NUTRITIONAL VALUE OF KIWI

Kiwi is highly rich in nutrient contents as shown in **figure 2**. Nutrient percentage of kiwi fruit in per calorie is nearly more than any other fruit. It contains zero sodium, zero cholesterol very less fat along with a heavy amount of dietary fibers, natural sugar, minerals and Vitamins [16]. Vitamins and minerals give perfect nutrition to the body. It maintains balance in the digestive system of body [74]. The important nutritional contents of kiwi fruit are discussed below:

VITAMIN C: In per 100g of fresh weight green cultivars there are typically 80-120mg of vitamins C present [7, 52]. In per 100 g of Sun Gold kiwifruit, it



FIGURE 2. Nutritional value of kiwi
<https://www.herbazest.com/herbs/kiwi>

contains 161.3mg of Vitamin C which is almost 3 times higher in concentration than in oranges and strawberries [74]. **Figure 3** shows the vitamin C content of kiwi in comparison to other fruits [73, 74].

Deficiency of Vitamin C cause fatigue and lethargy which can be resolved by the supplements of vitamin C [20]. Vitamin C is the cofactor of metalloenzymes necessary for the biosynthesis of neurotransmitters, catecholamine, peptide hormones and collagen-carnitine [3].

VITAMIN E: World widely about 35 000 tons of Vitamin E is manufactured per year, due to its wide applications in the pharmaceutical, food, and cosmetic industries [89]. It plays very important role in the prevention and treatment of many disorders for the promotion of health. Total of 15 mg (22.4 IU, International Unit) of vitamin E is recommended daily to adults [68]. Compared to other commonly consumed fruits Kiwifruit contains relatively high level of vitamin E [9]. Sun Gold kiwi contain 1.40mg and green contain 1.41mg of vitamin E in per 100g [41], the α -tocopherol is also present in its flesh [13] These are sufficient levels to identify a new form of vitamin E in kiwifruit, δ -tocomonoenol, it's antioxidant

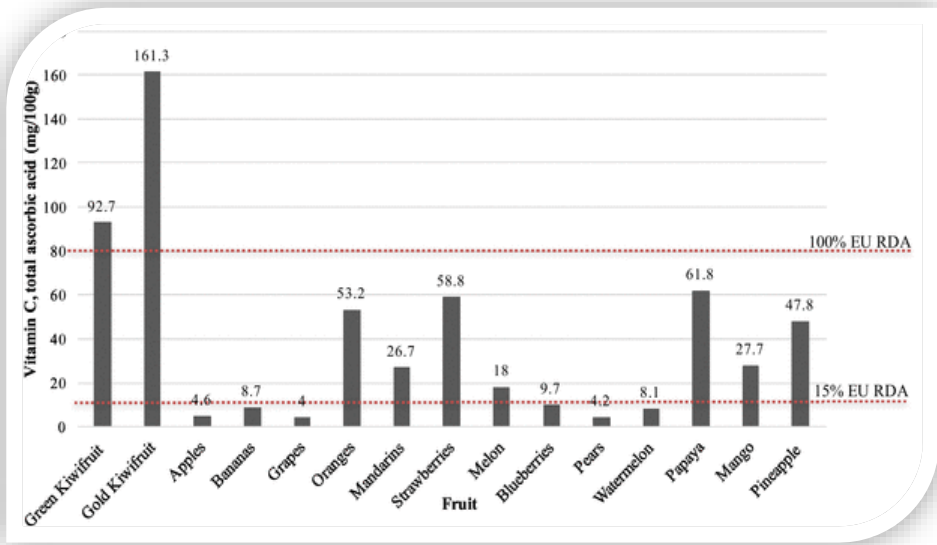


FIGURE 3. Comparing of vitamin C content of kiwi with other fruits [74]

and radical scavenging capacity contributed to the total antioxidant activity of kiwifruit (Fiorentino, et al. 2009). Vitamin E in kiwifruit are bioavailable that correlates with increased plasma of vitamin E concentrations by the consumption of both green and golden kiwifruit [19, 38].

FOLATE: Kiwifruit is a good source of dietary folate. The content of folate in green and golden kiwifruit compared with other commonly consumed fruits are shown in **figure 4**.

The folate in vegetables are easily destroyed by cooking so it is extremely labile compound, during maternity process when it was difficult to meet folate requirements [32] fresh kiwis make a useful contribution in total diet [94].

POTASSIUM: Potassium is a mineral that our body needs each day in relatively higher amount as compared to iron and zinc. The National Academies Institute of Medicine recommends that to buffer the effects of sodium and to promote normal blood pressure levels, in a day healthy adult consume at least 4,700 milligrams of potassium [85]. Intake of kiwifruit and bananas is a very good way to boost potassium. Green and gold kiwifruit contain typically 301-315mg of potassium in per 100g of kiwi. The sodium content of kiwi is only 3mg per 100g and can be described as naturally low in sodium.

According to the recommended value of sodium to potassium (Na^+/K^+) ratio, kiwifruit is amongst the most favorable balanced Na^+/K^+ selected fruit and its consumption increase potassium rich diet that can lower blood pressure and

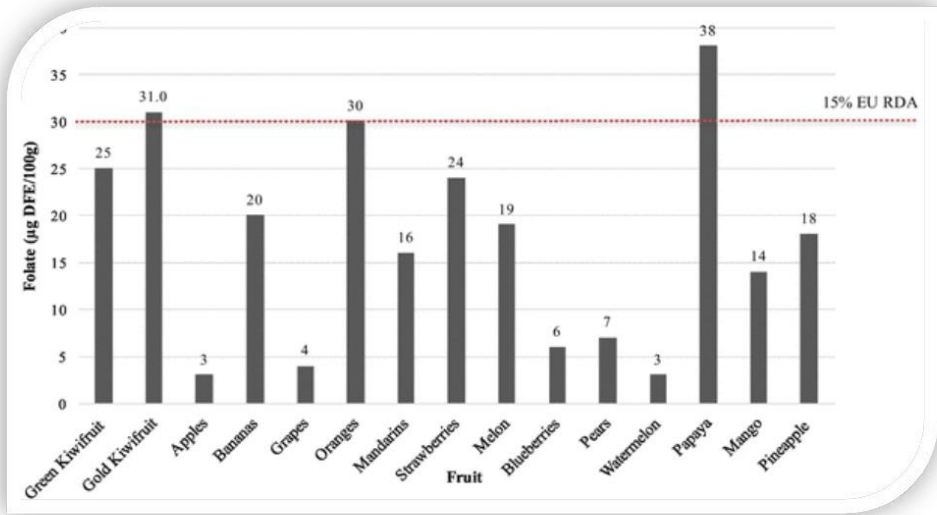


FIGURE 4. Comparing folate content in kiwi and other common fruits [74]

hypertension [80]. Two green kiwis provide 12 percent of daily recommended potassium value, same as banana intake in body [36, 15].

It is evident that consumption of potassium- According to the USDA, golden kiwi is higher in the percentage of potassium than green kiwi [62]. **Figure 5** shows the comparison of potassium content with other fruits [73].

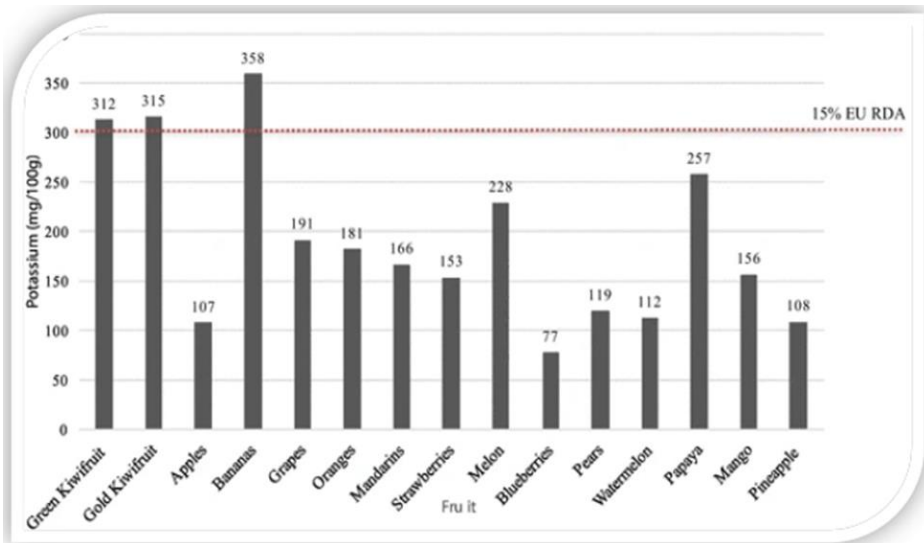


FIGURE 5. Comparing of potassium content in kiwi and in other fruits [74]

DIETARY FIBRE

The cell walls of kiwifruit particularly contain polysaccharides major structural component of these walls, which provide dietary fibers. It contains 2-3% of non-starch polysaccharides [79], that makes the cell wall of fruits, providing both soluble and insoluble fibers to diet [75]. Soluble fiber forms a gel that slows down the emptying process of the stomach contents, it is dissolves in water and comes from the inside of plant cells. Instead, Insoluble fibers add bulk to stool, and keeps it moving through the digestive tract, it doesn't dissolve in water and comes from the walls of plant cells. A single large kiwi fruit contains 1 gram of insoluble fiber and 0.7 gram of soluble fiber [35].

TABLE 1. (Dietary Guidelines for Americans 2015-2020)

	NUTRIENTS	AMOUNT IN 1 KIWI (69 G)	DAILY ADULT REQUIREMENT
1	Energy (calories)	42.1	1,600-3,000
2	Carbohydrate(g)	10.1, including 6.2 g of sugar	130
3	Fiber(g)	2.1	22.4-33.6
4	Calcium (mg)	23.5	1,000-1,300
5	Magnesium(mg)	11.7	310-420
6	Beta carotene (mcg)	35.9	No data
7	Folate (mg)	17.2	400
8	Vitamin C (mg)	64	65-90
9	Copper (mg)	90	890-900
10	Vitamin E	1.0	15
11	Phosphorus (mg)	23.5	700-1,250
12	Potassium (mg)	215	4,700

CARBOHYDRATE

10 grams of carbohydrate are present in one normal-sized green kiwi. Out of Total 10.1 grams, 6.2 grams of carbohydrate are from naturally occurring sugars and 2.1 gram from fibers. Kiwis are fruit of low glycemic acid with a value of 52 [82].

The **table 1** below shows the amount of specific nutrients in weighing 69g kiwi-fruit that an adult need per day by the Dietary Guidelines for Americans 2015-2020. where's requirements may vary, depending on person's gender and age [93].

SUGARS

When kiwis are ripened and ready to eat, glucose and fructose are predominant sugars present in it with trace amount of sucrose. Ripening of fruit, leads rapid increase in the concentration of fructose and glucose and decrease in starch concentration. Although the tissues of Kiwifruit are very hard but firmness of flesh decreases at later stages of its development [6].

With the variety and maturity function of kiwifruit the number and ratios of these sugars may vary [64]. The ratio of fructose: glucose should be around 1:1 for digestive health which reduce discomforts of gastrointestinal, such as bloating that caused due to the fermentation in gut. During ripening chlorophyll content is decreased and carotenoids and anthocyanins become dominant. The glycemic response effect of kiwis are potentially different in the management of blood sugar levels [64], relatively low 39.3 ± 4.8 to 48.5 ± 3.1 in green and golden kiwis [78]. Its low GI value is observed in both healthy and in the diabetic patients [56].

MEDICINAL VALUE OF KIWI

A. Chinese's shows a broad range of Pharmacological properties including Anti-tumor, Antioxidant, Anti-inflammatory, Immunoregulatory, Hypolipemic, Anti-diabetic, and Cardiovascular Protective activities, that may possibly be valuable in the prevention and treatment of anthologies associated with cancer, oxidative stress, and aging [34].

Healthful attributes of kiwifruit are high level of ascorbic acid [4, 67], polyphenols, and the presence of flavon [27].

SUPPORT HEART HEALTH

kiwifruit is a heart-healthy superstar. The folate in kiwis are associated with a low risk of blood clots, cardiovascular diseases and stroke [40]. The potassium in it helps to control BP and counteract sodium, relax blood vessels and act as a vasodilator throughout the body. The fiber along with vitamin K found in kiwis are very heart-healthy and able to prevent the buildup of calcium in the arteries that lower the risk of heart attacks [17]. As compared to other fruits, Studies shown that, people who regularly takes kiwifruit have 15 percent lowered value

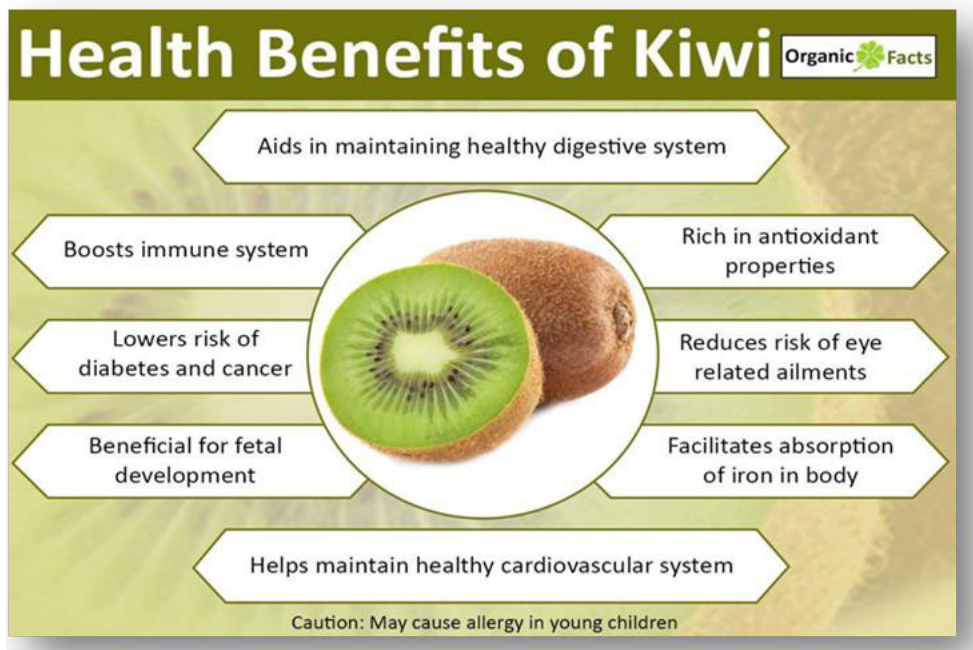


FIGURE 6. Medicinal value of kiwi

<https://diabeteswalls.blogspot.com/2019/08/benefits-of-kiwi-for-diabetics.html>

of triglycerides level [25]. Kiwifruit is also a great source of vitamin E ,omega-3s [76] magnesium and copper, which helps to keep the cardiovascular function properly, [72, 92] as similar to the daily dose of aspirin [57].

IMPROVE DIGESTIVE HEALTH

Kiwifruit are good source of both soluble and insoluble fibers. Dietary fiber increases bulk of the stool , decreases transit time of the waste, and supports in the healthy gut of bacteria that aid in digestion [18]. **Figure 7** shows the kiwi flavor digestive pills for acidity and healthy bowl function. Actinidia enzyme in kiwi enhances digestion of protein in the small intestines and stomach [26]. Adding two kiwis in patient diet introduces antioxidants and fibers, which results in the production of anti-inflammation so it improve overall bowel function [5, 65].

BOOST IMMUNITY

It is evident that adults associated with low consumption of vitamin C are with increased symptoms of bronchitis and wheezing [4], it is more stronger in asthma and bronchitis susceptible patients . Kiwifruit improve immune function and lower the severity of cold and flu-like illness in older and children [85]. The small kiwi fruit is packed with B6, B12, vitamin C, K, zinc, fiber and folate, and other nutrients all are a powerful immune-boosting punchers [76] .



FIGURE 7. Kiwi flavor digestive pills

<https://i3.pureformulas.net/images/product/altImg/large/kiwi-regularity-kiwi-flavor-30-relief-chews-by-enzymedica-extra2.jpg>.

GOOD FOR VISION

Kiwis protect from muscular degeneration which is the leading cause of vision loss [8]. Macular degeneration, deterioration of the retina and the age factor are considered the main reasons for vision loss. Retina, macula, is made of lutein and zeaxanthin, 220 mg of zeaxanthin and lutein are present in a cup of kiwi, which rebuild macula and prevent many eye diseases [14, 43, 69].

AID PREVENTION IN IRON DEFICIENCY ANEMIA

Bleeding disorders abnormally increase the amount of blood both from outside and inside leaving your body. Iron deficiency anemia is due to low level of iron in body, which can make you feel tired, weak, and dizzy [46]. A 2004 publication of “American Journal of Clinical Nutrition” evident that taking 63 milligrams of vitamin C rich meal results in non-heme iron that can increase three-fold of overall iron absorption, fresh kiwi fruit contains high amount of vitamin C like pineapple, oranges and peaches [48].

SUPPORT SKIN HEALTH

Collagen is a protein that contributes vastly to skin health by enhancing elasticity, reducing wrinkles, and healing wounds. The vitamin C in kiwi aids in collagen synthesis. Kiwi also contains tocopherol, the major form of vitamin E. **Figure 8** shows the use of kiwi in the flavoring of soap and in cosmetics.

One animal study revealed that topical use of vitamin E reduced acute and chronic damage from UV irradiation, moreover using kiwi externally on your skin may remove the spots of wounds [59].



FIGURE 8. Kiwi flavor soap

<https://www.kiwishoponline.com.au/eshop/images/P/Kiwifruit%20Soap%20100g.jpg>

PREVENT CHRONIC DISEASE

Many factors can cause oxidative stress, including ozone, certain pesticides, cigarette smoke, radiation, and pollution. Oxidative stress can damage our DNA, leading to several chronic health issues like cancer, heart disease, and diabetes [22]. There is evidence that eating kiwi or kiwi extracts has a protective effect against oxidative stress. Kiwis have antioxidants that makes this all possible [97].

IMPROVE SLEEP

The serotonin in kiwifruit increase efficiency of sleep by 5 to 13 percent. serotonin may also boost memory and helps to reduce depression [8].

HEALTHY FUNCTION OF NERVOUS SYSTEM

Copper is an important mineral for the healthy function of nervous system, but it is present in trace amounts in many foods.

A cup of kiwi contain 20 percent of daily recommended copper amount, which make it an unusually rich source of copper as compared to other fruits [8]. Maintained optimal nervous system improve function of retina part of eye that contained nerves to convert images into electrical impulses for interpretation of brain hence improve eyesight [95].

LOWER BLOOD PRESSURE

Presence of bioactive substances may lower blood pressure (BP) and improve function of endothelial [87]. AS compared to one apple a day ,intake of three kiwis can lower systolic and diastolic level in 24-h in men and women having moderately raised BP [86]. It also shows beneficial effect in platelet aggregation in male smokers [37].

PREVENT BLOOD CLOTING

Blood clotting can cause complications if not discovered and treated at time, adopting an anti-inflammatory diet which is high in omega-3 and vitamin E helps a lot and kiwi Is consider one of the best fruit for preventing blood clotting [87].

PREVENT AGAINST CANCER CELLS

Studies shown that the extract of kiwi fruits provide inhibition against growth of cancer cells [98] and protect cell against oxidative DNA damage [23]. Colo-rectal cancer is cancer of colon (large intestine or rectum), both of these organs are in the lower portion of the digestive system it is cured by taking fruits rich in vitamin C, K, and fiber and kiwi have these vitamins in sufficient. amount [2, 57].

FOR PREGNANT WOMENS

Vitamin C produce collagen- elastic-like material and boosts up immunity that is responsible for the generation of connective tissues in a body that fasten the healing power of pregnant women's. Lack of B9 cause error in baby body called Spina Bifida. Kiwi fruit, for having higher percentage of Folate content provide prevention against such issues [94].



FIGURE 9. Kiwi flavor nail paint remover
<http://www.hairproducts.com/images/hp-nai-sup106.jpg>

FOR BONES, TEETH AND NAILS

Biotin present in it may help to support nails [45]. **Figure 9** shows the kiwi flavor nail paint remover for healthy nails. Kiwis have fiber content and packed with calcium, which is a super dental mineral, Calcium neutralizes damaging acids, and helps to boost enamel defense [31]. It is an excellent source of Vitamin K hence proves good in the development of stronger bones [33].

ANTIOXIDANTS

Due to the antioxidant chemical profile of Actinidia species it has been extensively studied [81]. Antioxidants includes the carotenoids lutein, caffeic acid glucosyl derivatives, β -sitosterol, quinic acid ,zeaxanthin , β -carotene, chlorophylls, chlorogenic acid, and phenolics, including flavones and flavanones [53].

Various invitro chemical assays monitor the antioxidant capacity of kiwifruit by means of scavenging, retarding , or quenching of free radical generation [84].

For example, the total antioxidant capacity reported in kiwifruit is higher than an apple, pear and grapefruit, but less than strawberry ,raspberry , plum and orange [5]. These in-vitro studies indicate that antioxidants are preventive against delaying of cell damage, from unstable free radicals that are created each day during normal metabolic activities [29, 96]. In general, it has potential to inhibit inflammatory and oxidative processes [58, 91].

CONCLUSIONS

The increased in research data and growing consumer awareness about the health benefits of kiwifruit provide logical motivation for their regular consumption as part of a balanced diet. Having vitamin C, vitamin K and essentials minerals it is good for bones, teeth, hairs and nails. It contains vitamin B3 involved in DNA repair and for skin health Vitamin B12 which supports normal production of blood, Vitamins, B1, B2, and B6 in it helps in the healthy functioning of the nervous system kiwifruit has been shown to accelerate gastric and colonic transit, soften the stools, and to improve constipation. Kiwifruit should be considered as part of a natural and effective dietary strategy to tackle some of the major health and wellness concerns around the world. Due to its antioxidant and anti-inflammatory properties it is highly recommended fruit in these days of pandemic where to improve immune system is higher priority.

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