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REVIEW ON ANALYSIS OF KIWI FRUIT AND KIWI PEEL EXTRACT

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Abstract: The current study evaluated four different solvent compositions for their proportional ability to extract total phenolic, total flavonoid, and total tannin (TF and TT) components from the peels of kiwis (Actinidia Deliciosa Planch), as well as to profile the composition of these plant by-products and to measure their antioxidant, antimicrobial, and anticancer activities. Chemical studies revealed that the content of moisture, protein, crude fat, total carbs, and ash was 85.27% of fresh weight, 12.62, 3.70, 76.92, and 6.50% of dry weight, respectively. Kiwifruit is widely known for its ability to combat digestive difficulties, cardiovascular illnesses, skin health, diabetes, inflammation, and microbial activity, among other things, making it ideally suited for therapeutic interventions.

Key words: Kiwifruit, Nutritional composition, therapeutic uses, Kiwi extract, Kiwi Peel

1. INTRODUCTION

The edible fruits produced by plants in the genus actinidia are known as kiwifruit. Kiwi plants originated in China, where they grow wild, and were transferred to New Zealand by missionaries in the early twentieth century, when they were finally tamed and grown. Kiwifruit are nutrient-dense fruits that are high in Phytonutrients, minerals, and vitamins that improve one's health (Stonehouse et al., 2013). It is exceptionally high in sugars (glucose and fructose), vitamin C (420mg/100g), vitamin A, E, K, fiber, flavonoids, antioxidants (beta-carotene, xanthin, and lutein), and minerals (potassium as 312 mg/100g, zinc, selenium, magnesium, iron, copper), all of which provide functional and metabolic benefits. Kiwifruits also have laxative action, digestive characteristics, cardiovascular protective qualities, anti-diabetic properties, anti-inflammatory properties, and antibacterial properties (Ma et al., 2019). Kiwi fruit is used to make dried kiwifruit, jams, jellies, nectars, and many more products. As a result, this study focuses on the therapeutic profile and significant health advantages of Kiwifruit (Actinidia deliciosa). Actinidia fruits are botanically berries with many black seeds encased in a delicious pericarp. The most popular commercial cultivar with exceptional flavor is Actinidia deliciosa (A. Chev.) 'Hayward' ('green' kiwifruit). It's an oval berry the size of a hen's egg, with a light brown hairy exterior and emerald-green flesh containing numerous small black seeds trapped in a luscious pericarp. Fruits of Actinidia deliciosa feature long, stiff, bristlelike hairs that are partially removed during grading and packing.

2.Nutritional Composition

Fresh A. deliciosa and A. chinensis fruit's nutritional profile per 100 g is shown in Table 1 (US Department of Agriculture, 2011). Kiwifruit are rich in vitamin C, dietary fiber, and various phytochemicals that are good for your health. Magnesium and potassium levels are also high. A. deliciosa that is ripe contains carotenoids such b-carotene, lutein, violaxanthin, and neoxanthin as well as chlorophylls a and b. The cyclic sugar alcohol myoinositol, which is present in many meals, is also extremely abundant in kiwifruit. Early fruit growth had a high myoinositol level, which decreased to 1-2% as the fruit ripened. The kiwifruit does not contain a lot of energy.

A. Fibers

About 2-3% (fresh wt) of kiwifruit's weight is made up of nonstarch polysaccharide. According to recent studies, the dietary fiber in green and gold kiwifruit is made up of roughly one-third soluble fiber and two-thirds insoluble fiber. Gold kiwifruit, however, have less nutritional fiber than green varieties. Pectic polysaccharides make up the soluble portion of fibers, whereas cellulose, hemicellulose, and minor amounts of pectin make up the insoluble portion. 10% of the daily required dietary fiber intake can be met by kiwis.

B. Sugars

The three main sugars found in Actinidia are glucose, fructose, and sucrose. With different kiwifruit varieties and maturation phases, sugar content and ratios change. In A. deliciosa Hayward, a total sugar content of 8.4 g 100 g^{-1} fresh wt was recorded. According to the New Zealand Institute for Plant & Food Research, fresh weight samples had total sugar contents ranging from 7.7 to 10.8 g 100 g^{-1}. Kiwifruits have a low glycemic index, and the sugar they contain helps to regulate blood sugar levels.

C. Protein

The protein content of kiwis is not very high. Actinidin, a cysteine protease found in kiwifruit, is well known for its capacity to hydrolyze proteins. Actinidin makes up 40% of the soluble protein in green kiwifruit, making it the most prevalent soluble protein. Kiwellin and a protein that resembles thaumatin are among the other proteins found. There are studies that detail how actinidin helps with digestion and digestive motility.

D. Vitamin E

Vitamin E levels in kiwis are fairly high, and the major a-tocopherol form of the vitamin is found in the flesh, where it may be more accessible. D-tocomonoenol, a novel type of vitamin E, has been discovered in kiwifruit. The seeds of kiwifruit are the only parts of the fruit that contain any lipids. From the raw pulp extracts of Hayward, three vitamin E forms—b-sitosterol, stigmasterol, and its D isomer—were discovered.

E. Carotenoids

The carotenoid molecules b-carotene, lutein, violaxanthin, and neoxanthin are among those found in kiwifruit. The most prevalent carotenoids are lutein and beta-carotene. Kiwifruit has the greatest concentration of lutein among the numerous regularly consumed fruits, ranging from 0.09 to 1.080.17 mg 100 g^{-1} fresh weight. The highest concentrations of lutein are found in A. arguta and A. rufa, followed by A. deliciosa and A. chinensis. Similar levels of b-carotene can be found in A. chinensis and A. deliciosa (0.070.01 to 0.150.04 mg 100 g^{-1} fresh wt), with A. arguta having the highest level (0.290.04 mg 100 g^{-1} fresh wt). The overall carotenoid concentration of green variants is typically higher than that of gold/yellow kinds.

F. Organic Acids

The main acids in kiwifruit are citric, malic, and quinic acids, along with considerably lower levels of glucuronic and galacturonic acids. In kiwifruit, quinic acid is present in very high proportion. Other fruits often contain tiny levels of quinic acid. Kiwifruit acidity is also influenced by ascorbic acid.

G. Phytochemicals

The identification of two caffeic acid glucosy derivatives, two coumarin glucosides, campesterol, chlorogenic acid, and a few flavone and flavanol substances came from phytochemical study of crude extracts of kiwifruit pulp from "Hayward." In kiwifruit juice, phenolic components were distinguished and identified. Juice had a low concentration of phenolic chemicals. The most prevalent 3,4-dihydroxybenzoic acid derivatives, coumaric and caffeic acid derivatives, protocatechuic acid, and chlorogenic acid are among the strongly acidic phenolic acid compounds that have been found. The weekly acidic phenolic acid in clarified juice is composed of catechin, epicatechin, procyanidin dimers, and oligomers. The flavanols that are present are the glucoside, rhamnoside, and rutinoside glycosides of quercetin and the rhamnoside and rutinoside glycosides of kaempferol. Kiwifruit's anthocyanin level overall is smaller than that of many other berries, hence it makes little difference in the fruit's antioxidant capability. Anthocyanins are located in a ring around the fruit's center in A. deliciosa. Cyanidin-3-O-xylo-galactoside, with lower levels of cyanidin-3-O-galactoside, was the main anthocyanin found in A. chinensis. The two main anthocyanins found in A. deliciosa are cyanidin 3-O-galactoside and cyanidin 3-O-glucoside; no cyanidin-3-Oxylo-galactoside was found.

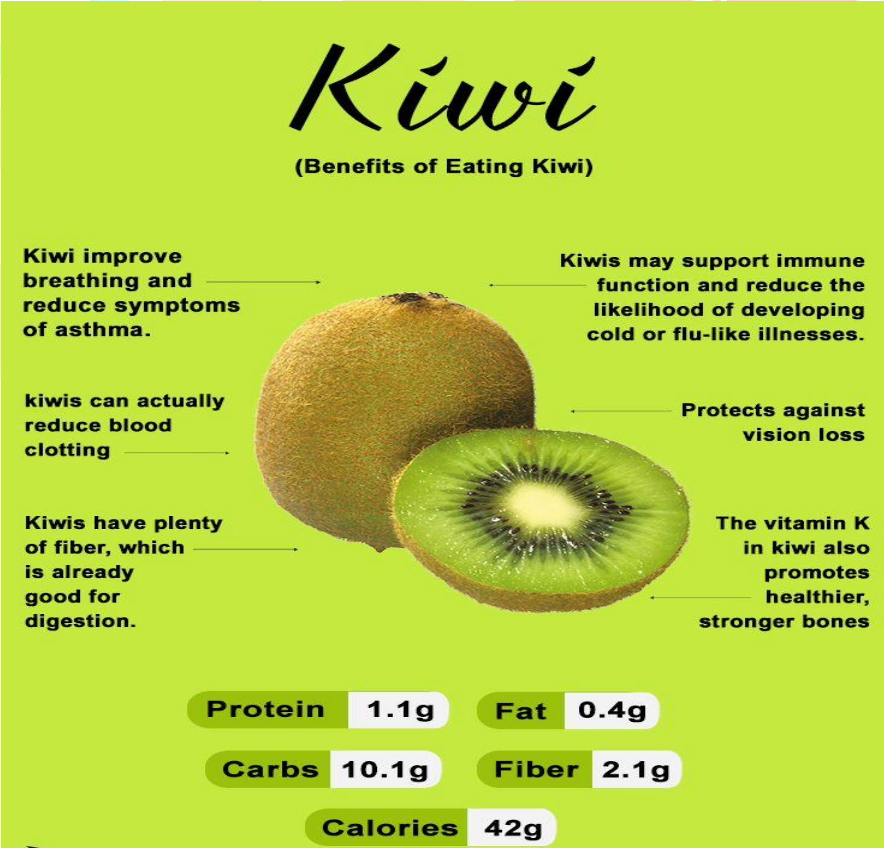

Table 1 Nutritional composition of kiwifruit in 100 g edible portion[a]

Nutrient	*Unit*	Actinidia chinensis *Yellow kiwifruit (Hort16A)*	Actinidia deliciosa *Green kiwifruit*
Proximates			
Water	g	83.22	83.07
Energy	kcal	60	61
Protein	g	1.23	1.14
Total lipid	g	0.56	0.52
Carbohydrate	g	14.23	14.66
Total fiber	g	2.0	3.0
Total sugars	g	10.98	8.99
Minerals			
Calcium, Ca	mg	20	34
Iron, Fe	mg	0.29	0.31
Magnesium, Mg	mg	14	17
Phosphorus, P	mg	29	34
Potassium, K	mg	316	312
Sodium, Na	mg	3	3
Zinc, Zn	mg	0.10	0.14
Vitamins			
Vitamin C	mg	105.4	92.7
Thiamin	mg	0.024	0.027
Riboflavin	mg	0.046	0.025
Niacin	mg	0.280	0.341
Vitamin B6	mg	0.057	0.063
Folate, DFE	µg	34	25
Vitamin A, RAE	µg	4	4
Vitamin A, IU	IU	72	87
Vitamin E	mg	1.49	1.46
Vitamin K	µg	5.5	40.3
Choline	mg	5.0	7.8
Lipids			
Total saturated fatty acids	g	0.149	0.029
Total monounsaturated fatty acids	g	0.036	0.047
Total polyunsaturated fatty acids	g	0.207	0.287
Cholesterol	g	0	0

[a]Source: The USDA National Nutrient Database for Standard Reference.

3. Material and Methods :

A. Plant material

Actinidia deliciosa kiwi fruits were purchased from the local Giza, Egypt, market. Chemicals and reagents: The analytical grade chemicals used in this investigation were all manufactured by Sigma (US), Aldrich, and Biodiagnostic Company.

B. Preparation of sample

A sharp knife was used to wash and separate the kiwi fruit from the peels. Kiwi peels were peeled, powdered, and then kept in the refrigerator at -4 °C until extraction by air-drying for ten days, followed by three days of drying in an oven at 40 °C.

C. Preparation of kiwi peels extracts

The dried kiwi peel samples (10 g) were dispersed separately in 100 ml of distilled water, 80% ethanol, 80% methanol, and 80% acetone for 24 hours at room temperature with shaking. Following three extraction steps, the mixture was filtered through Whatmann No. 1 filter paper. The filtrate was then concentrated in a rotary evaporator to dryness at 40 °C. Before analysis, the raw extracts were kept in a refrigerator.

D. Proximate analysis

According to AOAC[3], the amounts of moisture, ash, crude protein, total fat, total carbs, and macro-microelements were measured.

Table : 2

Proximate analysis of kiwi peels

Proximate analysis*	Composition (%)
Moisture	85.27± 0.18
Carbohydrate	76.92+0.76
Crude fat	3.70±0. 55
Crude protein	12.62± 0.56
Ash content	6.50± 0.40

* The other compounds than water were expressed to dry weigh bases.

E. Total phenolic content

According to Singleton and Rossi[4], the total phenolic content (TP) of kiwi peel extracts was spectrophotometrically assessed using the Folin Ciocalteu reagent assay and gallic acid as the reference. At 750 nm, the absorbance was measured using a spectrophotometer (Unicum UV 300). Gallic acid equivalents (GAE)/g dry weight sample was used to measure the total phenolic content in the samples. Each sample was examined three times.

F. Total flavonoid content

Using quercetin as a reference substance, the aluminum chloride method was used to spectrophotometrically measure the total flavonoid concentration (TF) of kiwi peel extracts. At 510 nm, the absorbance was measured using a spectrophotometer (Unicum UV 300). The sample's total flavonoids were calculated as mg quercetin equivalents (QE)/g dry weight. Each sample was examined three times.

G. Total tannins content

According to Polshettiwar et al[5], the total tannin content (TT) of kiwi peel extracts was determined using the Folin-Ciocalteu reagent. A spectrophotometer (Unicom UV 300) was used to detect absorbance at 775 nm in comparison to a produced reagent blank. The sample's total tannins were calculated as mg tannic acid equivalent (TE)/g of dry weight. Each sample was examined three times.

H. Identification of phenolic compounds by HPLC

Ben-Hammouda et al[6] report that phenolic components in kiwi peel acetone extract were detected using HPLC. Agilent's 1100 series HPLC system is attached to a UV-Vis detector (G1315B) and a degasser (G1322A). Chromatographic separations were carried out on a ZORBAX-Eclipse XDB-C18 column (4.6250 mm, particle size 5 m) using sample injections of 5 l from an Agilent 1100 series auto-sampler. Two mobile phases—(A) 0.5% acetic acid in distilled water at pH 2.65 and solvent (B) 0.5% acetic acid in 99.5% acetonitrile—were utilized with a constant flow rate of 1 ml/min. Using a UV detector set at a wavelength of 280 nm, the elution gradient was linear, beginning with A and ending with B over a period of 50 minutes. By comparing the relative retention durations of the kiwi peel extract's phenolic components to those of the standard mixture chromatogram, these compounds' identities were determined. Based on peak area measurements, the concentration of a certain component was estimated and then translated to mg/100g dry weight.

4. Results and Discussion

A. Chemical studies

Chemical Composition

Tables 2 and 3 contain the results of an analysis of the kiwi peels' moisture, ash, crude protein, crude lipid, total carbohydrate, and macro- and microelement contents. The contents of moisture, ash, and protein were respectively 85.27% of FW, 6.50, and 12.62% of DW. These results exceeded those of Anhwange et al. [7] and Shyamala and Jamuna [8] in terms of value.

Minerals content of kiwi peels

Macronutrients	Concentration (ppm)	Micronutrients	Concentration (ppm)
K	2300 ± 1.74	Fe	82.26± 18.77
Ca	2300± 0.08	Cu	6.64 ± 1.14
Na	900 ± 0.02	Zn	9.26 ± 3.31
P	600 ± 0.01	Mn	14.83 ± 4.25
Mg	8200 ± 0.05	----------	-------

Table 3

Total carbs made up 76.92% and fat 3.70% of the dry weight, respectively. The amount of fat was comparable to what Mahmoudi et al[9]. had previously discovered. Additionally, the total carbohydrate was higher than that found in two different types of kiwi fruits by Parameswaran and Murthi[10], but it was lower than that found by the same authors[9], who recorded 71 g/Kg FW.

B. Biological Studies

Antimicrobial activity of kiwi peels

Table 4 lists the ethanol and acetone extracts of Kiwi peels' antibacterial and antifungal properties. At concentrations of 400 and 600 ppm, both extracts exhibit a zone of inhibition against gram-positive and gram-negative bacteria (Bacillus subtilis and Staphylococcus aureus), yeasts (Saccharomyces cerevisiae and Candida albicans), and fungi (Aspergillus flavus). 80% acetone-prepared extract has more antibacterial activity than 80% ethanol-prepared extract. With an inhibition zone of 19.82 mm for B. subtilis at 600 ppm acetone extract and 17.65 mm for St. aureus at 600 ppm ethanolic extract, kiwi peels displayed superior antibacterial activity against gram-positive bacteria.

Table : 4

Antimicrobial activity of kiwi peels extract.

Extracts	Conc. µg/ml (ppm)	Zone Inhibition (mm)						
		Bacteria				Fungus	Yeast	
		B. subtilis (+)	*St. aureus* (+)	*E. coli* (-)	*P. aeruginosa* (-)	*A. fluves*	*S. cerevisiae*	*C. albicans*
Ethanol 80%	200	00.00	00.00	00.00	00.00	00.00	00.00	00.00
	400	13.20	11.30	10.23	10.23	11.70	12.40	11.67
	600	18.16	17.65	18.15	18.15	16.56	17.66	15.25
Acetone 80%	200	00.00	00.00	00.00	00.00	00.00	00.00	00.00
	400	14.16	11.73	13.12	12.56	10.10	11.62	10.87
	600	19.82	15.50	19.52	19.50	17.85	16.81	16.52

Additionally, kiwi peel acetone (80%) extract demonstrated the highest antimicrobial activity against gram-negative bacteria, with an inhibition zone of 19.52 and 19.50 mm for E. Coli and P aueginosa, respectively, and a fungus of 17.85 mm for A. flavus at a concentration of 600 ppm, higher than that found by Chou et al[11.] For kiwi fruit at a concentration of 200 g/ml, they also reported a zone of inhibition of 7 to 14 mm against gram-positive, 9 to 13 mm against gram-negative, and 7 to 13 mm against fungus. Human and plant pathogenic bacteria, fungi, and viruses can be defeated by plant ingredients without causing hazardous side effects or environmental hazards[12].

C. Health Effects

I. Antioxidant Capacity

The cells are shielded by dietary antioxidants from the oxidative reactive oxygen species produced by various biological activities. Studies have shown that eating a diet high in fruits and vegetables can lower your risk of developing degenerative diseases like cancer and cardiovascular disease. Fruits' antioxidant potential is aided by vitamins C and E, carotenoids, and phenolic substances. In general, the antioxidant capacity of kiwifruit is considerable, and it appears that vitamin C and polyphenol content play a significant role in this. The species and cultivars of Actinidia have a significant impact on their antioxidant capacity. Numerous antioxidants, including vitamin C, vitamin E, lutein, zeaxanthin, and other phytochemicals, can be found in kiwifruit.

II. Immune Functions

A good source of several phytonutrients and other compounds linked to a strong immune system is kiwifruit. A few studies using human and animal cells have looked into the immunomodulatory effects of kiwifruit ingestion. Human blood cells' ex vivo innate and adaptive immune cell functions were markedly improved by gold kiwifruit extract. Studies on elderly adults and young children looked at how frequently consuming gold kiwifruit affected the frequency and signs of upper respiratory tract infections. These investigations showed that eating gold kiwis decreased the intensity of cold and flu symptoms in the research groups. The older persons who ate gold kiwifruit also showed increases in plasma vitamin C, tocopherol, lutein/zeaxanthin, and erythrocyte folate content.

III. Cardiovascular Diseases

When compared to a healthy control diet, eating two green kiwis per day for four weeks improved the plasma HDL-C, TC/HDL-C ratio, and apolipoprotein B/apolipoprotein A1 ratio in a hypercholesterolemic male. According to some additional research, eating 1-3 green or gold kiwis per day for four to eight weeks improved HDL-C, decreased the TC/HDL-C ratio, and lowered triglycerides in comparison to baseline levels. When compared to the control treatment, eating three green kiwis per day for eight weeks dramatically lowered the diastolic and systolic blood pressure among male smokers. A decrease in the activity of the angiotensin-converting enzyme was also noted.

IV. Anticarcinogenic Activity

Two of the 12 phenolic compounds discovered in the roots of A. chinensis shown exceptional cytotoxic action against the leukemia-causing P-388 and cancer-causing A-549 cell lines. A polysaccharide component derived from the root of A. chinensis also showed antitumorous activity in mice in a different investigation. Different gold kiwifruit extracts demonstrated targeted cytotoxicity against human oral carcinoma cell lines. Additionally, human adenocarcinoma and human liver cancer cell lines were sensitive to two triterpenoids derived from A. chinensis roots. HepG2 and HT-29 cell growth was significantly reduced by extracts from A. arguta. Kiwifruit juice or extracts demonstrated an antimutagenic activity against chemical carcinogens, such as heterocyclic amines like 2-amino-1-methyl-6-phenylimidazo [4,5-b] pyridine (PhIP), in in vitro systems.

V. Kiwifruit Allergy

Additionally, kiwis contain allergens that, in those who are sensitive, might cause allergic reactions. A 53-year-old woman who got urticaria, wheezing, and laryngeal edema after handling kiwifruit was the first to report having an allergy to it in 1981. As kiwifruit use has expanded globally since then, there have been an increasing number of reports of allergy to this fruit. A kiwifruit allergy may manifest itself in a number of ways. Oral allergy syndrome and urticaria are frequent manifestations of kiwifruit allergy symptoms. The symptoms of oral allergy syndrome include mouth, lip, and throat itching, throat and lip swelling, and the development of tiny blisters on the oral mucosa. Indigestion, nausea, vomiting, Kiwifruit 493 wheezing, skin rashes, and other serious allergic responses like anaphylaxis have also been recorded as symptoms. Kiwifruit consumption can cause allergy in some people, but pollen and latex allergies are more common in others. This is because the allergens in kiwifruit and natural rubber latex, a condition known as the latex-fruit syndrome, are comparable to one another.[13]

5. Conclusion

1. Kiwi peels in acetone have antioxidant and antibacterial properties; hence, acetone would be a good solvent for kiwi peel extraction.

2. Kiwi fruit peels make excellent antioxidant and antibacterial sources for food goods, according to research. For the isolation of bioactive components and biological assay techniques for therapeutic formulations, more research is advised.[14]

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