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# Nutritional and Chemical, Studies on Kiwi (*Actinidia deliciosa*) Fruits

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**Abstract**

Kiwi fruit was one of the foods found to have immune-stimulatory activity. Kiwi fruit is rich in vitamins and polyphenols and has strong antioxidant effects. Kiwi (*Actinidia deliciosa*) fruit was determined for chemical composition, minerals, anti-nutritional factors, physicochemical properties and quality to their contents of phytochemicals. The results showed that a remarkable variation in the chemical composition of demonstrated samples being reflected in the high levels of carbohydrates (80.00%), while the small values means of fat (2.54%). The potassium content showed a profoundly higher with mean value of 233.0 mg/100g, than that of the other minerals, while the lowest value recorded with copper (0.16 mg/100g). It is contain high amount of vitamin C, which was 40.0 mg/1000g. All checked samples contain low amount of anti-nutritional factors. The highest values of phenolic compounds were recorded with protocatchuic, 3-OH tyrosol and pyrogallol. The mean values were 2634.27, 2246.06 and 1809.75 mg/100g on dry weight basis, respectively. While, the highest values of flavonoid compounds recorded with apignin 6-arabinose, hespirdine and narengin. The mean values were 1762.42, 444.43 and 183.26 mg/100g on dry weight basis, respectively. As conclusion, kiwi fruit has high nutritional value and antioxidant activity. Therefore, kiwi fruit could be used in our beverages and daily dishes, besides the fact that it has so many health benefits as protect from many diseases.

**Key words:** Kiwi fruit, Chemical composition, Phytochemicals and Nutritional value.

**Introduction**

Plants in general and fruits particularly have several compounds with antioxidant properties, which include ascorbic acid, carotenoids and polyphenols. Increased consumption of fruits protects cardiovascular diseases and many diseases **(Duttaroy, and Jorgensen, 2004**).

Kiwi fruit (*Actinidia deliciosa*) is rich in many vitamins (especially, vitamin C), flavonoids and minerals. Kiwi fruit is native to South Asia. There are more than 60 species in *Actinidias* and many have commercial potential. Kiwifruit is commercially cropped in many countries such as Italy, New Zealand, Chile, France, China, Iran and Greece **(FAO, 2007)**.

Kiwi fruit is a highly nutritional fruit due to its high level of vitamin C and its strong antioxidant including carotenoids, lutein, phenolics, flavonoids and chlorophyll. Kiwi fruit is a rich source of vitamins E, fructose, galactose and minerals, its contains iso-flavones and flavonoids which are important phytochemical in kiwi extract and represent the major class of phytosterogen, which has an important function as anti-carcinogenic, neuro-protective and cardio protective activity **(Hunter *et al.*, 2010)**.

Kiwi fruit (*Actinidia deliciosa*) can be used in making jam. The low gel strength of the jam can be improved by the addition of pectin during processing to attain the commercially acceptable gel strength or a combination of fruits rich in pectin can be used to make up for the deficiency. Optimum gel formation is reported at pH 3.4 and satisfactory gel formation in tropical fruits is achieved at lower pH range. The combination with other fruits could serve to improve the flavor and the color **(Reddy *et al.*, 2015)**.

Kiwi fruit has been reportedly used in traditional medicine for relief of symptoms of numerous disorders. In light of growing consumer acceptance of kiwi fruits worldwide, there has been an increased attention given to identifying health benefits associated with its consumption. Potential benefits include a rich source of antioxidants, improvement of gastrointestinal laxation, lowering of blood lipid levels, and alleviation of skin disorders. Some individuals report allergic symptoms to kiwi fruit, and a considerable research effort is being focused on characterizing kiwi fruits allergenicity among various populations of people. Kiwi fruit not only is rich in vitamin C but also is a good source of other nutrients such as folate, potassium, and dietary fiber. This fruit's content of nutrients and biologically active

phytochemicals has stimulated investigations into its antioxidant and anti-inflammatory actions that might then help prevent cardiovascular disease, cancer, and other degenerative disorders **(Keith, 2012)**.

Kiwifruit are an outstanding source of vitamin C, and also contain reasonable levels of other important micronutrients such as vitamins B, E and K, carotenoids and the minerals Cu and Mg. Since many of these micronutrients have been associated with improved mood, it is possible that increased ingestion of kiwifruit might enhance mood, particularly in individuals with low daily fruit and vegetable intakes **(Carr *et al.*, 2012)**.

**Shehata, and Soltan, (2013)** demonstrated that consumption kiwi fruit, (fruit and seed) can modulate the risk factors of CVD (Cardiovascular diseases) by reducing the LDL-C, LDL-C/HDL-C and increasing HDL-C and HTR ratio. The results suggested that consumption of kiwifruit, fruit and avocado seed might have some cardiovascular protective properties and beneficial effects on atherosclerosis, CVD risks in hypercholesterolemic rats.

**Tifani *et al.*, (2018)** reported that process affected the physicochemical properties of durian kiwifruit pulp with significant differences on pH and color among the cultivars but it did not affect the properties of the jam. Therefore, freezing is a suitable preservation technique for durian pulp. The sensory analysis indicates that the panelists preferred the jam made from cultivars Chanee and Petruk.

Based on these properties the golden kiwifruit would be expected to show stronger protection against effects of oxidative damage *in-vivo*. To test this hypothesis, we conducted a human dietary intervention trial with golden kiwifruit, examining potential effects on platelet function, plasma antioxidant status, DNA oxidation, and base excision repair (BER), as well as nucleotide excision repair (NER) activity. Plasma malondialdehyde (MDA) was measured by HPLC. As a product of lipid peroxidation, it acts as a marker for overall oxidative stress (**Stoner *et al.*, 2007)**.

This work was conducted to study the chemical composition, minerals, anti-nutritional factors, physicochemical properties and quality to their contents of phytochemicals of kiwi fruits.

## Materials And Methods

### Materials:

The fresh fruit of kiwi *(Actinidia deliciosa*) was obtained from local market, Alexandria City, Egypt.

### Chemicals:

Folin-Ciocalteu reagent and standard substances including gallic acid, sinapic acid, caffeic acid, chlorogenic acid, *p*-coumaric acid and dihydroxy benzoic acid were purchased from Sigma Chemical Company (St. Louis, USA), vanillic acid, ferrulic acid, rutin and quercetin from Fluka St. Gallen, Switzerland. All reagents and standards were prepared using Milli-Q deionized water (Millipore, Bedford, USA). All other chemicals and reagents were of analytical reagent grade and purchased from Al-Ghomhoria Company for Drug Chemical and Medical Instroments, Egypt.

### Methods

### Preparation of kiwi fruit

A part of the fresh kiwi appropriated has been peeled and dried at $45^{o}$C for approximately 6 hours in an hot air, then minced to powder by milling using a locally Milling machine and then kept in plastic sachets at room temperature ($25^{o}C\pm2^{o}$C) according to the methods described by **Engelhart *et al.*, (2002)**.

### Analytical Methods:

Moisture, Protein (N x 6.25 Keldahl method), fat (hexane solvent, Soxhielt apparatus), fiber and ash were determined according to the method recommended by **AOAC, (2000)**.

### Carbohydrates and energy value:

Carbohydrate calculated by differences as follows:

% Carbohydrates = 100 - (% moisture + % protein + % fat + % ash + % fiber).

Energy value was estimated by the sum of multiplying protein and carbohydrates by 4.0 and fat by 9.0 according to **FAO (1982)**.

### Physicochemical Analysis:

### pH measurement:

The pH value was measured using a pH meter of a glass electrode. The pH meter was allowed to stabilize for one minute and then the pH of the samples was directly reported according to the official method of analysis **(AOAC, 1984).**

**Total Acidity:**

Titratable acidity was determined according to the official method **(AOAC, 1984)**.

**Total Soluble Solids (TSS)**:

The total soluble solids (TSS) were determined at room temperature using hand refractometer with degree °Brix scale 0- 50 according to **(AOAC, 1984)** standard methods.

**Ascorbic acid (Vitamin C)**

Vitamin C was determined by using 2, 6- dichloro-phenol-indophenol dye according to the official method **(AOAC, 1984)**.

**Determination of anti-nutritional factors**

Phytic acid contents were determined by the method **Sadasivam and Manickam (1992).** The oxalate was analyzed by the method by **Abeza *et al.*, (1968)**, while trypsin inhibitor determined colorimetric in absorption at 410 nm according to **AOCS (1996)**. Spectrophotometric determination for total saponins at 544 nm were carried out as described by **Moghimipour and Handali, (2015).**

**Determination of minerals content:**

Minerals content (Na, Ca and K) were determined in the diluted solution of ash samples by using emission flam photometer (Model Corning 410). The other minerals (Cu, Zn, Mn, Fe, P and Mg) were determined by Atomic absorption spectrophotometer (PerKin – Elmer Instrument Model 2380, Germany), according to the method described by **Nzikou *et al.*, (2009)**.

**Determination of phenolic compounds**

Extraction, separation and quantification of phenolic compounds using HPLC system Perkin Elmer PE200 were determined according to the method described by **Goupy *et al.*, (1999)**.

**Statistical analysis**

Data were recorded as means and analyzed by (SPSS) (Ver.10.1). One-way analysis of variance (ANOVA) and Duncan comparisons were tested to signify differences between different treatments of kiwi fruit **SAS (1988)**.

**Results And Discussion**

Data presented in Table (1) show the chemical composition of kiwi fruit as wet weight and dry weight. It is clear to notice that the percentage of moisture, protein, fat, ash, fiber, carbohydrates and energy

value of kiwi fruit as wet weight were 82.65%, 0.99%, 0.44%, 0.64%, 1.40%, 13.88% and 68.39 kcal/100g, respectively.

On the other hand, the percentage of moisture, protein, fat, ash, fiber, carbohydrates and energy value of kiwi fruit as dry weight were 11.34%, 5.71%, 2.54%, 3.68%, 8.07%, 80.70% and 365.70 kcal/100g, respectively. These results are in agreement with **Hassan *et al.*, (2009)**, they reported that the kiwi fruit had the fat content of 0.51%. Due to the seed and seed oil, kiwifruit has slightly more fat than other fruits. However, the total fat content is less than a gram per serving. The fiber content of kiwi fruits was 2.10%. Fiber helps in the maintenance of human health by reducing cholesterol level in the body and decreasing the risk of various cancers and improves general health. Also, the moisture content in the range of 80-87% in different varieties of kiwi fruit was observed.

Data tabulated in Table (2) showed the physicochemical properties of kiwi fruit. It is clear to mention that the values of titratable acidity (T.A %), ascorbic acid (mg/100g), total soluble solids (T.S.S. %) and PH of kiwi fruit were 1.7 %, 40.70mg/100g, 12.25 % and 3.83, respectively. These results are in agreement with **Celik *et al.*, (2007)**, who reported that total soluble solids ranged from 8.4 to 15.3 (0Brix) and titratable acidity ranged between 0.44% and 0.89% in kiwifruit juice. Similarly, vitamin C content also ranged between 27.44 - 41.80 mg/100 g

Data given in Table (3) showed the minerals content of kiwi fruit. It is clear to mention that the highest minerals content of kiwi fruit were recorded for potassium, phosphorus and magnesium. The values were 332.0, 40.0 and 30.0 mg/kg, respectively. On the other hand, the lowest minerals content of kiwi fruit were recorded for iron, copper and zinc. The values were 0.14, 0.16 and 0.17 mg/kg, respectively. These results are in agreement with **Tingting *et al.*, (2019)**, they reported that the kiwi fruit is a good source of mineral elements for humans, while dried kiwifruit slices and kiwi fruit jam showed high mineral element contents. Thus, consuming dried kiwifruit slices and kiwifruit jam could supply more mineral elements, while consuming raw kiwifruit could supply the most comprehensive amounts of nutritional substances.

Data Tabulated in Table (4) showed the anti-nutritional factors of kiwi fruit. The obtained data indicated that the kiwi fruit values of tannins, phytates, oxalates, saponins and trypsin inhibitor were 16.35 mg/100g, 12.10 mg/100g, 1.15 g/100g, 0.08 and 0.75 TIU/g, respectively. These results are in agreement with **Khaled *et al.*, (2016)**,

they reported that the total alkaloid content of kiwifruit was determined and was about 0.6±0.04gm/100gm. This amount may not interfere any metabolic processes. The phyate content of green kiwifruit was 0.151gm/100gm. But the amount present in kiwi fruit may not chelate with much more amounts of minerals. Phytate and alkaloids are also present in such amount that may not create adverse effect being an anti-nutritional factor.

Data given in Table (5) showed the identification of phenolic compounds of kiwi fruit. The obtained results indicated that the highest phenolic compounds of kiwi fruit recorded for protocatchuic acid, 3-OH-tyrosol and pyrogallol. The values were 2634.27, 2246.06 and 1809.75 mg/kg, respectively.

On the other hand, the lowest phenolic compounds of kiwi fruit recorded for alpha- cumaric, coumarin and caffeic acid. The values were 2.96, 7.66 and 8.14 mg/kg, respectively. These results are in agreement with **Wojdyło *et al.*, (2017),** they revealed that the various *Actinidia* species have been extensively analyzed for their antioxidant chemical profiles. As well as vitamins C and E, the other antioxidants include the carotenoids lutein, zeaxanthin and β-carotene, chlorophylls, quinic acid, caffeic acid glucosyl derivatives, β-sitosterol, chlorogenic acid, phenolics, including flavones and flavonones, to name but a few.

Data given in Table (6) showed the identification of flavonoid compounds of kiwi fruit. The obtained results indicated that the highest flavonoid compounds of kiwi fruit recorded for apignin 6-arabinose, hespirdine and narengin. The values were 1762.42, 444.43 and 183.26 mg/kg, respectively.

On the other hand, the lowest flavonoid compounds of kiwi fruit recorded for campferol, apignin and apignin 7- glucose. The values were 1.54, 2.20 and 4.36 mg/kg, respectively. These results are in agreement with **Hettihewa *et al.*, (2018),** they revealed that the sub-class flavonol was the most abundant group of flavonoids detected in all the extracts tested from three different kiwifruit cultivars. Quercetin-3-*O*-galactoside, quercetin-3-*O*-glucoside, quercetin-3-*O*-rhamnoside, quercetin-3-*O*-rutinoside, quercetin-3-*O*-arabinoglucoside, catechin, epigallocatechin gallate, epigallocatechin, chlorogenic, ferulic, isoferulic, and caffeic acid were prominent phenolics found in *A. macrosperma* kiwifruit.

## Conclusion:

Kiwi fruit has high nutritional value and antioxidant activity. Therefore, kiwi fruit could be used in our beverages and daily dishes, besides the fact that it has so many health benefits as protect from many diseases.

**Table (1): Chemical composition of kiwi fruit**

| Constituents(%) | Kiwi frits | |
|---|---|---|
| | W/W | D/W |
| **Moisture** | 82.65 | 11.34 |
| **Protein** | 0.99 | 5.71 |
| **Fat** | 0.44 | 2.54 |
| **Ash** | 0.64 | 3.68 |
| **Fiber** | 1.40 | 8.07 |
| **Carbohydrates** | 13.88 | 80.00 |
| **Energy value( Kcal /100 g)** | 68.39 | 365.70 |

**W/W= Wet weight D/W= Dry weight**

**Table (2): Physicochemical properties of fresh kiwi fruit**

| Kiwi fruits | Compounds |
|---|---|
| **Titratable acidity (T.A %)** | 1.70 |
| **Vitamin C as (ascorbic acid) (mg/100g)** | 40.70 |
| **Total soluble solids (T.S.S. %)** | 12.25 |
| **PH** | 3. 83 |

**Table (3): Minerals content of kiwi fruits**

| Minerals | Concentrations (mg/kg) |
|---|---|
| **Calcium (Ca)** | 26.0 |
| **Iron (Fe)** | 0.41 |
| **Magnesium (Mg)** | 30.0 |
| **Phosphorus (P)** | 40 .0 |
| **Potassium (K)** | 332.0 |
| **Sodium (Na)** | 5.0 |
| **Zinc (Zn)** | 0.17 |
| **Copper (Cu)** | 0.16 |

**Table (4): Anti-nutritional factors of kiwi fruit**

| Anti-nutritional | Concentrations |
|---|---|
| **Tannins (mg/100g)** | 16.35 |
| **Phytates (mg/100g)** | 12.10 |
| **Oxalates (g/100g)** | 1.15 |
| **Saponins** | 0.08 |
| **Trypsin inhibitor (TIU/g)** | 0.75 |

**Table (5): Identification of phenolic compounds of kiwi fruit**

| Phenolic compounds | Concentrations (mg/kg) |
|---|---|
| **Pyrogallol** | 1809.75 |
| **Gallic acid** | 428.57 |
| **3-OH tyrosol** | 2246.06 |
| **Protocatchuic** | 2634.27 |
| **Catechol** | 406.52 |
| **4-Aminobenzoic** | 51.71 |
| **Catechein** | 411.24 |
| **Chlorogenic acid** | 243.10 |
| **P-OH-benzoic** | 125.52 |
| **Benzoic** | 250.87 |
| **Caffeic acid** | 8.14 |
| **Vanillic acid** | 44.22 |
| **Caffeine** | 75.08 |
| **Ferulic acid** | 35.07 |
| **Iso-Ferulic acid** | 10.71 |
| **Alfa-coumaric** | 2.96 |
| **Coumarin** | 7.66 |
| **3,4,5- methoxy cinnamic** | 31.04 |

**Table (6): Identification of flavonoid compounds of kiwi fruit**

| Flavonoidcompounds | Concentrations (mg/kg) |
|---|---|
| **Apignin 6-arabinose** | 1762.42 |
| **Rosmaric** | 14.81 |
| **Narengin** | 183.26 |
| **Luteolin 7-glucose** | 36.43 |
| **Hespirdine** | 444.43 |
| **Rutin** | 14.41 |
| **Apignin 7- glucose** | 4.36 |
| **Apig.7-O-neohespiroside** | 35.66 |
| **Quercetrin** | 18.13 |
| **Narengenin** | 20.94 |
| **Quercetin** | 15.42 |
| **Hespirtin** | 5.24 |
| **Campferol 3-2-P-coumaryl** | 33.57 |
| **Acacetin 7neo-rutinoside** | 18.83 |
| **Campferol** | 1.54 |
| **Apignin** | 2.20 |

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# دراسات تغذوية وكيميائية على ثمار الكيوى

**شريف صبرى رجب ـ سهام عزيز خضر ـ إيمان خيرت صالح عبد الحميد**
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**الملخص العربى**

ثمار فاكهة الكيوي واحدة من الأغذية التي لوحظ أن لها نشاط لتحفيز المناعة. فاكهة الكيوي غنية بالفيتامينات والفينولات العديدة ولها تأثيرات قوية كمضاد للأكسدة. تم دراسة فاكهة الكيوي التركيب الكيميائي والمعادن والعوامل المضادة للتغذية والخصائص الطبيعية الكيميائية و محتوياتها من المواد الكيميائية النباتية النشطة. أوضحت النتائج أن هناك تبايناً ملحوظاً في التركيب الكيميائي للعينات الظاهرة ينعكس في المستويات العالية من الكربوهيدرات (80.00٪) ، بينما تحتوى على نسبة منخفضة من الدهون (2.54٪). أظهر محتوى البوتاسيوم أعلى تركيز مع قيمة 233,0مجم/100جم، بالمفارنة بالمعادن الأخرى ، بينما سجلت أقل قيمة مع النحاس 0,16 مجم/100جم. كذلك تحتوي ثمار الكيوى على كمية عالية من فيتامين ج (40,0 مجم / 100 جرام). كذلك تحتوي جميع العينات التي تم دراستها على كمية منخفضة من العوامل المضادة للتغذية. تم تسجيل أعلى قيم للمركبات الفينولية وهى بروتوكاتشويك ، 3-هيدروكسى تيروزول, بيروجالول . حيث كانت القيم 2634,27 , 2246,06, 1809,75 مجم/100 جم على أساس الوزن الجاف على التوالي. بينما سجلت أعلى قيم لمركبات الفلافونيدات مع الأبيجنين 6-أرابينوز وهسبيردين ونارينجين. حيث كانت القيم 1762,42 , 444,43 , 183,26 ملجم / 100 جم على أساس الوزن الجاف على التوالي. في الختام ، فاكهة الكيوي لها قيمة غذائية عالية ونشاط مضاد للأكسدة. لذلك يمكن استخدام فاكهة الكيوي في المشروبات والأطباق اليومية ، إلى جانب كونها تحتوي على العديد من الفوائد الصحية فى الحماية من العديد من الأمراض.

**الكلمات الدالة:** ثمار الكيوى, التركيب الكيماوى, المركبات النباتية الطبيعية, القيمة التغذوية.