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AN OVERVIEW ON CHEMICAL COMPOSITION AND HEALTH IMPORTANCE OF KIWIFRUIT

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Native to mountainous South and Central China, *Actinidia* species culture has expanded and spread in many countries due to the commercial character and great taste of fruits. Nowadays, is an important crop in China, Italy, New Zealand, Turkey and lately there are concerns regarding this culture in Romania. Kiwifruit are one of the most nutrient-rich fruits with high content in vitamin C, potassium, phytochemicals, fibre. The components found in kiwi may act synergistically and in many cases, improve health of the consumers. There are many scientific evidences that sustain the beneficial effects of kiwi consumption that are presented in a systematic manner in this paper.

Keywords: Actinidia, antioxidant activity, chemical composition, health, kiwifruit.

INTRODUCTION

Recently, kiwifruit consumption increased significantly, having in view its high nutritive and medicinal attributes. Worldwide, kiwifruit represent a minor crop amounting 0.2–0.3% from total fresh fruit production[1].

In 1970 were less than 1000 ha of kiwifruit planted in world, outside of China, and in 2010 was estimated the area of kiwifruit, including China, to be over 160,000 ha[2]. Only four species of *Actinidia* are of interest with the purpose of fruit production: *A.chinensis Planch var.chinensis* (golden kiwifruit), *A.chinensis Planch var.deliciosa (A.Chev.)* (green or fuzzy kiwifruit), *A. kolomikta (Maxim.) Maxim.* and A. *arguta* (Siebold et Zucc.) Planch. ex Miq (baby kiwifruit)[3]. Even if kiwifruit represents an important horticultural crop in China, Italy, New Zealand, nowadays there are interest regarding this culture in Romania, for instance the mild microclimates where peach, apricot and almond trees grow.

On the international market are available mainly two kiwifruit cultivars: *Actinidia deliciosa* cv. 'Hayward' (green flesh) and *Actinidia chinensis* cv. 'Hort16A' (yellow fleshed) that present differences in chemical composition and taste[4]. About 80% of total area planted with kiwifruit throughout the world is with *A. deliciosa*, meanwhile the rest is represented by *A.chinensis*. Consequently, 'Hayward' cultivar accounts for about 70% of the kiwifruit traded worldwide[5].

The aim of the present work is to provide systematization and an overview of extensive literature data on kiwifruit to evidence the importance of kiwifruit consumption associated with its chemical composition.

CHEMICAL COMPOSITION OF KIWIFRUIT

Vitamins

Literature studies indicate that ascorbic acid content in kiwifruits is higher than that found in orange, strawberry, lemon and grapefruits[6]. Analyzing the data from Table 1 it is obvious that vitamin C content in kiwifruit is higher than in orange or strawberries[7].

Ascorbic acid found in *A. deliciosa* 'Hayward' grown in five orchards in Italy ranges between 53–75 mg/100 g FW (60 mg/100 g FW, as average)[9]. Some studies[10,11] reported that ascorbic acid in kiwifruit samples from *A. chinensis* is higher than mean content in *A. deliciosa* 'Hayward' and some of the lesser known species have high contents of vitamin C as *A. latifolia* with levels of 671– 2140 mg/100 g FW and a level of 1008 mg/100 g FW in *A. kolomikta*[12]. For *A. deliciosa* cultivars grown in Turkey, reported values for ascorbic acid content ranges from 52 to 78 mg/100g FW. Fruits of

'Elmwood' and 'Monty' cultivars contained the highest concentrations, followed by 'Hayward' and 'Tere', meanwhile 'Abbott' and 'Bruno' contained the lowest levels of ascorbic acid[13]. There are variations in ascorbic acid levels in kiwifruits and this behavior is related to degree of ripeness, storage methods, growing conditions[14].

Besides vitamin C, kiwifruits contain fat-soluble vitamins (E and K) (Table 1) and there are some controversies regarding concentration situs of vitamin E in these fruits. Some researchers[15] consider that it is concentrated into kiwifruit seeds and is not available from seeds, meanwhile others[16] identified it in the flesh of kiwifruit. A new vitamin E, namely δ-tocomonoenol has been isolated from *A. chinensis* fruits and the compound analysis indicated more amounts in the peel than in the pulp. Also, the presence of α-tocopherol and δ-tocopherol has been evidenced in both matrices[16].

The presence of vitamin K, present in plants mainly as phylloquinone, was found by Gentili and Caretti[17] in small amounts: 86 μg phylloquinone/100g FW in green kiwifruit and 53 μg phylloquinone/100g FW in gold kiwifruit.

Folate (vitamin B_9) is known for its role to prevent the foetus from developing affections of spine and brain[8]. The contents of green and gold kiwifruit are reported as 23 μg/100g FW[18] and 34 μg/100g FW, respectively[12] and are higher than those reported for other fruits[8] (Table 1).

PHENOLIC COMPOUNDS

Kiwifruits contain biologically active compounds with significant importance for human health. Among bioactive compounds, phenolics contribute to color, flavour and aging characteristics of kiwi juice or extract[19]. The main phenolic compounds found in kiwifruit are chlorogenic acid, protocatechuic acid and derivatives of 3,4-dihydroxybenzoic acid[20]. Park and co-workers[21] found that the highest total phenolic content was identified for kiwifruits, followed in order by red plum, mango, apple, banana, lemon, orange, peach.

Total polyphenols for *A. deliciosa* 'Hayward' grown in five orchards in Italy, range between 80–96 mg gallic acid /100 g FW (90 mg gallic acid /100g FW as average)[9]. Also, for *A. deliciosa* fruits polyphenol contents are 267 mg gallic acid/100 g FW meanwhile *A. chinensis* contain higher levels (366 mg gallic acid/100 g FW)[12].

Other studies[6] revealed that polyphenol content of kiwifruits is influenced by harvest time, storage conditions, and light exposure. Pal and co-workers[22] developed a study with five kiwi cultivars ('Abbot', 'Bruno', 'Allison', 'Hayward', 'Monty') and found that total phenols content decreased during storage. Accordingly, during three months storage, phenol content (mg gallic acid/100g FW) decreased with 60.93% for 'Abbot', 41.76% for 'Bruno', 11.88% for 'Allison', 29.87% for 'Hayward' and with 11.64% for 'Monty'.

There are studies that evidence the higher content of polyphenols in peel than in flesh for both kiwiberry and kiwifruit cultivars. Thus, 'Hayward' contains 91 mg gallic acid/100g FW in peel and 19.4 mg gallic acid/100 g in flesh[23]. These values are lower than those found for kiwiberry cultivars, especially in peel.

PIGMENTS

The main pigments found in kiwifruits are chlorophylls and carotenoids[24]. It contains chlorophyll a and b in levels that varies between varieties. For yellow/gold varieties, during maturation it is observed a decrease of chlorophyll meanwhile the color of mature fruit is given by the carotenoids[12]. The transformation of fruit color during ripening from green to yellow, orange or red is due to chlorophyll degradation and carotenoid formation[25].

Table 1

Vitamins content in different fruits[7, 8]

Fruits		Ascorbic acid mg/100 g FW	Vitamin E (α-tocopherol) mg/100 g FW	Vitamin K (phylloquinone) μg/100 g FW	Folate μg/100 g FW
Kiwi	*A. deliciosa*	92.7	1.46	40.30	29
	A.chinensis	105.4	1.49	5.50	-
Orange		59.1	0.15	0.00	24
Apple		4.6	0.18	2.20	3-4
Banana		8.7	0.10	0.50	7
Strawberries		58.8	0.29	2.20	8
Blueberries		9.7	0.57	19.30	-

The most concentrated carotenoids of kiwifruit are lutein and β-carotene with potent antioxidant activity. The importance of β-carotene for human health is sustained by conversion into vitamin A; also present antioxidant activity and the ability to prevent chronic diseases[26].

Concentration of β-carotene in kiwifruits is higher than in apple, banana, blueberries, but lower than in oranges[7]. β-carotene contents are reported as lower for *A. deliciosa* in comparison with *A. chinensis* and *A. rufa*, meanwhile lutein levels are lower in *A. chinensis*, followed by *A. deliciosa* and *A. rufa*[24].

Some studies[27] indicate that *A. eriantha* ('Bidan') present higher total chlorophyll and total carotenoids content in comparison with *A. deliciosa* ('Hayward') (32.88 mg/100 g DW vs. 8.45 mg/100 g DW and 2.526 mg/100 g DW vs. 0.673 mg/100 g DW, respectively).

Chlorophyll molecules in kiwifruits are easily degraded through thermal treatments, meanwhile carotenoids are more stable and thermal processing does not affect significantly its content[24].

PROTEIN

As most other commonly consumed fruits, kiwifruit it is not an important source of proteins. It has been found that the protein content is related with variety, degree in ripeness and with soil characteristics and horticultural practices[2].

Reported levels of protein are 1.14% and 1.23% for A. *deliciosa* and *A. chinensis*, respectively[12]. Other results[28] indicated the same variation of protein content: *A. deliciosa* 'Hayward' lower protein content (0.86%) and A. *chinensis* 'Hort 16A' higher (1.85%).

Storage (3 weeks at 1°C and 90–95% RH) of kiwifruit harvested in commercial maturity did not affect the protein composition[29].

LIPIDS

In kiwifruits, the lipids are concentrated in the seeds and usually range between 0.5–0.6 g/100g[12]. Total lipids contents for cultivars 'Hayward' and 'Hort16A' are similar 0.52 g/100g and 0.56 g/100, respectively[30]. Among fatty acids present in kiwifruits, polyunsaturated ones were identified in higher concentrations (Table 2). Also, kiwifruits are cholesterol-free[30].

The oils extracted from seeds contain mainly polyunsaturated fatty acids, especially linolenic acid[30]. Some studies[31] indicated that kiwi seed oil contains significant amounts of sterols and tocopherols and this recommend its use for nutritional and cosmetic purposes.

SUGARS

The market quality of the fruits is associated also with sugar content, which is a main parameter in this issue. Also, it was found that during fruit ripening starch concentration declines and instead increase glucose and fructose levels. Accordingly, starch concentration decreases from 6% FW to trace level at the beginning of the kiwifruit ripening process, meanwhile total sugars increase up to 12–15%[32]. Green kiwifruit (*A.deliciosa*) contain lower level of sugar than gold kiwifruit (*A. chinensis*) (Table 3) and both of them contain higher sugar content than orange and strawberries[7].

Table 2

Fatty acid contents in kiwifruit (g/100g)[30]

Fatty acids content	***A. deliciosa* 'Hayward'**	***A. chinensis* 'Hort16A'**
Fatty acids, total (saturated)	0.029	0.149
Fatty acids, total (monounsaturated)	0.047	0.036
Fatty acids, total (polyunsaturated)	0.287	0.207

Reference: Henare, 2016

Table 3

Total sugars (g/100g FW) content in fruits[7]

Fruits		**Total sugars**
Kiwifruit	*A. deliciosa*	8.99
	A. chinensis	10.98
Orange		8.50
Apple		10.39
Banana		12.23
Strawberries		4.89
Blueberries		9.06

Table 4

Sugar contents (g/100g FW) in fruits of *Actinidia* genotypes [24]

***Actinidia* genotypes**	**Glucose**	**Fructose**	**Sucrose**	***Myo*-inositol**
A. deliciosa				
Hayward	3.52±0.15	3.64±0.14	1.28±0.27	0.116±0.019
Bruno	2.96±0.33	3.12±0.39	2.02±0.55	0.177±0.038
Abbott	4.06±0.98	3.94±0.83	2.33±0.46	0.100±0.023
Elmwood	2.46±0.12	2.59±0.11	1.43±0.69	0.032±0.008
A. chinensis				
Golden king	2.87±0.32	2.47±0.22	3.74±0.40	0.060±0.022
Sanuki gold	4.38±0.67	3.85±0.46	2.20±0.14	0.050±0.013
Hort16A	3.84±0.28	4.15±0.26	1.77±0.34	0.040±0.014

Main sugars found in kiwifruits are glucose, fructose and sucrose. Sugars content varies with cultivar and mean sugar content of four South African grown kiwifruit cultivar were reported by Fourie and Hansmann[33].

Generally, the levels of glucose and fructose in kiwifruits are around 4–5.7 g/100 g FW[24] meanwhile sucrose ranges between 0.7–1.5g/100g FW[12, 34]. Some studies indicate for 'Hayward' cultivar sucrose content in smaller amounts or under detection limit of the quantification method[24,33].

The concentrations of glucose, fructose, sucrose and *myo*-inositol in different *A. deliciosa* cultivars and *A. chinensis* ones[24] are depicted in Table 4.

Among sugars identified in kiwifruit a great importance has *myo*-inositol, a carbocyclic sugar (cyclohexane-1,2,3,4,5,6-hexol) classified as a member of vitamin B complex[24]. The beneficial effects of *myo*-inozitol on humans are related with its insulin-mimetic properties and therefore prevention or treatment of some diabetic complications[35]. Nishiyama[24] reported myo-inositol contents in *A. deliciosa* genotypes that are higher than those identified in *A. chinensis*.

FIBRE

Kiwifruit are known as important source of fibre, these components having an important role on food digestion. It contains 2–3% dietary fiber and provides 10% of the recommended daily requirement[15]. Lintas and co-workers[36] reported kiwifruit dietary fibre content from 2.13 to 3.12 g/100g FW values comparable to that of pear and persimmon. Dietary fibre is mostly insoluble, being 70–75% from total[36], mostly cellulose and hemicelluloses and small amount of pectin. The soluble fibre fraction contains pectin polysaccharide and was evaluated as total uronic acid content (708 mg/100 g FW) and neutral sugar composition (472 mg/100g FW)[37].

A. deliciosa fruits contain total dietary fibre and insoluble fibre content higher than *A. chinensis* and other common fruits[7]. Total dietary fibre content reported for *A. deliciosa* 'Hayward' grown in Italy was on average 2.50 g/100g FW (range 2.30–2.83 g/100g FW)[9].

Among some kiwi cultivars grown in South Africa, 'Bruno' presents highest total dietary fibre (3.43 g/100g FW), followed by 'Donné' (2.60g/100g FW), 'Allison' (2.56 g/100g FW) and 'Hayward' (1.98g/100g FW)[33].

MINERAL PROFILE

There are many studies[12,33,38] that present mineral composition of different cultivars of kiwifruit, but the most important mineral found in the highest concentration is potassium. Kiwifruit consumption provides about 10% of the daily requirement for potassium[15].

Having in view that is essential for life, growth, development and lifespan[39] it is understandable the recommendation to consume kiwifruits.

Potassium concentration found in kiwifruit is similar to that reported for bananas and much higher than in other commonly consumed fruits[7]. *A. deliciosa* and *A. chinensis* contain similar levels of potassium (around 300 mg/100g FW)[7,12].

Potassium contents from *A. deliciosa* 'Hayward' grown in central Italy, range between 254–300 mg/100g FW[9]. Other researchers[38] reported potassium content for different varieties of *A. chinensis* that ranges between 250–400 mg/100g FW. Similar values were also reported by Ma and co-workers[28].

Beside high content of K, kiwifruits contain other minerals in various concentrations, well represented being P, Ca and Mg.

ANTIOXIDANT ACTIVITY

Assessment of antioxidant activity it is usually done through the following methods: Trolox equivalent antioxidant capacity test (TEAC), the oxygen radical absorbance capacity assay (ORAC), radical scavenging activity using 1,1-diphenyl-2-picrylhydrazyl (DPPH), [2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)] (ABTS), antioxidant assay using β-carotene linoleate model system, scavenging activity against nitric oxide[21,22], ferric-reducing/antioxidant power (FRAP)[27].

Antioxidant capacity of *Actinidia* fruits is strongly influenced by total phenolic and ascorbate concentrations, even if there are also other species present in fruits that may influence this behavior: vitamin E, carotenoids, lutein, zeaxanthin, chlorophyll[23,40].

According to literature, antioxidant activity assessed by different methods evidenced that kiwifruit is on top positions. For example, a study[21] evidenced that strawberries and kiwifruit present the highest antioxidant activity, followed in order by red plum, mango, white grapes, persimmon, apples, pears, red grapefruit, lemons, pomelos, banana and peaches.

Some researchers[41] reported that skin of kiwifruit present compounds with antioxidant activity three times higher than flesh. This result present just scientific significance since the skin of kiwifruit is rarely consumed.

Hădărugă *et al.*[42] also reported that kiwi peels extract are more valuable for their antioxidant activity this being correlated with higher content of polyphenolic compounds. Latocha *et al.*[23] evidenced that the total antioxidant activity of *Actinidia* fruit is influenced by species and cultivars and found that the average antioxidant properties measured in peel are higher than in flesh. Moreover, antioxidant capacity of peel extract from cultivar 'Hayward' is much lower than for kiwiberry peel up to four times and for flesh the differences are much lower.

Due to the proven antioxidant properties, consumption of kiwifruits has potential to inhibit oxidative processes and thus, has preventive effect against cancers[32,40].

HEALTH BENEFITS OF KIWIFRUIT CONSUMPTION

According to studies developed worldwide, kiwifruit is proven to be one of the most nutrient – dense fruits available[2], consumption plays a protective role against reactive oxygen species (ROS) due to the presence of great content of antioxidants[43,44], enhance iron retention[7], have beneficial effects on digestion[36] and may decrease cardiovascular disease incidence[7].

Antioxidant effects

Antioxidant effects generated by kiwifruit consumption are associated with ascorbic acid, polyphenolic and carotenoid contents. There are studies[43] carried out on *Actinidia* species that evidence a high correlation between antioxidant activity with ascorbic acid and polyphenolic content. Other results[6] emphasize that ascorbic acid contributed to antioxidant capacity much more than other present antioxidants (carotenoids, polyphenols).

Dietary antioxidants have the ability to fight against reactive oxygen species (ROS) and act as antimutagens and may slow the progression towards cancer[18].

Regular intake of golden kiwifruits (*A. chinensis* 'Hort16A') can protect against lymphocyte DNA oxidation and increase of total antioxidant activity and plasma vitamin C[45].

Some investigations of radical-scavenging ability of vitamin E species, δ-tocomonoenol and δ–tocopherol, found in pulp and peel extract of *A.chinensis* fruit are quite similar; δ-tocomonoenol was able to reduce the DPPH radical by 24% and the anion superoxide radical by 29.2%[40].

Kiwifruit influence iron retention

It is widely known that iron absorption is favoured by the presence of vitamin C. The high content of vitamin C, accompanied by citric acid and carotenoids found in kiwifruits enhance iron retention[7].

Sleep-inducing effects

There are studies[44] that sustain the sleep-inducing effects of kiwifruit consumption that are associated with its chemical composition. The similar nature of flavonoids (naringenin, quercetin, catechin, rutin) identified in kiwifruit peel with those found in sedative herbs explain this statement.

A study[46] developed on 24 subjects (2 males and 22 females) 20 to 55 years that consumed two kiwifruits one hour before bedtime nightly for 4 weeks indicated that this behavior may improve sleep onset, duration and efficiency in adults with self-reported sleep disturbances.

Digestion

Acknowledged for its beneficial effects on digestion due to the presence of high content of dietary fibre[36], kiwifruit consumption it is recommended to prevent constipation, irritable bowel syndrome, gut health[7,36]. Laxative properties of kiwifruit are due to the presence of proteolytic enzyme actinidin and non-digestible oligosaccharides as inulin[47]. Also, kiwifruit acts a prebiotic, enhancing the growth of intestinal lactic acid bacteria[48].

Protection against cardiovascular disease

Consumption of kiwifruit has been associated with decrease of cardiovascular problems and this is owing to the presence of polyphenols, carotenoids and other antioxidants. It has been stated that kiwifruit may reduce oxidation of cholesterol, lowering the formation of atherosclerotic lesions[7].

Some studies evidenced that, regular consumption of kiwifruit, may exert beneficial effects on the risk factors for cardiovascular disease. Some researchers[49] investigated the effects of consumption of two kiwifruits per day on the lipid profile for hyperlipidemic adults. The results indicated that after 8 weeks of kiwifruit consumption, the HDL cholesterol was significantly increased and the LDL cholesterol/HDL cholesterol ratio and total cholesterol/HDL cholesterol ratio were significantly decreased.

Other study indicates that plasma triglycerides decreased after regular consumption of golden kiwifruits[45].

The intake of 3 kiwifruits per day promotes evidenced anti-hypertensive and anti-thrombotic effects in male smokers and was also observed a significant decrease of systolic blood pressure[50]. The antiplatelet effect of fruit is independent of their antioxidant activity. Kiwifruit and tomato have the highest antiaggregation activity of 89 and 70 (% of inhibition), respectively. The green and gold kiwifruit inhibit ADP and collagen – induced whole-blood platelet aggregation[51].

Immunity

The great importance of nutrition in maintaining the immunity is worldwide recognized and low immunity it is associated with deficiencies in certain nutrients. The importance of polyphenols and carotenoids from kiwifruit on immune function has investigated recently[44] and the evidence that kiwifruit may support immune health in growing.

A human trial determined the effects of gold kiwifruit consumption on symptoms of cold and influenza in older adults (>65 years). The results indicated that kiwifruit consumption significantly reduced head congestion and sore throat symptoms[52].

Moreover, in other trial, regular consumption of kiwifruit by pre-scholar children (2–5 years) lead to reduction of incidence of cold and influenza-like symptoms.

All these results sustain the idea according to kiwifruit consumption may modulate the immune system, improving health by reducing symptoms of cold and influenza for different human age categories[52].

DETRIMENTAL EFFECTS OF KIWIFRUIT CONSUMPTION ON HUMAN HEALTH

Allergic effects

Even if the popularity of kiwifruit is growing due to its pleasant taste, low caloric value and to beneficial effects on human health, there are some issues that may pose health disturbances. Kiwifruit has become one of the most common causes of food allergies and these effects are intensively studied[53-56].

According to some studies[57], persons that are birch pollen-allergic present allergy to kiwifruit; also, almost 12–17% from persons that are allergic to rubber latex can develop kiwifruit allergy[58].

The main allergens identified in kiwifruits are actinidin, kiwellin and thaumatin-like proteins[30,55]. Actinidin, a cysteine protease that has the ability to hydrolyze proteins and it is suspected to be the main allergen in kiwifruit[30].

There are studies[30] that indicate a significant variation for these allergenic proteins in ripe kiwifruit and extrapolating allergenicity results must be realized carefully both within and between *Actinidia* species. Acidic and basic isoforms of actinidin were identified in *A. deliciosa* ‘Hayward’ and *A. arguta* ‘Hortgem Tahi’, while only a basic isoform of actinidin was identified in *A. chinensis* ‘Hort16A’. One isoform of each kiwellin and thaumatin-like proteins were identified in ripe fruit[30].

Most patients with kiwifruit allergy claim symptoms localized to the oral mucosa but severe

systemic reactions have been observed at children[54,59]. The majority of allergic manifestations appear within minutes after kiwifruit consumption[60].

Extreme kiwifruit allergies are uncommon and generally, this allergy is often cross-reactive with other common allergies (to pollen, dust, other tropical fruits)[15].

Oxalate in kiwifruits

Oxalate appears as a by-product of photosynthesis and by cleavage of ascorbic acid in many plants and therefore may be stored in fruits[61]. Kiwifruits contain appreciable amounts of oxalate that may be responsible for unpleasant oral irritation, unpleasant sensation and other pathological effects[11,15]. At least half of oxalate is found as insoluble calcium oxalate and as consequence, an important amount it is unavailable.

Even if the presence of oxalate may cause a lot of health problems (kidney stone formation, reduced bioavailability of calcium)[62], oxalate found in kiwifruit is not such a nutritional problem as in the case of rhubarb or spinach[15]. Oxalate levels in *Actinidia* fruits correspond to only 1–10% of that found in spinach[24].

Kiwifruit juices contain lower oxalate levels because an important fraction of insoluble oxalate was retained in the pomace during extraction[63].

Some studies[64] evidenced that the oxalate content in *A. arguta* was lower than in *A. deliciosa*, whereas that in *A. rufa* was slightly higher.

CONCLUSIONS

A thorough analysis of the scientific literature evidenced the importance of kiwifruit for improving health. With a great taste, kiwifruits present high antioxidant activity, are good sources of vitamin C, potassium with content almost at the same level with banana and low levels of sucrose. Also, nutritional quality suffers slightly during storage and ripening. Therefore, daily consumption of kiwifruit is a great strategy to prevent different diseases and to cure existing ones.

REFERENCES

1. Testolin R., Ferguson A.R., *Kiwifruit (Actinidia spp.) production and marketing in Italy, New Zealand Journal of Crop and Horticultural Science*, **2009**, *37(1)*,1-32.
2. Ward C., Courtney D., Kiwifruit: Taking Its Place in the Global Fruit Bowl. In M.Boland, P.J.Moughan (Eds.), Nutritional Benefits of Kiwifruit, Academic Press, 2013, 68, pp.1-339.
3. Peticilă A.G., Stanica F., Venat-Dumitriu O., Madjar R., *Studies on the multiplication of two new fruit-growing species, Actinidia deliciosa and Actinidia arguta, Annales of the University of Craiova,* **2012**, *XVII(LIII)*, 307-314.
4. Grozdanovic M., Popovic M., Polovic N., Burazer L., Vuckovic O., Atanaskovic-Markovic M., Lindner B., Petersen A., Gavrovic-Jankulovic M., *Evaluation of IgE reactivity of active and thermally inactivated actinidin, a biomarker of kiwifruit allergy, Food and Chemical Toxicology*, **2012**, *50*, 1013-1018.
5. Huang H., "Main cultivars in commercial production" in Kiwifruit - the genus Actinidia, 2016, Chapter VI, pp.239-263.
6. Tavarini S., Degl'Innocenti E., Remorini D., Massai R., Guidi L., *Antioxidant capacity, ascorbic acid, total phenol and carotenoids changes during harvest and after storage of Hayward kiwifruit, Food Chemistry*, **2008**, *107*, 282-288.
7. Stonehouse W., Gammon C., Beck K., Conlon C., von Hurst P., Kruger R., *Kiwifruit: our daily prescription for health, Canadian Journal of Physiology and Pharmacology*, **2013**, *91*, 442-447.
8. Chew S.C., Loh S.P., Khor G.L., *Determination of folate content in commonly consumed Malaysian foods, International Food Research Journal*, **2012**, *19(1)*, 189-197.
9. D'Evoli L., Moscatello S., Lucarini M., Aguzzi A., Gabrielli P., Proietti S., Battistelli A., Famiani F., Böhm V., Lombardi-Boccia G., *Nutritional Traits and antioxidant capacity of kiwifruit (Actinidia deliciosa Planch., cv.Hayward) grown in Italy, Journal of Food Composition and Analysis*, **2015**, *37*, 25-29.
10. Esti M., Messia M.C., Bertocchi P., Sinesio F., Moneta E., Nicotra A., Fantechi P., Palleschi G., *Chemical compounds and sensory assessment of kiwifruit (Actinidia chinensis (Planch.) var. chinensis): electrochemical and multivariate analyses*, *Food Chemistry*, **1998**, *61(3)*, 293-300.
11. Nishiyama I., Yamashita Y., Yamanaka M., Shimohashi A., Kukuda T., Oota T., *Varietal difference in vitamin C content in the fruit of kiwifruit and other Actinidia species, Journal of Agricultural and Food Chemistry*, **2004**, *52*, 5472-5475.
12. Drummond L., "The Composition and Nutritional Value of Kiwifruit". In M.Boland, P.J.Moughan (Eds.), Nutritional Benefits of Kiwifruit, Academic Press, 2013, 68, pp.33-58.
13. Yildirim B., Yesiloglu T., Uysal-Kamiloglu M., Incesu M., Tuzcu O., Cimen B., *Pomological characterization of different kiwifruit (Actinidia deliciosa) cultivars in Adana (Turkey), African Journal of Agricultural Research*, **2011**, *6(6)*, 1378-1382.
14. Selman J.D., *The vitamin C content of some kiwifruits (Actinidia chinensis Planch., variety Hayward, Food Chemistry*, **1983**, *11*, 63-75.
15. Ferguson A.R., Ferguson L.R., *Are kiwifruit really good for you? Acta Horticulturae,* **2003**, *610*, 131-135.
16. Fiorentino A., D'Abrosca B., Pacifico S., Mastellone C., Scognamiglio M., Monaco P., *Identification and assessment of antioxidant capacity of phytochemicals from kiwi fruits, Journal of Agricultural and Food Chemistry*, **2009**, *57*, 4148-4155.
17. Gentili A., Caretti F., *Evaluation of a method based on liquid chromatography diode-array detector-tandem mass spectrometry for a rapid and comprehensive*

characterization of the fat-soluble vitamin and carotenoid profile of selected plant foods, Journal of Chromatography A, **2011**, *1218*, 684-697.
18. Skinner S., Hunter D., Chom S., Skinner M., The potential health benefits of the subtropical fruits - kiwifruit, feijoa and tamarillo. In Bioactives in Fruit, Health benefits and functional foods, 2013, John Wiley and Sons Ltd.
19. Dawes H., Keene J., *Phenolic composition of kiwifruit juice, Journal of Agricultural and Food Chemistry*, **1999**, *47(6)*, 2398-2403.
20. Duttaroy A.K., "Kiwifruit juice in Handbook of Functional Beverages and Human Health", Publisher: CRC Press, 2016, Chapter 27, pp.331-337.
21. Park Y.S., Im M.H., Ham K.S., Kang S.G., Park Y.K., Namiesnik J., Leontowicz H., Leontowicz M., Trakhtenbergm S., Gorinstein S., *Quantitative assessment of the main antioxidant compounds, antioxidant activities and FTIR spectra from commonly consumed fruits, compared to standard kiwi fruit. LWT - Food Science and Technology*, **2015**, *63*, 346-352.
22. Pal R.S., Kumar V., Arora S., Sharma A.K., Kumar V., Agrawal S., *Physicochemical and antioxidant properties of kiwifruit as a function of cultivar and fruit harvested month, Brazilian Archives of Biology and Technology*, **2015**, *58(2)*, 262-271.
23. Latocha P., Lata B., Stasiak A., *Phenolics, ascorbate and the antioxidant potential of kiwiberry vs. common kiwifruit: The effect of cultivar and tissue type, Journal of Functional Foods*, **2015**, *19*, 155-163.
24. Nishiyama I., *Fruits of the Actinidia genus, Advances in Food and Nutrition Research*, **2007**, *52*, 293-324.
25. Schoefs B., *Plant pigments: properties, analysis, degradation, Advances in Food and Nutrition Research*, **2005**, *49*, 41-91.
26. Rao A.V., Gao L.G., *Carotenoids and human health, Pharmacological Research*, **2007**, *55*, 207-216.
27. Leontowicz H., Leontowicz M., Latocha P., Jesion I., Park Y.S., Katrich E., Barasch D., Nemirovski A., Gorinstein S., *Bioactivity and nutritional properties of hardy fruit Actinidia arguta in comparison with Actinidia deliciosa ('Hayward') and Actinidia eriantha 'Bidan', Food Chemistry*, **2016**, *196*, 281-291.
28. Ma T., Sun X., Zhao J., You Y., Lei Y., Gao G., Zhan J., *Nutrient compositions and antioxidant capacity of kiwifruit (Actinidia) and their relationship with flesh color and commercial value, Food Chemistry*, **2017**, *218*, 294-304.
29. Drzewiecki J., Latocha P., Leontowicz H., Leontowicz M., Park Y.S., Najman K., Weisz M., Ezra A., Gorinstein S., *Analytical methods applied to characterization of Actinidia arguta, Actinidia deliciosa and Actinidia eriantha kiwifruit cultivars, Food Analytical Methods*, **2016**, *9*, 1353-1366.
30. Henare S., "The nutritional composition of kiwifruit (*Actinidia* spp.)", In Nutritional composition of fruit cultivars, Elsevier, 2016, pp. 337.
31. Piombo G., Barouh N., Barea B., Boulanger R., Brat P., Pina M., Villeneuve P., *Characterization of the seed oils from kiwi (Actinidia chinensis), passion fruit (Passiflora edulis) and guava (Psidium guajava). Fondamental*, **2006**, *13*,195-199.
32. Richardson D., Ansell J., Drummond L., *The nutritional and health attributes of kiwifruit: a review. European Journal of Nutrition*, **2018**, https://doi.org/10.1007/ s00394-018-1627-z.
33. Fourie P.C., Hansmann C.F., *Fruit composition of four South African-grown kiwifruit cultivars, New Zealand Journal of Crop and Horticultural Science*, **1992**, *20(4)*, 449-452.
34. Sanz M.L., Villamiel M., Martinez-Castro I., *Inositols and carbohydrates in different fresh fruit juices, Food Chemistry*, **2004**, *87*, 325-328.
35. Croze M., Soulage C., *Potential role and therapeutic interests of myo-inositol in metabolic diseases, Biochimie,* **2013**, *95*, 1811-1827.
36. Lintas C., Adorisio S., Cappelloni M., Monastra F., *Composition and nutritional evaluation of kiwifruit grown in Italy, New Zealand Journal of Crop and Horticultural Science*, **1991**, *19*, 341-344.
37. Sims I.M., Monro J.A., Fiber: Composition, Structures and Functional Properties. In M.Boland, P.J.Moughan (Eds.), Nutritional Benefits of Kiwifruit, Academic Press**,** **2013**, 68, pp.81-100.
38. Samadi-Maybodi A., Reza Shariat M., *Characterization of elemental composition in kiwifruit grown in Northern Iran, Journal of Agricultural and Food Chemistry*, **2003**, *51*, 3108-3110.
39. Celik A., Ercisli S., Turgut N., *Some physical, pomological and nutritional properties of kiwifruit cv.Hayward, International Journal of Fod Sciences and Nutrition*, **2007**, *58(6)*, 411-418.
40. Fiorentino A., Mastellone C., D'Ambrosca B., Pacifico S., Scognamiglio M., Cefarelli G., Caputo R., Monaco P., *δ-Tocomonoenol: A new vitamin E from kiwi (Actinidia chinensis) fruits*, Food Chemistry, **2009**, *115(1)*, 187-192.
41. Guo C.J., Yang J.J., Wei J.Y., Li Y.F., Xu J., Jiang Y.G., *Antioxidant activities of peel, pulp and seed fractions of common fruits as determined by FRAP assay, Nutrition Research*, **2003**, *23*, 1719-1726.
42. Hădărugă D, Pantea C, Hădărugă N (2016). Antioxidant activity and kinetics on kiwifruit (*Actinidia deliciosa*) ethanolic extracts by 2,2-diphenyl-1-picrylhydrazyl(DPPH·) method. Journal of Agroalimentary Processes and Technologies 22(3):207-211.
43. Du G., Li M., Ma F., Liang D., *Antioxidant capacity and the relationship with polyphenol and vitamin C in Actinidia fruits*, Food Chemistry, **2009**, *113*, 557-562.
44. Skinner M.A., Bentley-Hewitt K., Rosendale D., Naoko S., Pernthaner A., Effects of kiwifruit innate and adaptive immunity and symptoms of upper respiratory tract infection. In Advances in Food and Nutrition Research, Burlington Academic Press, 2013, 68, pp.301-320.
45. Brevik A., Gaivao I., Medin T., Jorgenesen A., Piasek A., Elilasson J., Karlsen A., Blomhoff R., Veggan T., Duttaroy A., Collins R., (2011). *Supplementation of a western diet with golden kiwifruits (Actinidia chinensis var.'Hort16A'): effects on biomarkers of oxidation damage and antioxidant protection*, *Nutrition Journal*, **2011**, *10*, 54; http://www.nutrionj.com/content/10/1/54.
46. Lin H.H., Tsai P.S., Fang S.C., Liu J.F., *Effect of kiwifruit consumption on sleep quality in adults with sleep problems, Asia Pacific Journal of Clinical Nutrition*, **2011**, *20(2)*, 169-174.
47. Rush E.C., Patel M., Plank L.D., Ferguson L.R., *Kiwifruit promotes laxation in elderly, Asia Pacific Journal of Clinical Nutrition*, **2002**, *11*, 164-168.
48. Lee Y.Y., Low K.Y., Siah K., Drummond L., Gwee K.-A., *Kiwifruit (Actinia deliciosa) changes intestinal microbial profile. Microbial Ecology in Health&Disease,* **2012**, *23*, 18572; http://dx.doi.org/10.3402/ mehd.v23i0.18572.

49. Chang W.H., Liu J.F., *Effects of kiwifruit consumption on serum lipid profiles and antioxidative status in hyperlipidemic subjects, International Journal of Food Sciences and Nutrition*, **2009**, *60(8)*, 709-716.
50. Karlsen A., Svendsen M., Seljeflot I., Laake P., Duttaroy A.K., Arnesen C.A., Tonstad S., Blomhoff R., *Kiwifruit decreases blood pressure and whole-blood platelet aggregation in male smokers, Journal of Human Hypertension*, **2013**, *27*, 126-130.
51. Duttaroy A.K., Cardioprotective Properties of Kiwifruit. In M.Boland, P.J.Moughan (Eds.), Nutritional Benefits of Kiwifruit, Academic Press, 2013, 68, pp.81-100.
52. Skinner M.A., *Wellness food based on the health benefits of fruit: gold kiwifruit for immune support and reducing symptoms of colds and influenza, Journal of Food and Drug Analysis*, **2012**, *20(1)*, 161-264.
53. Pastorello E., Conti A., Pravettoni V., Farioli L., Rivolta F., Ansaloni R., Ispano M., Incorvaia C., Giuffrida M.G., Ortolani C., *Identification of actinidin as the major allergen of kiwifruit, Journal of Allergy and Clinical Immunology*, **1998**, *101, 4(1)*, 531-537.
54. Lucas J.S., Nieuwenhuizen N.J., Atkinson R.G., Cochrane S.A., Warner J.O., Hourihane J., *Kiwifruit allergy: actinidin is not a major allergen in the United Kingdom, Clinical and Experimental Allergy*, **2007**, *37*, 1340-1348.
55. Maddumage R., Nieuwenhuizen N., Bulley S.M., Cooney J.M., Green S.A., Atkinson R.G., *Diversity and relative levels of actinidin, kiwellin and thaumatin-like allergens in 15 varieties of kiwifruit (Actinidia), Journal of Agricultural and Food Chemistry*, **2013**, *61*, 728-739.
56. Popovic M., Grozdanovic M., Gavrovic-Jankulovic M., *Kiwifruit as a food allergen source, Journal of the Serbian Chemical Society*, **2013**, *78(3)*, 333-352.
57. Eriksson N.E., Werner S., Foucard T., Moller C., Berg T., Kiviloog J., *Self-reported hypersensitivity to exotic fruit in birch pollen-allergic patients. Allergology International*, **2003**, *52*, 199-206.
58. Kim K.T., Hussain H., *Prevalence of food allergy in 137 latex allergic patients, Allergy and Asthma Proceeding*, **1999**, *20*, 95-97.
59. Lucas J.S., Grimshaw K.E., Collins K., Warner J.O., Hourihane J., *Kiwi fruit is a significant allergen and is associated with differing patterns of reactivity in children and adults, Clinical and Experimental Allergy*, **2014**, *34*, 1115-1121.
60. Bublin M., *Kiwifruit allergies, Advances in Food and Nutrition Research*, **2013**, *68*, 321-340.
61. Nguyen H.V.H., *Oxalate and antioxidant concentrations of locally grown and imported fruit in New Zealand*. PhD Thesis, 2012, Lincoln University.
62. Noonan S.C., Savage G.P., *Oxalate content of foods and its effect on humans, Asia Pacific Journal of Clinical Nutrition*, **1999**, *8,* 64-74.
63. Nguyen H.V.H., Savage G., *Oxalate contents of kiwifruit (Actinidia deliciosa) juice extracted by pressing or enzyme extraction, Journal of Food, Agriculture and Environment*, **2013**, *11(2)*, 228-230.
64. Watanabe K., Takahashi B., *Determination of soluble and insoluble oxalate contents in kiwifruit (Actinidia deliciosa) and related species. Journal of the Japanese Society of Horticultural Sciences*, **1998**, *67(3)*, 299-305.