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Original Article

Chemical Composition and Benefiting of Some Wild Edible Plants

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Abstract

Gross chemical composition, minerals content and some vitamins contents of tow wild edible plants namely. Chicory (*Cichorium intybus* L.) and Sorrel (*Rumex vesicarius* L.) were determined. Phenolic and flavonoids compounds were determined by HPLC. Also the contents of chlorophyll, carotenoids and antioxidant activity of these materials were done. Finally, the possibility to utilize and benefit of using fresh chicory and sorrel leaves as a replacement of fresh coriander to prepare Tamia (a famous Egyptian product) was considered as well as chemical and sensory evaluation of the final product. The obtained data revealed that, chicory and sorrel leaves contained 88.50 and 89.35% moisture, 14.06 and 19.60% crude protein, 3.91 and 2.11% crude fat, 11.06 and 9.02% crude fiber, and 11.24 and 18.92% ash (on dry weight), respectively. Pyrogallol was the major phenolic compound in sorrel leaves which recorded 292.59 mg/100g dry weight. While, it was ellagic acid in chicory leaves which recorded 78.22 mg/100g dry weight. However, using of chicory or sorrel leaves by 12 or 15% had no significant effect on test, color, odor, texture and overall acceptability of the prepared Tamia using 12% fresh coriander.

Keywords: *Chicory, sorrel, phenols, flavonoids, vitamins.*

Introduction

Since ancient times, wild plants have widely been used in traditional Mediterranean culture, and the link between wild plants and human life is a prominent feature. Wild plants are known to be used in ancient cultures for different purposes, such as food, medicines, production of goods (for example clothes), and magic and religious rituals. In particular, the use of wild edible plants in Europe has been mainly linked to periods of famine, therefore these herbs are called “famine food” (Petropoulos *et al.,* 2018).

Today, the renewed interest in wild edible plants, and knowledge of the healthy role of phytochemical compounds, makes it possible to define them as “new functional foods” because they contain physiologically active ingredients capable of providing health benefits beyond basic nutrition (Pinela *et al.,* 2016).

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Chicory (*Cichorium intybus* L.) is known as "Succory", "Hendibeh"or "Witloof" is a wild edible plant consumed in Lebanon, Arab countries and other parts of the world. Chicory can grow wild, in its natural habitat, in fields, road sides or home gardens, Chicory is of interest to food industry not only as a source of dietary fibers such as inulin and fructo-oligosaccharides but also as a functional food ingredient that affects in maintaining good health and in preventing disease. Roots and green leaves are the edible parts of the plant.

Chicory can be eaten raw in green salads or in cooked dishes mainly mixed with lemon juice, olive oil, salt and fried onions (Bais and Ravishanker, 2001).

Khalaf *et al.,* (2018) mentioned that, chicory leaves contain high levels of moisture, crude protein, crude ether extract, ash contents and carbohydrates which they were 85.77, 10.22, 2.54, 15.13 and 72.11%, on dry weight basis, respectively.

Sorrel (*Rumex vesicarius* L.) is a wild edible plant collected in spring time and eaten fresh, or cooked. The main chemical constituents of Rumex are anthraquinones and flavonoids (Zhang *et al.,* 2012). The medicinal importance of this plant is a reflection to its chemical composition since this plant contains many bioactive substances such as flavonoids, anthraquinones particularly in roots, quinones, carotenoids, vitamins (especially vitamin C), proteins, lipids, carbohydrates, reducing sugars, phenols, tannins, saponins, and organic acids. This plant is also a good source of minerals, such as: K, Na, Ca, Mg, Fe, Mn and Cu **(**Mostafa *et al.,* 2011 & Prasad and Ramakrishnan, 2012**)**.

The aim of this study was focused on the chemical composition and phytochemicals content of chicory and sorrel leaves, and the possibility to utilize and benefit of using fresh chicory and sorrel leaves as a replacement of fresh coriander for preparing Tamia.

Materials and Methods

Materials

Chicory (*Cichorium intybus* L) and sorrel (*Rumex vesicarius* L.) plants are shown in Fig (1), which obtained from the farm of Faculty of Agriculture, Assiut University, Egypt. during January to April (2019 - 2020).

Fig. 1. Chicory and sorrel wild plants.

Methods

Preparation of the samples

The plants were carefully selected, washed with tap water, then drained from the excess water and used for analysis. Chicory and sorrel leaves were cut manually by using a knife into small parts. The obtained parts were placed in oven trays, dried in an air oven provided with a fan, at 50 -55 ºC for 4 - 5 hrs, till its moisture content reached to ≤ 10%. The dehydrated plants were ground to fine powder using a laboratory electronic mill according to Hashem *et al.,* (2013). The powder was kept into polyethylene bags and stored at -18°C for further analysis.

Preparation of Tamia

The fresh chicory and sorrel leaves were used for preparing Tamia paste by 12 and 15 % of total ingredients (the common practice ratios) as replacement of fresh coriander.

Analytical Methods

Gross chemical composition of raw materials and the prepared tamia product

Moisture, crude protein (N x 6.25), crude fiber, ether extract and ash contents were determined according to the methods of A.O.A.C. (2010).

Nitrogen free extract (NFE) was calculated by difference as followed:

%NFE= 100 – (% crude protein +% fat + % ash +% crude fiber).

Determination of minerals

The minerals content of chicory and sorrel leaves were determined according to the method described by A.O.A.C. (2012), using atomic absorption device (Perkin – Elmer, Model 3300, USA) in Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

Determination of some B complex group vitamins by HPLC

Some B- complex vitamins namely: Thiamine, Riboflavin, Pyridoxine, Folic acid and Cyanocobalamin of chicory and sorrel leaves were determined using HPLC in Food Chemistry Laboratory, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt, according to the method of Antakli *et al.* (2015).

Determination of fat soluble vitamins

Fat soluble vitamins were determined by HPLC as described by Plozza *et al.* (2012).

Fractionation and identification of phenolic and flavonoid compounds by HPLC

Fractionation and identification of phenolic and flavonoid compounds were determined by HPLC according to the method of Schieber *et al.,* (2001).

Determination of chlorophyll and carotenoids content

The chlorophylls (A and B) as well as total carotenoids of studied samples were determined according to the methods described by Holm (1954) and Wetsttein (1957), respectively.

Determination of antioxidant activity

Antioxidant activity was determined by 2, 2-Diphenyl-1- picrylhydrazyl (DPPH) radical scavenging activity, according to the calorimetric method of Brand-Williams *et al*., (1995).

Sensory Evaluation of the prepared Tamia

The prepared Tamia samples were sensory evaluated by 10 panelists (staff of Agricultural Research Station in Assiut, Agricultural Research Center) for color, taste, odor, texture and overall acceptability using a scale from 1 to 10 and the decisions were as Follows: Excellent (10); Very good (8-9); Palatable (6-7) and Non-palatable (0-5) according to (Larmond, 1970).

Statistical analysis

The statistical analysis of the obtained data was performed by analysis of variance (ANOVA) and the results were submitted to Duncan's test according to the program SAS (SAS, 1999).

Results and Discussion

Gross chemical composition of chicory and sorrel leaves

Chemical composition of chicory and sorrel leaves are present in Table (1). From the obtained data sorrel leaves were higher in their contents of moisture, crude protein and ash compared with chicory leaves. While, chicory leaves were higher than sorrel leaves of their contents of crude fat, crude fiber and nitrogen free extract content.

Table1. Gross chemical composition*of chicory and sorrel leaves (%on dry weight except moisture):

Compound	Chicory	Sorrel
Moisture	88.501^{a}	89.352^{b}
Crude protein	14.060^{a}	19.602^{b}
Crude Fat	3.911^{b}	2.110^{a}
Crude fiber	11.063^{b}	9.024^{a}
Ash	11.236^{a}	18.918^{b}
Nitrogen free extract (NFE)	59.73^{b}	56.18^{a}

* Means of triplicates

The obtained results for chicory analysis was in the same line with that reported by Massoud *et al*. (2009), where the crude protein, ash, total carbohydrate, total soluble sugar, crude ether extract, Inulin and crude fiber content of chicory leaves were 14.70, 10.91, 70.71, 7.80, 3.68, 10.95 and 16.78%, respectively.

Regarding to sorrel leaves the obtained results are agree partially with those of Jimoh *et al.* (2010), they pointed out that, sorrel leaves contained 89.85,18, 4.25, 17.06 and 16.7% for moisture, protein, lipids, crude fiber, and ash, respectively and Alfawaz, (2006) who found that, sorrel leaves contained 18.6% protein, 17.1% ash, 3.4% fat and 8.3% fiber, respectively.

However, the significance high content of fiber in human nutrition (as found in chicory and sorrel leaves) had a role in lowering blood cholesterol with the attendant benefit of reducing the risk of developing diabetes, hypertension, cancer and hyper-cholestroleamia (Singh *et al.,* 2002, Koulshon *et al.,* 2005, Oboh and Omofoma 2008).

Minerals content of chicory and sorrel leaves

Mineral contents of chicory and sorrel leaves are presented in Table (2). It could be concluded that chicory and sorrel leaves are considered to be a good source of minerals.

Table 2. Minerals content of chicory and sorrel leaves (mg/100g dry weight)

Minerals	Chicory	Sorrel	Minerals	Chicory	Sorrel
Calcium (Ca)	1641.025	609.756	Selenium (Se)	7.051	8.911
Potassium (k)	2474.358	1716.697	Zinc (Zn)	7.435	3.939
Sodium (Na)	1391.025	1442.307	Iron (Fe)	13.717	9.193
Phosphorus (P)	313.205	209.943	Manganese (Mn)	6.153	2.908
Magnesium (Mg)	234.743	188.086	Cadmium (Cd)	0.006	0.011
Copper (Cu)	1.923	1.594	Lead (Pb)	ND	ND

From the obtained data, chicory leaves had higher contents of calcium, potassium phosphorus, magnesium, iron, zinc and copper compared with sorrel leaves which had higher contents of sodium, selenium and cadmium. However, the contents of cadmium were low (0.006 and 0.011mg/100g dry weight of chicory and sorrel leaves, respectively) while lead was not detected in both plants. On the other hand, the obtained data of minerals content for chicory leaves was higher than the reported by Abo -Taleb *et al.* (2017).

Moreover, the high contents of iron, selenium, zinc and copper are considered the most important minerals for the human health.

Vitamins content of chicory and sorrel leaves

Some B-complex vitamins as well as fat soluble vitamins in chicory and sorrel leaves are presented in Table 3.

Regarding to group B vitamins sorrel leaves was the higher in their contents of B_{12}, B_6, B_1, and B_9 vitamins compared with chicory leaves, which was higher in their content of B_2.

These results are in the same line with that of Saeed *et al.* (2017), they reported that, vitamins (B1, B2, B3, B5, B6) and (B9) representing about (0.06, 0.01, 0.05, 1.16, 0.11mg/100g) and (107µg/100g), respectively. On other hand, sorrel leaves had nearly 6 times more of vitamin A and double content of vitamin

D compared with chicory leaves, while the later had about 4 times more of vitamin K.

Table 3. Vitamin B-complex and A, D, E, K vitamin contents of chicory and sorrel leaves (mg/100g dry weight)

Vitamins		Chicory	Sorrel
Vit. B complex	Pyridoxine (B6)	0.033	0.118
	Thiamine (B1)	0.013	0.023
	Cobalamine (B12)	0.286	0.908
	Folic acid (B9)	0.032	0.048
	Riboflavin (B2)	0.152	0.116
Vit. A		4.969	27.437
Vit. D		0.208	0.399
Vit. E		0.162	0.168
Vit. K		113.729	42.059

However, vitamin K is essential for the process of blood clotting. Vitamin A as an antioxidant is known to scavenge free radicals in the body and thus prevents cellular damage. It is important in maintenance of healthy eyes and skin, normal growth and reproduction as well as enhancement of immune function (Roth and Townsend, 2003). Besides, the effectiveness of tocopherols (vitamin E) and lipid antioxidants has been attributed mainly to its ability to prevent cell membrane damage by free radicals, by reducing the levels of lipid peroxides (Rodriguez and Rodriguez, 2007).

Phenolic compounds of chicory and sorrel leaves

The fractionation and identification of phenolic compounds by HPLC in chicory and sorrel leaves are presented in Table (4). There are 17 phenolic compounds were detected and determined in the studied leaves. The sorrel leaves were distinguished by their high content of phenolic compounds compared to the chicory leaves.

However, pyrogallol was the major phenolic compound in sorrel leaves which recorded 292.59 mg/100g dry weight, followed by oleuropin (57.23 mg/100g), ferulic acid (30.84 mg/100g), ellagic acid (26.53 mg/100g), chlorogenic (24.97 mg/100g) and catechein (19.83 mg/100g). Whereas ellagic acid compound represented the major phenolic compound in chicory leaves which recorded 78.22 mg/100g, followed by oleuropin (22.86 mg/100g), pyrogallol (12.85 mg/100g), chlorogenic (10.74 mg/100g), ferulic acid (9.2 mg/100g) and catechein (6.57 mg/100g). Phenolic compounds are very important plant constituents because of their scavenging ability on free radicals due to their hydroxyl groups (Heim *et al.,* 2002).

Table 4. HPLC analysis of phenolic compounds of chicory and sorrel leaves (mg/100g dry weight)

Phenolic compounds	Chicory	Sorrel
Pyrogallol	12.855	292.593
Gallic	0.339	10.044
3-OH Tyrosol	0.119	1.423
Catechol	0.759	4.822
4-Aminobenzoic	0.416	1.292
Catechein	6.570	19.838
Chlorogenic	10.744	24.973
P-OH- benzoic	0.943	1.369
Benzoic	1.115	7.071
Caffeic	1.395	3.295
Vanillic	0.709	4.980
Caffeine	1.105	3.662
Ferulic	9.202	30.845
Ellagic	24.525	26.536
Salycillic	2.151	6.497
Oleuropin	22.861	57.233
Coumarin	1.188	3.085

However, Khalaf *et al.,* (2018) found that, the major polyphenol fractions in chicory leaves were chlorogenic acid, e- vanilic acid, catechein, ellagic acid, benzoic acid, caffene and vanillic acid which were found at the levels of 272.48, 131.02, 96.41, 91.19, 77.5, 68.76 and 30.66 mg/100g on dry weight basis, respectively.

Flavonoids compounds of chicory and sorrel leaves

Flavonoids are widely distributed group of plant phenolic compounds, which are very effective antioxidants. Fractionation and determination of flavonoid contents of the studied wild plants leaves using HPLC are presented in Table (5). Using HPLC analysis there were 14 different flavonoid compounds detected and determined in chicory and sorrel leaves.

Narengin represented the major flavonoid compound in both chicory and sorrel leaves which amounted 49.96 and 146.84 mg/100g of total flavonoids, respectively. The narengin has antioxidant, anti-carcinogenic and cholesterol lowering activity. In addition, naringin and quercetin contents of sorrel leaves amounted about 3 times its contents of chicory leaves.

On other hand, Khalil *et al.* (2019) mentioned that, flavonoids fractionation of chicory extract reveals that a high content of rutin recording 416.81 ppm, naringin 378.02 ppm and luteolin 7- glucose 301.03 ppm. However, the lowest contents were quercetin and narigenin recording12.93 and 5.64 ppm, respectively.

Table 5. HPLC analysis of flavonoids compounds of chicory, and sorrel leaves (mg/100g dry weight)

Flavonoid compounds	Chicory	Sorrel
Apigenin 6-arabinose 8-galactose	25.856	9.934
Apiening 6-rhamnose 8-glucose	1.720	6.464
Rutin	0.892	1.480
Naringin	49.962	146.840
Luteolin 7 glucose	0.245	2.702
Hesperdine	1.315	14.493
Rosmarinic	0.120	4.153
Quercetrin	6.899	17.095
Apigenin-7-glucose	1.667	12.330
Quercetin	1.565	4.185
Naringenin	0.116	0.219
kampferol 3-2 p-coumaryl - glucose	5.643	4.320
Kampferol	1.109	0.849
Apigenin	0.430	0.178

Chlorophyll, carotenoids contents and antioxidant activity of chicory and sorrel leaves

Chlorophyll (A& B) and carotenoids contents of chicory and sorrel leaves are shown in Table (6), it was found that, chicory leaves contain more chlorophyll B compared with sorrel leaves. While no significant deference's between their contents of chlorophyll A and total carotenoids.

Table 6. Chlorophyll A and B, total carotenoids and antioxidant activity of chicory and sorrel leaves (mg/100g on dry weight)

Characteristics	Chicory	Sorrel
Chlorophyll A	2.56^b	2.83^b
Chlorophyll B	2.34^b	1.54^a
Total carotenoids	0.798^b	0.939^b
Antioxidant activity (%)	83.45^a	93.36^b

Regarding to antioxidant activity sorrel leaves recorded high significantly antioxidant activity (93.36%) compared with chicory leaves (83.45%). Besides, the high content of pyrogallol in sorrel leaves (292.59 mg/100g dry weight) as indicated in table (4) reflex it's highly antioxidant activity.

Moreover, Oliveira *et al.* (2009) suggested that sorrel leaves may be useful as potential source of antioxidant in food.

Chemical composition of the prepared Tamia

Effect of using chicory and sorrel leaves as a replacement of fresh coriander leaves are presented in Table (7) and Fig (2 - 4). The addition of chicory and sorrel leaves instead of fresh coriander caused significant increment of protein, crude fiber, fat and ash contents of the final prepared Tamia. By increasing the addition ratio from 12 to15% the level of increment was increased. Moreover, the high content of crude fiber in the final product had a good role in human health.

Table 7. Chemical composition of the prepared Tamia (%)

Plants / Parameter	Fresh coriander leaves(control)		Fresh chicory leaves		Fresh sorrel leaves	
	12%	15%	12%	15%	12%	15%
Moisture	42.937^{a}	44.281^{b}	43.575^{b}	45.386^{c}	44.585^{b}	46.432^{c}
Crude protein	25.360^{a}	25.452^{a}	26.955^{b}	27.260^{b}	27.610^{b}	28.162^{b}
Crude fat	43.231^{a}	44.027^{a}	45.563^{c}	45.979^{c}	44.503^{b}	44.761^{b}
Crude fiber	1.480^{a}	1.570^{a}	2.483^{b}	2.773^{b}	2.201^{b}	2.470^{b}
Ash	3.370^{a}	3.482^{a}	4.421^{b}	4.820^{b}	5.411^{c}	6.030^{c}

Sensory evaluation of fried Tamia

Sensory evaluation of prepared Tamia is present in Table (8). Generally, using fresh coriander by 12% was best for all tested parameter and overall acceptability of the final product. However, using of chicory leaves or sorrel leaves by 12% or 15% had no significant effect on taste, color, odor, texture and overall acceptability of the prepared Tamia using 12% fresh coriander. So, it could be recommended to use both of chicory or sorrel leaves in preparing of Tamia instead of fresh coriander and found a new role for such edible wild plants.

Table 8. Sensory evaluation of the prepared Tamia

Plants / Parameter	Fresh coriander leaves(control)		Fresh chicory leaves		Fresh sorrel leaves	
	12%	15%	12%	15%	12%	15%
Taste (10)	8.6^{b}	7.4^{a}	8.0^{ab}	8.1^{b}	8.2^{b}	8.6^{b}
Color (10)	8.3^{b}	7.1^{a}	8.0^{b}	8.3^{b}	8.0^{b}	8.4^{ab}
Odor (10)	8.0^{ab}	7.7^{a}	7.6^{a}	8.1^{b}	8.1^{b}	8.5^{b}
Texture (10)	8.4^{b}	7.5^{a}	8.3^{b}	8.1^{b}	7.8^{a}	8.4^{b}
Overall acceptability(40)	33.3^{c}	29.7^{a}	31.9^{b}	32.6^{b}	32.1^{b}	33.9^{c}

12% fresh coriander leaves

15% fresh coriander leaves

Fig. 2. Tamia with fresh coriander leaves

12% fresh chicory leaves 15% fresh chicory leaves

Fig. 3. Tamia with fresh chicory leaves

12% fresh sorrel leaves 15% fresh sorrel leaves

Fig. 4. Tamia with fresh sorrel leaves

Conclusion

From the obtained data it could be concluded that the studied wild plants, Chicory and Sorrel leaves had high nutritional value and antioxidant activity and could be useful in practical preparing some food products.

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التركيب الكيميائى والإستفادة من بعض النباتات البرية الصالحة للأكل

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الملخص

تم تقدير التركيب الكيميائي العام والمحتوى من العناصر المعدنية وبعض الفيتامينات لنباتين بريين صالحين للأكل هما الشيكوريا والحميض.

كما تم تقدير محتواهما من المواد الفينوليه والفلافونية بواسطة التحليل الكروماتوجرافى السائل عالى الكفاءة (HPLC). كما تم أيضا تقدير محتوي أوراق كل من الشيكوريا والحميض من الكلوروفيل والكاروتينات بالإضافة إلى تقدير النشاط المضاد للأكسدة بهما. وأخيرًا ، تم دراسة إمكانية الاستفادة منهما كبديلا عن نبات الكزبرة الطازجة فى إعداد الطعمية مع تقييم الطعمية الناتجة من ناحية التركيب الكيميائي والتقييم الحسي.

أظهرت النتائج المتحصل عليها أن أوراق الشيكوريا والحميض تحتوي على 88.50 و 89.35٪ رطوبة ، 14.06 و 19.60٪ بروتين خام ، 3.91 و 2.11٪ دهن خام ، 11.06 و 9.02٪ ألياف خام و 11.24 ، 18.92٪ رماد (على أساس الوزن الجاف) على الترتيب. كان مركب البيروجالول هو المركب الرئيسي من بين المركبات الفينوليه المفصوله في أوراق الحميض والذى سجل 292.59 ملجم / 100 جرام وزن جاف .بينما كان حمض الإلاجيك هو المركب الرئيسى في أوراق الشيكوريا مسجلاً 78.22 ملجم / 100 جرام وزن جاف. كما بينت النتائج إن إستخدام أوراق الشيكوريا أو الحميض بنسبة 12 أو 15٪ ليس لها تأثيراً معنوياً على الطعم واللون والرائحة والقوام ودرجة التقبل العام عند إعداد الطعمية بدلاً عن الكزبره الطازجة بنسبة 12٪.