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Dietary potential of some forgotten wild leafy vegetables from Morocco

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Abstract

Morocco's vascular flora is one of the richest in the Mediterranean region. Women, particularly in rural areas, know how to use the wild edible plants available in their environment to make many popular traditional dishes. To our knowledge, there are no studies on the nutritional composition of these plants in Morocco. The present aim of this study is to contribute filling this gap by the determination of the nutrient composition (moisture, proteins, fats, total carbohydrates and ashes) and the energy value of 17 wild edible plants traditionally used as vegetables in the country. Moisture, total protein and Ash contents were analyzed using AOAC official methods. Fats content was determinate by the Mojonnier method and total carbohydrates were calculated by difference. The finding showed that most wild plants analyzed are low fat food with protein levels in the range or higher than several common cultivated vegetables. The highest total carbohydrates values were found in four Apiaceae species. *Mercurialis annua* and *Urtica dioica* stand out respectively for their fat and ash high levels. The reported data suggest that the wild leafy vegetables studied can be considered as good resources, with interesting nutritive potential, especially in the case of low-calorie human diets.

Introduction

Morocco's vascular flora is one of the richest in the Mediterranean region. It consists of 3,913 plant species spread over 155 families and 981 genera (Fennane and Ibn Tattou, 2012). Women, particularly in rural areas have known, for generations, how to use the wild edible plants (WEPs) available in their environment to make many popular traditional dishes. Today, despite the general declining trend in the knowledge related to their use (Tbatou *et al*., 2016), the tradition of eating these wild plants continues to be part of food habits among local populations. Most wild food plants used in the country are herbaceous consumed mainly for their young leaves and/or tender stems and frequently cooked as vegetables in several recipes including tajines, couscous and beqoula traditional local dish (Nassif and Tanji, 2013; Tbatou *et al.*, 2016).

Few years ago, Nassif and Tanji (2013) reviewed the ethnobotanical data available in the literature and published a list of almost 80 species consumed as wild vegetables in Morocco. Shortly thereafter, more than 30 species of wild leafy vegetables (WLVs) were recorded by Powell *et al*. (2014) following the field survey they conducted in 3 regions in Morocco: Taounate, Azilal and El Haouz. According to the authors, the greatest knowledge and diversity of WLVs have been noted in Taounate (Rif Mountains) where these plants were consumed up to 4 times a week by 84% of the households surveyed. Most recently, we published a field survey results conducted between 2013 and 2015 on the use of WEPs in the rural area of El Jadida (Tbatou *et al*., 2016). In that survey, a total of 32 WEPs have been identified as being cooked as vegetables, in the present or in the past in this coastal area. Among the latter, 6 had not previously been recorded as wild edible vegetables used in Morocco.

In recent years, with the continuous increasing demand of natural, healthy and sustainable food, several authors have shown interest in evaluating the nutritional and bioactive components of WEPs, including those used as vegetables, in several Mediterranean countries and regions. Many studies have demonstrated that these wild Mediterranean species have a great potential as a source of essential nutrients such as vitamins (Sánchez-Mata *et al*., 2016), minerals (García-Herrera and Sánchez-Mata, 2016), fibre (Cámara *et al.*, 2016) and essential fatty acids (Guil-Guerrero and Torija-Isasa, 2016). They are also considered as good dietary source of antioxidants due to their high levels of flavonoids and other polyphenolic constituents (Barros *et al.*, 2016) that can scavenge free radicals contributing to

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reduce the risks of several human health problems as cardiovascular diseases, neurodegeneration, diabetes and cancer (Devasagayam *et al*., 2004).

However, despite the participation of many researchers to provide data on the composition of these species, the number of scientific publications remains very limited and the nutritional value of most Mediterranean wild vegetables is not known today. In fact, due to the scarcity of information on their composition in the literature, these wild plants are not included in available food composition databases and their value cannot be evaluated properly.

To our knowledge, there are no studies on the nutritional value of WEPs in Morocco. The aim of the present study is the determination of the energy value and the nutrient composition (moisture, proteins, fat, carbohydrate and ashes) of 17 Moroccan wild leafy vegetables contributing to fill this gap and highlighting the potential food use of these natural underutilized plants in the contemporary diets.

Materials and Methods

Sample selection

The species analyzed were selected following two criteria: 1- the species known for their use as wild vegetables in Morocco. At this level, we relied primarily on the results of the field ethnobotanical survey we conducted between 2013 and 2015 in the rural area of El Jadida (Tbatou *et al*., 2016), and on two others references: Nassif and Tanji (2013) and Powell *et al.* (2014); 2- The species are among the most available WEPs in the rural area of El Jadida, according to the local population.

Table 1 presents the families, scientific names, Moroccan vernacular names and the traditional culinary use of the 17 wild plant species selected. The edible parts analyzed are shown in Figure 1.

Table 1. Families, scientific names, vernacular names and the traditional culinary use of the wild plant species selected

N°	Family	Scientific name	Vernacular names	Traditional culinary uses
1	Apiaceae	*Ammi majus* L.*	Traylal, tlaylan,trylane	Cooked in beqoula dish
2	Apiaceae	*Foeniculum vulgare* Mill. *	El-besbas el-beldi, lebgoul, wamsa	Cooked in tajines, couscous, beqoula dish and other traditional recipes
3	Apiaceae	*Ridolfia segetum* Moris.*	Tebch, slily	Cooked in tajines, couscous, beqoula dish and other traditional recipes
4	Apiaceae	*Scandix pecten-veneris* L.**	Mochita	Cooked in beqoula dish
5	Asteraceae	*Calendula algeriensis* Boiss. & Reut.*	Ejjemra	Cooked in beqoula dish or a garnish in couscous
6	Asteraceae	*Chrysanthemum coronarium* L. *	Rjel djaja, kra djaja, gahwan, ghadou mlal	Cooked in beqoula dish
7	Asteraceae	*Scolymus hispanicus* L. *	El-gernina, jarnij, taghediwt	Cooked in tagines with meat or in beqoula dish
8	Asteraceae	*Silybum marianum* (L.) Gaertn.*	Chouka hmar, tawra, bouzerwal	Cooked as vegetable in tagines
9	Caryophyllaceae	*Silene vulgaris* (Moench) Garcke.*	Tirecht, tighighit, taghirasht	Cooked in beqoula dish
10	Chenopodiaceae	*Beta macrocarpa* Guss.*	Boumsselli, selg, tibidas	Cooked in beqoula dish
11	Chenopodiaceae	*Chenopodium murale* L.*	Berremram	Cooked in beqoula dish
12	Euphorbiaceae	*Mercurialis annua* L.**	Horriga lmalssa, horriga lbarda	Cooked in beqoula dish or as a garnish for some traditional soups
13	Malvaceae	*Lavatera cretica* L. *	Khobbiza, baqoula, tibi, abajir	Cooked as the main ingredient of the traditional beqoula dish or as a garnish for couscous
14	Papaveraceae	*Papaver rhoeas* L.*	Belaaman, bennaâman	Cooked in beqoula dish
15	Polygonaceae	*Emex spinosa* (L.) Campd.*	Hommaida, hanbaza, lhenzab, tassemount	Cooked in beqoula dish or as vegetable for couscous
16	Polygonaceae	*Rumex pulcher* L.*	Hommaida, hamrat erras	Cooked in beqoula dish or as vegetable for couscous
17	Urticaceae	*Urtica dioica* L. *	Horriga lharcha, horriga el harra, taqzint	Cooked in beqoula dish

* Consumed as vegetables in the rural region of El Jadida and in other parts of Morocco (based on Nassif and Tanji (2013), Powell *et al.* (2014) and Tbatou *et al.* (2016)); ** Consumed as vegetables specifically in the rural area of El Jadida (based on Tbatou *et al.* (2016))

Sample collection

The samples were gathered from the rural area of El Jadida (Moulay Abdallah rural commune) between January and March 2016. The local population was involved in the determination of the site as well as the criteria of the sample harvest (Pereira *et al.,* 2011). For each species, three subsamples consisting of 25 randomly selected individual plants, each with a healthy appearance (Sánchez-Mata *et al*., 2012), were collected from three different sites (douar Louwjayna (33°6’N;8°31’W), douar oulad lghadbane (33°10’N;8°36’W), douar Fahs (33°10’N;8°30’W)). Most plants were collected before flowering, when their edible portions were quite large but still tender. These sub-samples were mixed (25 x 3) in equal parts to get a composite sample to be analyzed (Trichopoulou *et al*., 2000). The plants were then packed in a plastic bag and transported on the same day to the laboratory for preparation. A botanist at the Faculty of Sciences in El Jadida and co- author of this paper carried out the plants scientific identification.

Samples preparation

Once in the laboratory, the collected samples were prepared in accordance with the recommendations of Greenfield and Southgate (2007) for leafy vegetables. Thus, the outer yellow or wrinkled leaves and tough stems were discarded and only the traditionally consumed parts were kept. The plants were then washed with running water to remove visible dirt, rinsed with distilled water and then with demineralized water. After draining, the edible

Figure 1. Wild species selected (edible parts analyzed): a. *Foeniculum vulgare* (young stems with leaves); b. *Ammi majus* (basal leaves); c. *Scolymus hispanicus* (mid-ribs of basal leaves); d. *Calendula algeriensis* (young leaves); e. *Scandix pecten-veneris* (basal leaves); f. *Ridolfia segetum* (young stems with leaves); g. *Silybum marianum* (mid-ribs of basal leaves); h. *Emex spinosa* (basal leaves); i. *Mercurialis annua* (aerial parts); j. *Chrysanthemum coronarium* (basal leaves); k. *Urtica dioica* (aerial parts); l. *Silene vulgaris* (tender stems with leaves); m. *Rumex pulcher* (Basal leaves); n. *Papaver rhoeas* (Basal leaves); o. *Chenopodium murale* (aerial parts); p. *Beta macrocarpa* (tender leaves); q. *Lavatera cretica* (tender stems with leaves)

parts were cut and homogenized and a minimum of 500 g was kept for analysis. Immediately after, a test portion of the fresh material was collected for the determination of water content. The rest of the sample was dried to constant weight at a temperature below 50°C and stored in a dry place, protected from light, pending completion of further analysis.

Water content

Determination of water content (moisture) was carried out by desiccation of 3-4 g of the sample in the air oven at 100±2°C to constant weight (Horwitz and Latimer, 2005).

Total protein

Total proteins content were determined as nitrogen content obtained by the Kjeldahl method. In brief, 0.5g of dried sample was digested in sulfuric acid, NH_3 was distilled over N/10 H_2SO_4 and the excess of sulfuric acid was titrated against N/10 NaOH. The factor 6.25 was used for the conversion from total nitrogen content to protein content (Horwitz and Latimer, 2005).

Total fat

The plants total fat content was determined gravimetrically by the Mojonnier method (ISO, 2000). An amount of 1-1.5 g of the dried sample was dissolute and treated with an ammoniacal ethanolic solution. Diethyl ether and petroleum ether were used for fat extraction. The solvents were removed by evaporation then the extracted fat was dried at 100°C, cooled and weighted.

Ash content

Ashes were gravimetrically quantified after incineration of 3 g of the dried sample in a muffle furnace at 550°C according to the AOAC official method 930.05 (Horwitz and Latimer, 2005).

Total carbohydrates

Total carbohydrates were calculated by difference according to the following formula (Greenfield and Southgate, 2007):

100 – (Weight in grams of [protein + fat + water + ash] in 100 g of the sample)

Total energy

Energy values of the WLVs studied were calculated according to the following equation (FAO, 2003):

Energy (kcal) = 9 × [fats (g)] + 4 × [proteins (g) + carbohydrates (g)].

Statistical analysis

All the assays were carried out in triplicate. The results are expressed as mean values ± standard deviation. The analysis of variance (ANOVA) followed by Duncan's test at the 95% confidence level was performed using SPSS, version 20. Pearson correlation coefficients (r) and p-values between the parameters analyzed were determined for a better explanation of the variability obtained.

Results and Discussion

Table 2 presents moisture content, macronutrients composition and energy value of the 17 wild species analyzed expressed per 100g of the plant edible portion (fresh weight basis).

Water content

The results show that the water content (moisture) ranged between 83.1 and 95.0 g/100 g. The minimum was observed in Ammi majus and the maximum in Silybum marianum. Due to the fleshy texture of its

Table 2. Moisture (g/100 g), macronutrients composition (g/100 g) and energy value (kcal/100 g) of the wild species analyzed (fresh weight basis)

N°	Species	Moisture	Proteins	Fat	Total carbohydrates	Ash	Energy
1	*Ammi majus* L.	83.1±0.3^{a}	4.09±0.01^{k}	0.14±0.02^{c}	10.66±0.31^{h}	2.02 ±0.01^{l}	60.19±1.13^{l}
2	*Foeniculum vulgare* Mill.	85.3±0.5^{c}	3.30±0.04^{j}	0.18 ±0.00^{d}	9.26±0.48^{g}	1.96±0.01^{j}	51.84±1.98^{j}
3	*Ridolfia segetum* Moris.	85.3±0.6^{c}	2.68±0.00^{g}	0.17±0.00^{d}	9.58±0.61^{g}	2.28±0.00^{m}	50.50±2.38^{j}
4	*Scandix pecten-veneris* L.	83.8±0.2^{b}	4.22±0.03^{l}	0.08 ±0.00^{b}	9.55±0.22^{g}	2.36±0.02^{n}	55.76±0.76^{k}
5	*Calendula algeriensis* Boiss. & Reut.	91.4±0.60^{h}	1.94±0.01^{c}	0.09 ±0.00^{b}	5.14±0.59^{b}	1.43±0.00^{e}	29.13±2.40^{c}
6	*Chrysanthemum coronarium* L.	90.8±0.10^{g}	2.08±0.01^{d}	0.08 ±0.00^{b}	5.70±0.10^{bc}	1.34±0.00^{c}	31.84±0.40^{d}
7	*Scolymus hispanicus* L.	93.2±0.1^{i}	0.95±0.04^{b}	0.08 ±0.00^{b}	5.39±0.10^{b}	0.38±0.00^{a}	26.08±0.40^{b}
8	*Silybum marianum* (L.) Gaertn.	95.0±0.2^{j}	0.50±0.00^{a}	0.01 ±0.00^{a}	3.17±0.20^{a}	1.32±0.00^{b}	14.77±0.80^{a}
9	*Silene vulgaris* (Moench) Garcke.	89.4±0.3^{e}	2.25±0.01^{e}	0.26±0.00^{g}	6.39±0.30^{de}	1.70±0.00^{i}	36.88±1.20^{fg}
10	*Beta macrocarpa* Guss.	89.5±0.2^{e}	3.18±0.01^{i}	0.13±0.00^{c}	5.19±0.19^{b}	2.00±0.00^{k}	34.63±0.83^{ef}
11	*Chenopodium murale* L.	87.9±0.3^{d}	3.12±0.02^{i}	0.12±0.00^{c}	6.40±0.31^{de}	2.46±0.00^{o}	39.16±1.20^{gh}
12	*Mercurialis annua* L.	83.6±0.5^{ab}	4.78±0.01^{m}	0.84±0.00^{h}	8.00±0.50^{f}	2.78±0.01^{p}	58.68±1.98^{l}
13	*Lavatera cretica* L.	88.0±0.3^{d}	4.10±0.14^{k}	0.21±0.01^{e}	6.05±0.39^{cd}	1.64±0.00^{g}	42.47±1.25^{i}
14	*Papaver rhoeas* L.	89.1±0.5^{e}	3.29±0.02^{j}	0.22±0.00^{f}	5.78±0.50^{bcd}	1.61±0.00^{f}	38.26±2.00^{g}
15	*Emex spinosa* (L.) Campd.	90.6±0.1^{fg}	2.62±0.03^{fg}	0.13±0.01^{c}	5.25±0.11^{b}	1.40±0.00^{d}	32.65±0.43^{de}
16	*Rumex pulcher* L.	90.1±0.1^{f}	2.57±0.03^{f}	0.17±0.00^{d}	5.39±0.09^{b}	1.68±0.01^{h}	33.31±0.45^{de}
17	*Urtica dioica* L.	85.8±0.1^{c}	2.93±0.02^{h}	0.25±0.00^{g}	6.70±0.12^{e}	4.32±0.01^{q}	40.75±0.42^{hi}

Values are given as average ±standard deviation. For each column, different letters mean significant differences (p < 0.05).

peeled leaves tissues, the latter species has shown the highest moisture value (92.9-93.4 g/100g) among all wild edible plants that Sánchez-Mata *et al*. (2012), García-Herrera *et al*. (2014b) and Morales *et al.* (2014) have analyzed.

Similarly to our results, other authors have found moisture values in the range of 80-95 g/100g for different Mediterranean WLVs (e.g. Trichopoulou *et al*., 2000; Sekeroglu *et al.*, 2006; Pereira *et al*., 2011; Morales *et al.*, 2014; Maurizi *et al.*, 2015; Tuncturk *et al*., 2015). The high water content of these food plants contributes positively to their texture and palatability but limits their microbiological and preservation stability (García-Herrera *et al*., 2014b).

In the Table 3 the Pearson correlation coefficient (r) and p-values between the parameters analyzed are presented. The results show significant negative correlations (r < -0.472; p-value < 0.01) between moisture and all the compounds studied. This can be attributed to the water dilution effect on the plant nutrients amounts. According to Greenfield and Southgate (2007) moisture value is a good determinant of the levels of the other components. It makes it possible to compare nutrient values in a similar water content basis, hence the importance of determining this parameter when studying the nutritional composition of foods.

Total protein

Regarding the protein contents, the highest levels were found in *Mercurialis annua* (4.78 g/100g), *Scandix pecten-veneris* (4.22 g/100g), *Lavatera cretica* (4.10 g/100g) and *Ammi majus* (4.09 g/100g). The lowest values were obtained in *Silybum marianum* (0.50 g/100g), *Scolymus hispanicus* (0.95 g/100g) and in *Calendula algeriensis* (1.94 g/100g). The present study results are close to those reported by other authors; for exemple protein values of 2.6 g/100g were found for *Silene vulgaris* (García-Herrera, 2014), 3.5 g/100g for *Papaver rhoeas* (Maurizi *et al*., 2015) and 3.3 g/100g for *Rumex plucher* (García-Herrera, 2014). For *Foeniculum vulgare* our value (3.30g/100g) is comparable to the result reported by Trichopoulou *et al*. (2000) (3.80 g/100g) but higher than those found by Alonso-Esteban (2015) on the same species (1.08-1.16 g/100g). On the other hand, higher total protein contents (1.75 g/100g) were reported by García-Herrera *et al.* (2014b) for *Scolymus hispanicus* compared to our value (0.95 g/100g) for this species. Also, the protein value (4.35 g/100g) reported by Guil-Guerrero and Torija-Isasa (2002) in the leaves of *Chenopodium murale* was higher than this we found (3.12 g/100g) in the aerial parts of this same Chenopodiaceae species.

In commonly consumed leafy vegetables the protein contents varied for example in 2.4-2.6 g/100g for spinach, 0.4-2.2 g/100g for cabbage and 0.7-1.8 g/100g for lettuce (TÜRKOMP, 2014; INSA, 2015; SEH-LELHA, 2015). Therefore we could state that most wild plants analyzed in the present study reach protein values in the range of or higher than several cultivated vegetables. Similar trend has been noted also by Yildirim *et al.* (2001) and Sekeroglu *et al.* (2006) for the studied nutritional values of some wild plants used as vegetables in Turkey.

Total fat

The highest level of fat (0.84 g/100g) was found in *Mercurialis annua*. The average fat content of this species was exceptionally higher than the levels found in the most other wild or cultivated leafy vegetables (e.g. FAO, 2016). For the other 16 plants investigated, the values found are in the range of 0.01-0.25 g/100g and in agreement with those reported by other authors related to fat content in wild greens. For example, García-Herrera (2014) found an average value of 0.17 g/100g for *Foeniculum vulgare* and 0.20 g/100g for *Rumex pulcher.* Values of 0.10 and 0.22 g/100g were also found respectively for *Rumex acetosella* and *Rumex papillaris,* a species from the same genus of *Rumex pulcher* and with similar uses (García-Herrera, 2014; Ereifej *et al*., 2015). Fat contents in *Scolymus hispanicus* (0.08 g/100g) and *Silybum marianum* (0.01 g/100g) were similar to those reported by García-Herrera *et al*. (2014b), while a lower value (0.41g/100g) was found for *Silene vulgaris* (García-Herrera, 2014), comparatively to the value reported in the present study for the same species.

From the results, all the WLVs studied (except *Mercurialis annua*) can be defined as " low fat" food according to the Regulation (EC) on nutrition and health claims made on foods of the European Parliament and the Council (EPC; No 1924/2006 of 20 December 2006), as they are less than 3% of fat. However, despite their low fat content, WLVs contain in general an interesting proportion of essential fatty acids often higher than many cultivated species. Indeed, the study of Morales *et al.* (2012) about the fatty acids profiles of 20 Spanish wild vegetables showed that the majority of the samples analyzed can be considered as interesting source of omega-3 essential fatty acids, whose modern diet are deficient. The authors also found that these wild food plants present a low omega-6/omega-3 ratio, desirable in the prevention of cancer, arthritis, cardiovascular, inflammatory and autoimmune diseases as well as for the proper brain function.

Total carbohydrates

The total carbohydrate content of the wild vegetables analyzed fluctuated between 3.17 and 10.66 g/100g. *Silybum marianum* contained the lowest value probably due to its high water content. The highest levels (9.26-10.66 g/100g) were found in the four Apiaceae species: *Ammi majus, Ridolfia segetum, Scandix pecten-veneris* and *Foeniculum vulgare.* In these species values were higher than those reported in some common leafy vegetables from the same family such as celery, coriander or parsley (2.97-6.33 g/100g) or other families, such as spinach and lettuce (2.14-3.90 g/100g) (USDA, 2016). *Mercurialis annua* showed also exceptionally high total carbohydrate content (8.00g/100g) while for the other food plants studied *(Calendula algeriensis, Beta macrocarpa, Emex spinosa, Rumex pulcher, Scolymus hispanicus, Chrysanthemum coronarium, Papaver rhoeas, Lavatera cretica, Silene vulgaris, Chenopodium murale* and *Urtica dioica)* the values ranged from 5.14 to 6.70 g/100g, approaching certain common cultivated vegetables such as common cabbage (5.6 g/100g) or broccoli (6.6 g/100g) (USDA, 2016). In general, excepting for *Silybum marianum*, total carbohydrates were the most abundant macronutrient in the wild greens analyzed in this study due probably to their high fibre content. Indeed, fibre content in several WLVs reported in the literature represent more than 3% and can be considered as "source of fibre" according to the regulation of EPC (2006); e.g. value of 3.8 g/100g was obtained in *Papaver rhoeas* (Maurizi *et al*., 2015), 4.3 g/100g in *Chenopodium murale* (Guil-Guerrero and Torija-Isasa, 2002) and 5.50 g/100g was found in *Foeniculum vulgare* (García-Herrera, 2014). Other species such as *Rumex pulcher* (García-Herrera, 2014) and *Scolymus hispanicus* (García-Herrera *et al.*, 2014b) with fibre values exceeding 6 g/100g can be claimed as "high fibre" food according to the same regulation.

Total energy

Macronutrients provide energy to human body. In the species studied, the contribution of total carbohydrates to the total number of calories was 55-86% (Figure 2). High and significant positive correlation was found also between energy and total carbohydrates in the wild greens analyzed ($r=0.931$; p-value < 0.01; Table 3).

The highest levels of energy (59-60kcal/100g) were found in *Ammi majus* and *Mercurialis annua* without significant statistical differences between them ($p<0.05$). They are followed by *Scandix pecten-veneris, Foeniculum vulgare, Ridolfia segetum, Lavatera cretica* and *Urtica dioica* (41-56 kcal/100g). On the other hand for the 10 plant species; *Silybum marianum, Scolymus hispanicus, Calendula algeriensis, Chrysanthemum coronarium, Emex spinosa, Rumex. pulcher, Beta macrocarpa, Silene vulgaris, Papaver rhoeas* and *Chenopodium murale*; their energy contents were under 40 kcal/100g and can be defined as "energy low" according to EPC

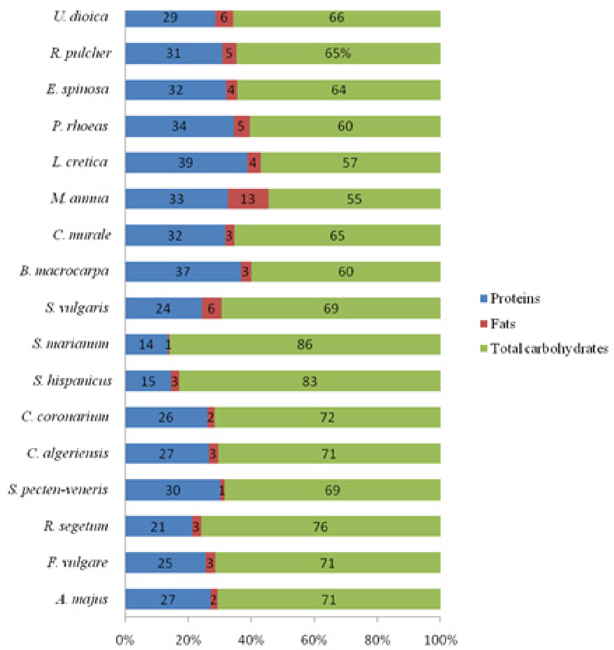

Figure 2. Contribution of the macronutrients to the total energy (%)

(2006)'s regulation.

The present study results concerning energy values in different species of wild greens are in agreement with those reported by other authors. It is the case of Trichopoulou *et al.* (2000) that found 48 kcal/100g for *Foeniculum vulgare*, close to our result (51 kcal/100g). The values in our study are however lower than those reported by Alonso-Esteban (2015) (84-86 kcal/100g) for this species. The six wild edible plants studied by García-Herrera *et al.* (2014b) provided around 12-54 kcal/100g with a lowest value for *Silybum marianum*, similarly to our result for this Asteraceae. In the present investigation, all the wild food plants analyzed have however total energy values in the range or higher than several common cultivated vegetables such as lettuce, spinach, cabbage, cauliflower, asparagus, endive or celery (TÜRKOMP, 2014; INSA, 2015; SEH-LELHA, 2015).

Ash content

Regarding ash content, high variations (0.38-4.32 g/100g) were observed between the species studied (Table 2). The highest content was obtained for the aerial part of Urtica dioica. These values are much higher than those previously reported (1.20-1.86 g/100g) for the leaves of the same species (Guil-Guerrero and Torija-Isasa, 2002; Sekeroglu *et al*., 2006; Civelek and Balkaya, 2013). The lowest ash content (0.38 g/100g) was found in *Scolymus hispanicus* with a considerably lower value (3.19 g/100g) than that found by García-Herrera *et al.* (2014b) for this species. This variability between the available data concerning the same species can be explained by the influence of the environmental conditions on the plants mineral content (García-Herrera and Sánchez-Mata, 2016). Thus, it would be interesting to conduct analyzes on samples gathered in different sites and different years to obtain more representative data on this parameter. Yet, certain previously published data regarding ash content in WLVs are in the same range as in the present study. Indeed, a similar value was found here in *Foeniculum vulgare* (1.96 g/100g) compared to that reported by (García-Herrera *et al.,* 2014) (1.9 g/100g) for this plant. Also, values reported before for *Silybum marianum* (1.54 g/100g; García-Herrera *et al*., 2014b), *Papaver rhoeas* (1.9 g/100g; Bianco *et al*., 1998; Maurizi *et al*., 2015) and *Rumex pulcher* (1.9 g/100g; García-Herrera, 2014) were close to our result for these species in the present investigation.

Table 3. Correlations coefficients and (p-values) between the variables analyzed

	Moisture	Proteins	Fat	Carbohydrates	Ash
Proteins	-0.863 (0.000)**				
Fat	-0.472 (0.000)**	0.555 (0.000)**			
Carbohydrates	-0.909 (0.000)**	0.651 (0.000)**	0.239 (0.092)		
Ash	-0.663 (0.000)**	0.519 (0.000)**	0.410 (0.003)**	0.396 (0.004)**	
Energy	-0.979 (0.000)**	0.870 (0.000)**	0.493 (0.000)**	0.931 (0.000)**	0.506 (0.000)**

**Significant correlations ($p < 0.01$).

Conclusion

The present study is the first to report on the energy value and nutrient composition (moisture, proteins, fats, total carbohydrates and ashes) of some wild leafy vegetables in Morocco. Such information is essential to estimate more precisely the local population dietary intakes and evaluate the health characteristics of these foods (Elmadfa and Meyer, 2010). According to the extensive literature search for the latest and most accurate nutritional data we conducted in order to compare our results to those published by others authors for the same species in the Mediterranean, nine species *(Ammi majus, Ridolfia segetum, Scandix pecten-veneris, Calendula algeriensis, Chrysanthemum coronarium, Beta macrocarpa, Mercurialis annua, Lavatera cretica* and *Emex spinosa*) among the 17 examined here have not been previously investigated from a nutritional point of view, as far as we know, in the region, while some scarce data only were reported for the eight remaining food plants. Further research on this topic is now highly warranted. The reported data suggest that the wild leafy vegetables studied can be considered as good resources, with interesting nutritive potential, especially in the case of low-calorie human diets. The promotion of these under-exploited products could contribute to the diversification of vegetables consumed and to the improvement of the local population's nutritional status.

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