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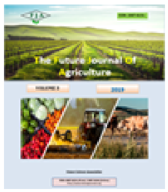

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CHEMICALS AND NUTRITIONAL PROPERTIES OF SOME EDIBLE WEEDS SPECIES AS POTENTIAL FOODS AND FUTURE CROPS

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ABSTRACT: Edible weed species are of great interest in human food demand due to their contributions in the provision of people's daily intake or as supplemented nutrition over the world. Therefore, a survey study was conducted to record wild edible plants in Egypt. Which, about 44 plants species were distributed into 21 genera belonging to 14 botanical families which have domestic usages. Based on the chemical analysis of elemental composition (Mg, Ca, Na, K, Mn, and Fe) and dietary nutritive values including ash content, fiber, fat, protein, and total carbohydrates were ranked. Considerably interested found in *Corchorus olitorius* which recorded the highest nutritive values with higher content of nutritional values and amino acids, followed by *Portulaca oleracea* in the second order. Australian Weed Risk Assessment protocols revealed that *Cichorium intybus*, *Sonchus oleraceus* and *C. olitorius* were achieved an accepted risk, while the other species had low risks scoring. The analysis revealed a positive correlation between oxalate content and risk assessment of edible weeds. Therefore, these species can be considered as a good and low-cost source for amino acids and minerals compared with the locally consumed vegetables. Finally, this information can provide the priority species for future domestications as promising food crops.

Key words: Wild plants, edible weeds, risk assessments, agroecosystem, human nutrition.

INTRODUCTION

Food insecurity and malnutrition encounter a lot of people over the world due to the ever-growing human population **(Godfray *et al.*, 2010**), especially in the largely import-dependent countries of Africa (**FAO, 2011**). Globally, an estimated 1.02 billion people are undernourished **(FAO, 2009).** Wild edible plants are available from their natural habitat and are used as a part of food (**Mahapatra *et al.*, 2012**). Whereas, wild edible plants (WEPs) are part of the cultural and genetic heritage of different regions of the world. In times of famine and scarcity, these sources of nutrients and health-promoting compounds have received high importance mainly in rural and suburban areas (**Pinela *et al.*, 2017**). Wild plant species grow spontaneously in self-maintaining populations in natural or semi-natural habitats (**Maurer and Schueckler, 1999**). Currently several indigenous and traditional communities consume 200 or more species. Whilst, edible wild plants are regularly deprecated by policymakers and considered to be the 'weeds of agriculture (**Grivetti and Ogle, 2000 & MEA, 2005**). Wild edible plants have always been important in the traditions folk of the Mediterranean region (**Hadjichambis *et al.*, 2007**). Wild edible plants particularly weeds, continue to be an important dietary component of many people around the world (**Molina *et al.*, 2014**). Many wild edible plants used by tribal communities are a great source of proteins and minerals (**Oommachan and Masih, 1988**). Wild edible plants/weeds are critical for the sustenance of tribal communities in a form of food materials and also as a source of income like timber and so on (**PowarPriyatama *et al.*, 2019**). Wild edible plants or weeds are used as a source of food by local people and they still rely on nature (**Jhamta *et al.*, 2019**). Weeds are culturally cognitively important for local farmers as a vegetable source. (**Cruz-Garcia *et al.*, 2012**). Meanwhile, there are increasing concerns about the safety, standardization, quality, and availability of products derived from these species (**Ceccanti *et al.*, 2018).**

The Mediterranean basin is a high biodiversity of wild edible species (**Leonti, 2006**) and the gathered food plant (GFP) is higher at the periphery of the Mediterranean **(Rivera, 2006)**. Whereas, domestication of wild species seems a promising approach for exploiting these "new functional foods" (**Ceccanti *et al.*, 2018).** The nutritional value will encourage people to consume a greater quantity of food and provide them with a better balance of nutrients (**FAO, 1989**). The nutritional values of wild edible plants are less explored but considered as a potential contributor to dietetic diversity and food security of rural communities **(Grivetti and Ogle 2000 & Ogle *et al.*, 2003**). *P. oleraceae* L. is a widespread weed, which is highly appreciated for its high nutritional value with particular reference to the content in omega-3 fatty acids, phenolic compounds, and oleracein derivatives (**Petropoulos *et al.*, 2019**). *C. olitorius* had good amount of protein (3.79%), iron (67.93 mg/kg), β-carotene (51.0 mg/kg) and potassium (4400 mg/kg) (**Choudhary *et al.*, 2013**). *P. olaracea* were found to be a good source of proteins, fats, carbohydrates, hence capable of providing energy to the consumer and significantly useful in terms of mineral sources, particularly Fe, Ca, Zn, Cu and Mg (**Ullah *et al.*, 2017**). Protein content of different wild species ranged from 19.03 ± 0.26 to 31.16 ± 0.20 percent. The crude fiber content was found highest in *Polygonum plebijum*, while the highest ash content was observed in *P. oleracea*. (**Sinha, 2018**). Carbohydrates, protein, and mineral contents of mallow *M. parviflora* can be affected and controlled by selenium concentration (**Salama *et al.*, 2019**). *Cichorium endivia* L. subsp. *pumilum* offers antimicrobial potency and provides a basis for further phytochemical and pharmacological research (**Amer, 2018**). *Rumex dentatus* L. (Plygonaceae) has antibacterial, antifungal, cytotoxic, antitumor, and allopathic potential due to the presence of alkaloids, saponins, anthraquinones and tannins while flavonoids were also found in both methanol as well as hexane extract (**Fatima *et al.*, 2009**). *C. intybus* (chicory) pave the way for possible therapeutic applications (**Helal *et al.*, 2011**). The antioxidant content and nutritional value of purslane (*P. oleracea)* are important for human consumption. While purslane possesses mucilaginous substances which are of medicinal importance (**Md. Kamal Uddin *et al.*, 2014**). *Beta vulgaris* subsp. maritima, is the most common edible among wild beet species and is the wild ancestor of all cultivated beets (**Tan *et al.*, 2017**). *R. dentatus* (Family: Polygonaceae) has strong antioxidant activities that are correlated with its high levels of phenolic compounds (**Elzaawely and Tawata, 2012**). Jute (*Corchorus spp*.) leaf as a vegetable contains an abundance of antioxidants that have been associated with protection from chronic diseases such as heart disease, cancer, diabetes, and hypertension as well as other medical conditions (**Islam, 2013**). *C. intybus* possessed hepatoprotective, gastroprotective, cardiovascular, antioxidant, hypolipidemic, anticancer, reproductive, antidiabetic, anti-inflammatory, analgesic, sedative, immunological, antimicrobial, anthelmintic, and anti-protozoal, wound healing and many other pharmacological effects (**Al-Snafi, 2016**).

Greater awareness of the presence of wild populations and their potential to contribute to global food security (**Henry, 2019**). While the domestication of wild edible weed species need to be considered all plant traits and potential on other plant and environments. In contrast, less attention has been paid to nutritional traits (**Uhlmann and Beckles, 2010**). Therefore, weed risk assessment methods were created by **Pheloung (2001**) are important to assess their potential, it developed two risk assessment approaches; a pre-border screen for proposed novel plant introductions and a post-border approach used to assess plants already present in the environment for purposes of weed management prioritization **(Auld, 2012**). Weed risk assessment methods are widely applied to regulatory decision-making about potentially problematic plants. They are designed to encompass a broad variety of plant forms and traits in different environments and can provide reliable conclusions even with limited data (**Keese, 2014).** The Australian post-border weed risk assessment PBWRA incorporates the Australian/New Zealand Risk Management Standard (**Standards Australia, 2004**). It has been adopted by the **FAO (2011)** and various Australian government departments, agencies and research bodies.

Edible weeds are highly mineralized and powerful plants in the rural and desert settlers of Egypt as essential food or they can mix with normal vegetables or with medicinal weeds (**Balah, 2021**). Rural communities in the Middle East countries depended on many weeds until recently, for food, fodder and medicines, perfumes and dyes. However, with globalization and changes in lifestyle, many of these species have fallen into disuse, becoming neglected or underutilized (**Rao *et al.*, 2014**). Whereas, there is inadequate knowledge about edibility properties and nutritive aspects of wild edible weed species in Egypt. Therefore, these types of plants are least explored as local initial food and not cooperative in worldwide food security as needed. In view of the high scientific potentialities traditional medicine and economic feasibility in particular nutritional values of wild edible weeds as observed in their geographic consumption area. The present work seeks to investigate the importance of wild edible species food compositional analysis as sustainable nutrition to local communities and identify their risk assessment as weeds and as possible food crops in the future for sustainable consumption.

MATERIALS AND METHODS

The study was carried out field survey along with the old and new cultivated lands of Nile River and some Oases for edible weeds species whereas the main source of livelihood is agriculture for local inhabitants for collecting voucher of weeds specimens during three years. This information was checked with historical reviews and extensive research on the checklist of Students Flora of Egypt (**Tâckholm, 1974**) and Weed Flora of Egypt (**Boulos, 1984**). The voucher specimens were identified by a taxonomist, then dried and kept under laboratory for analysis. The purpose is to define the basic nutritive features of edible weeds and to make their composition known.

Biomass Sampling Materials

Weed leaves of *Cichorium intybus*, *Sonchus oleraceus*, *Beta vulgaris L.*, *Malva pariviflora*, *Rumex aegyptiacus* (winter season), *Corchorus olitorius* and shoots of *Portulaca oleracea* (summer season) were collected before flowering stages from Banger El-Succor villages, Borg Al Arab - Alexandria Governorates as the most popularly common edible weeds in Egypt. The selected plant's fresh mass and after air-dried were measured.

Nutritional Composition Analysis

The dried parts were ground into a fine powder, sieved through 20-mesh and placed in polyethylene bags until analysis. The Association of Official Analytical Chemists (AOAC) methods were used to determine the nutritive compositions; ash by ignition in a muffle furnace for 4 h at 600ºC. The fiber content was estimated from the loss in weight from the ignition of dried residues in the fat-free sample (**AOAC, 1984**). Carbohydrates were estimated by the phenol sulphuric acid method (Dubois ***et al.*, 1956**). The total sugars as described by (Dey, 1990). Fat or lipid contents were determined gravimetrically (AOAC 920.39). Total protein was determined by the Kjeldahl method from the nitrogen content using conversion factors by multiplying N percentage with 6.25(**AOAC, 1990**). The energy values were estimated from this question; Carbohydrates (%) × 4.3+ Lipids × 9.1 + Proteins×4.3 = Energy (kcal/100 g) (**Merrill and watt, 19973 & Satter *et al.*, 2014).** The total oxalate contents were analyzed by titration using KMnO4 according to **AOAC, 1990**. The elemental compositions were determined after digesting known weight of each plant by acids mixture (5 ml of H_2SO_4 and 3 ml of H_2O_2). Sodium and potassium were measured by a flame photometer (JANWAY), While, Mg, Ca, Mn and Fe were determined by Atomic Absorption (UNICAM 929 AA spectrometer) using the standard method **(Cottenie *et al.*, 1982**). Total amino acids were estimated according to **Block *et al.* (1958)** by Amino Acid Analyzer (Eppendorf – LC 3000). The peak percentage of each amino acid was calculated using software AXXIOM CHROMAO.

Weed risk assessment

The selected weed's potential risks on agriculture and the environment were assessed using the Australian Weed Risk Assessment (AWRA) according to (**Pheloung *et al.*, 1999**) after modifying question numbers 2.01, 2.04, 8.05 to be suitable to Egypt condition. The protocols consist of three sections; bio-geography (A), undesirable attributes (B), and biology and ecology (C). These include domestication/ cultivation, climate & distribution, weed elsewhere, undesirable traits, plant type, reproduction, dispersal mechanisms, and persistence attributes distributed. The answers were Yes or No, whereas, not all questions should be answered if not sure and a final risk score ranged from – 26 to 60. According to (**Pheloung *et al.*, 1999)** a minimum of 10 questions had to be answered for each species. The questions were answered using an online database and books. The outcome is the sum of the score which the risk accepted ≤ 0, and rejected ≥ 6 and need further evaluation from 0 to 6 (Appendix, 1).

Statistical analysis

The data of weed composition was statistically analyzed and performed using the Statistical Package for IPM SPSS19 statistics. The analysis of Variance (ANOVA) was performed at the 5% level of significance according to **Snedecor and Cochran (1990**).

RESULTS

Edible weed survey

Forty-four edible weed species were recorded during the study in different localities of Egypt (table 1). These species occurred in 21 genera, belonging to 14 families and spreading in both agriculture and natural rangelands areas.

These families were presented in Asteraceae (15.91%), Amaryllidaceae (9.09%), Amaranthaceae (15.91%), Apiaceae (2.27%), Fabaceae (4.55), Malvaceae (15.91%), Brassicaceae (13.64%), Cyperaceae (2.27%), Oxalidaceae (2.27%), Plantaginaceae (6.82%), Polygonaceae (4.55%), Portulacaceae (2.27%), Umbellifereae (2.27%) and Urticaceae (2.227%), respectively. The highest genera abundant was *Amaranthus* including 6 species (13.64%), followed by *Corchorus* including 5 species (11.36%), *Allium* including 4 species (9.09%). Alternatively, the lowest genera number was *Sonchus*, *Beta*, *Daucus*, *Medicago*, *Lathyrus*, *Cyperus*, *Oxalis*, *Portulaca*, *Ammi* and *Urtica* by 2.27%, respectively. These species according to their life habitat were divided into 61.36% annuals, 22.72 % perennials, 6.81% biannuals, 2.77% annual / perennial and 6.82% annual / biennial species, respectively. These herbaceous species were reproduced sexually (100%) by seeds and asexual by other organs (25 %) respectively.

Table 1. Chick list of edible weeds in Egypt

No	Family	Weeds	Common name	Sexual	Asexual	Life form	Edible parts
1	Asteraceae	*Cichorium intybus*	Wild chicory	Seeds	Taproot	Annuals	Shoots and leaves
2		*Cichorium pumilum*	common chicory	Seeds	Taproot	Annuals	Shoots and leaves
3		*Sonchus oleraceus*	Milk-thistle	Seeds		Annual	Shoots and leaves
4		*Taraxacum minimum*	dandelion	Seeds	Apomixis	Perennials	Flowers ,leaves, and roots
5		*Taraxacum turcicum*	dandelion	Seeds	Apomixis	Perennials	Flowers, leaves, and roots
6		*Latuca serriola*	Prickly Lettuce	Seeds		Biannual	Leaves
7		*Latuca undulata*	Prickly Lettuce	Seeds		Biannual	Leaves
8	Amaryllidaceae	*Allium rothii*	Wild onion	Seeds	Bulb	perennial	Shoots and Bulbs
9		*Allium mareoticum*	Wild onion	Seeds	Bulb	perennial	Shoots and Bulbs
10		*Allium curtum*	Wild onion	Seeds	Bulb	perennial	Shoots and Bulbs
11		*Allium vineale*	Wild Garlic	Seeds	Bulb	perennial	Shoots and Bulbs
12	Amaranthaceae	*Beta vulgaris L.*	Weed beet	Seeds		Annual/ biannual	Leaves and stems
13		*Amaranthus ascendens*	Amaranth	Seeds		Annuals	Young plants, Leaves
14		*Amaranthus viridis*	Amaranth	Seeds		Annuals	Leaves
15		*Amaranthus tricolor*	Amaranth	Seeds		Annuals	Leaves
16		*Amaranthus lividus*	Amaranth	Seeds		Annuals	Leaves
17		*Amaranthus blitum*	Amaranth	Seeds		Annuals	Leaves
18		*Amaranthus caudatus*	Amaranth	Seeds		Annuals	Leaves, Seeds
19	Apiaceae	*Daucus carota*	Wild carrot	Seeds		biannual	Young roots
20	Fabaceae	*Medicago* polymorpha	Bur clover	Seeds		Annual	Leaves
21		*Lathyrus sativus*	Gilban/ grass pea	Seeds		Annual	Roots
22	Malvaceae	*Corchorus olitorius*	Nalta jute	Seeds		Annual	Leaves
23		*Corchorus asplenifolius*	Nalta jute	Seeds		Annual	Leaves
24		*Corchorus burmanii*	Nalta jute	Seeds		Annual	Leaves
25		*Corchorus tridens*	Nalta jute	Seeds		Annual	Leaves
26		*Corchorus trilocularis*	Nalta jute	Seeds		Annual	Leaves
27		*Malva aegyptica*	Round-leaved	Seeds		Annual/ biennial	Leaves
28		*Malva pariviflora*	mallow /Persian	Seeds		Annual/ biennial	Leaves
29	Brassicaceae	*Brassica kaber*	kaber	Seeds		Annuals	Leaves, oil from seeds
30		*Brassica tournefortii*	Mustard	Seeds		Annuals	Leaves, oil from seeds
31		*Brassica nigra*	Mustard	Seeds		Annuals	Leaves, oil from seeds
32		*Lepidium virginicum*	*Garden cress*	Seeds		Annual	Seeds
33		*Lepidum sativum*	*Garden cress*	Seeds		Annual	Seeds
34		*Lepidum latifolium*	*Garden cress*	Seeds		Annual	Seeds
35	Cyperaceae	*Cyperus esculentus*	Purple nutsedge	Seeds	Tubers	Perennials	Tubers
36	Oxalidaceae	Oxalis corniculat	Woodsorrel	Seeds	Stolons	Annual/perennial	Leaves
37	Plantaginaceae	*Plantago major*	broad leaf plantain	Seeds		Perennial	Young tender leaves, seeds
38		*Plantago aegyptiaca*	broad leaf plantain	Seeds		Perennial	Young tender leaves, seeds
		Plantago lanceolata	*Plantain*	Seeds		Perennial	Young tender leaves, seeds
39	Portulacaceae	*Portulaca oleracea*	Purslane	Seeds	Stem cutting	Annual	Leaves and stems
40	Polygonaceae	Rumex dentatus	toothed dock	Seeds		Annuals	Succulent leaves
42		Rumex aegyptiacus	toothed dock	Seeds		Annuals	Succulent leaves
43	Umbellifereae,	*Ammi majus*	khelh	Seeds		Annual	Seeds
44	Urticaceae	*Urtica uerns*	Nettles	Seeds		Annual	Leaves

Nutritional values of the common edible weeds

The dietary composition values of the used edible weeds were shown in Table (2). Leaves were the most edible parts followed by shoots. The content of ash was ranged from 2.687 to 1.640% (g/100g), whereas, leaves of *M. pariviflora* was achieved the highest level and *S. oleraceus* recorded the lowest percentage of ash, respectively. Concerning the total carbohydrates, it was ranged from 5.973 to 2.50 g/100g in descending order as *C. olitorius* > *M. pariviflora* > *B. vulgaris* >*C. intybus* >*P. oleracea* > *R. aegyptiacus* and finally *S. oleraceus*, respectively. The total sugars ranged from 1.154 to 0.235 g/100g in descending order as *R. aegyptiacus* > *C. olitorius* > *M. pariviflora* > *B. vulgaris* >*C. intybus* > *S. oleraceus* and finally *P. oleracea*, respectively. The lowest fiber content was detected in *S. oleraceus* by 1.153 g/100g. However, the highest level was found in *C. intybus* by 1.887 g/100g. As for fat content, the highest level of fat was recorded in *R. aegyptiacus* by 0.777%, while, the lowest concentration was measured in *M. pariviflora* leaves by 0.147%. For the crude protein of selected species, the highest protein percentage was found in *C. olitorius* by 4.64 g/100g, however, the lowest level was detected in *S. oleraceus* reached 1.270 g/100g. The decreased order of high energy content of weeds was *C. olitorius* (541.9), *M. pariviflora* (400.63), *B. vulgaris* (348.5), *P. olaracea* (334.2), *C. intybus* (324.9) Kcal/100g, respectively. Although, *R. aegyptiacus* and *S. oleraceus* were achieved the lowest energy values with small difference by 307.4 and 246.6 (Kcal /100g), respectively. This finding of energy content depended on the summation of previous dietary composition values.

Table 2. The analysis of selected edible weed's nutritional composition

Species	Ash	Total Carbohydrate	Total sugars	Total Fiber	Total Fat	Total Protein	Energy
				%(g /100 g)			K cal/100g
C. intybus	1.707^{c}	3.560^{d}	0.249	1.887^{a}	0.207^{d}	1.387^{d}	32.497
S. oleraceus	1.640^{d}	2.507^{f}	o.245	1.153^{g}	0.330^{bc}	1.270^{d}	24.560
B. vulgaris L.	2.330^{b}	3.827^{c}	0.722	1.450^{d}	0.213^{d}	1.970^{c}	34.851
M. pariviflora	2.687^{a}	4.503^{b}	0.854	1.718^{b}	0.147^{d}	2.291^{b}	40.063
R. aegyptiacus	2.540^{a}	2.753^{e}	1.154	1.646^{c}	0.777^{a}	2.113^{bc}	30.746
P. oleracea	1.500^{d}	3.470^{d}	0.235	1.259^{f}	0.393^{b}	2.207^{b}	33.421
C. olitorius	1.653^{cd}	5.973^{a}	1.054	1.352^{e}	0.310^{c}	4.640^{a}	54.192
F values	89.64	281.80	148.0	242.02	81.11	347.54	
P values	0.000	0.000	0.000	0.000	0.000	0.000	

Qualitative and quantitative analysis of amino acids was performed by an amino acid analyzer (Table, 3). Interestingly, the concentrations of total amino acid were found greater in C. *olitorius*, followed with *P. oleracea* than other weeds. The middle concentration was recorded in *M. pariviflora* leaves. The lowest concentrations of total amino acids were detected in *S. oleraceus* and *C. intybus.* The highest level of arginine, aspartic, lysine, histidine, phenyl alanine, leucine valine, alanine, glycine and glutamic acids were detected in *C. olitorius* leaves with low concentrations of ammonia. The highest level of proline was detected in *P. oleracea*.

Table 3. Amino acids composition of tested parts of selected edible weeds species (mg/g dry weight)

Species	Arg*	Asp	Lys	His	Phe	Tyr	Leu	Iie	Met	Val	Ala	Gly	Pro	Glu	Ser	Thr	Amm
C.intybus	0.066	0.157	0.049	0.028	0.010	0.023	0.047	0.019	0.020	0.092	0.073	0.077	0.020	0.113	0.017	0.012	0.118
S. oleraceus	0.063	0.130	0.017	0.025	0.012	0.026	0.097	0.019	0.027	0.094	0.087	0.090	0.011	0.153	0.021	0.014	0.105
B.vulgaris	0.080	0.213	0.020	0.022	0.011	0.024	0.110	0.017	0.014	0.096	0.093	0.110	0.013	0.147	0.022	0.015	0.133
M. pariviflora	0.115	0.295	0.033	0.036	0.026	0.048	0.125	0.025	0.022	0.139	0.075	0.125	0.021	0.190	0.044	0.037	0.145
R. aegyptiacus	0.125	0.165	0.087	0.090	0.019	0.081	0.130	0.023	0.185	0.191	0.135	0.205	0.016	0.176	0.026	0.019	0.143
P. oleracea	0.195	0.285	0.034	0.042	0.025	0.045	0.170	0.087	0.023	0.194	0.210	0.205	0.038	0.282	0.036	0.029	0.132
C. olitorius	0.230	0.340	0.144	0.094	0.127	0.096	0.240	0.082	0.029	0.195	0.275	0.265	0.029	0.342	0.039	0.027	0.103

*; Arg = Argenine, Asp= Aspartic, Lys= Lysine, His=Histidine, Phe= Phenyl alanine, Tyr= Tyrosine, Leu= Leucine, Iie= isoleucine, Met= Methionine, Val= Valine, Ala = Alanine, Gly = Glycine, Pro= Proline, Glu = Glutamic, Ser = Serine, Thr= Therionine, Amm = Ammonia.

The results of total oxalates analysis in the selected weed species appeared with their contents ranging from 195.7 to 315.4 mg/ 100 g dry weights. *C. olitorius* recorded the lowest amount of total oxalates. However, the greatest amounts were detected in *M. pariviflora* leaves (Fig 1).

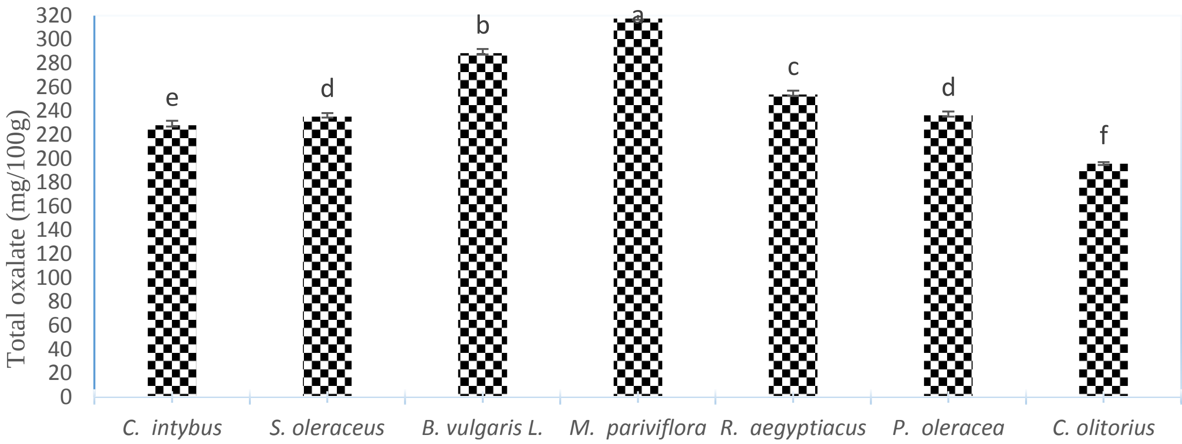

Fig. 1. Oxalate content in selected edible weed parts (mg/100 g dry weight)

The minerals composition of the selected edible weed species was quantified in dry matter (Table 4) which differs from one to the other. The macro-elements content can be ranked in the following descending order, nitrogen (N) content was the highest concentration ranged from 7424.0 to 2218.67 mg/100g. Potassium (k) in the range of 1623.67 to 550.0 mg/100g was the most abundant element. Magnesium (Mg) contents were observed in the amount of 1235.0 to161.0 mg/100g. The range of calcium in the selected species was 653.7 to 123.93 mg/100g. Sodium (Na) contents were ranged from 1337.33 to 208.33 mg/100 in the studied species. To quantify micronutrient contents of manganese (Mn) and iron (Fe) in tested species, it was found Mn contents in the range of 280 to7.14mg/100g. The levels of inedible parts were ranged from 469.7 to 4165 mg /100g. Generally, it could be concluded that the descending order of elements was found to be K > Mg > Na > Ca > Fe > Mn in the tested weeds (Table 4).

Table 4. Mineral contents of selected edible weeds

Species	Macro-elements (mg/100g)					Micro-elements (mg/100g)	
	Mg	Ca	Na	K	N	Mn	Fe
C. intybus	370.42^{d}	153.57^{e}	360.33^{cd}	775.00^{b}	2218.67^{d}	44.73^{a}	83.27^{e}
S. oleraceus	460.17^{d}	224.87^{d}	208.33^{d}	550.00^{b}	2032.00^{d}	7.14^{f}	137.40^{d}
B. vulgaris L.	775.08^{c}	513.23^{b}	1337.33^{a}	1623.67^{b}	3152.00^{c}	37.73^{b}	178.67^{c}
M. pariviflora	858.50^{bc}	315.67^{c}	633.33^{b}	483.33^{b}	3665.60^{b}	26.04^{d}	41.65^{f}
R. aegyptiacus	161.00^{e}	123.93^{e}	426.67^{c}	587.33^{b}	3381.33^{bc}	35.67^{b}	83.20^{e}
P. oleracea	924.00^{b}	653.70^{a}	438.33^{c}	4970.67^{a}	3530.67^{b}	31.13^{c}	199.53^{b}
C. olitorius	1235.00^{a}	210.97^{d}	208.33^{d}	730.00^{b}	7424.00^{a}	12.30^{e}	469.70^{a}
F values	95.42	307.00	55.50	4.11	347.54	280.51	3336.21
P values	0.000	0.000	0.000	0.014	0.000	0.000	0.000

Weed risk assessment of selected edible weeds

The potentials risk were distinguished using the Australian Weed Risk Assessment (AWRAS) for scaling up the studied edible species by answering the minimum required question for each species. This assessment was a guidance tool for the possibility of domestication. Based on the AWRS risk score, *C. intybus, S. oleraceus, C. olitorius* were appreciated and their risk was accepted and accounted for by -4, 1, -1 respectively. However, the *B. vulgaris ssp. maritima, M. pariviflora R. aegyptiacus* was rejected, which had 6, 9 and 6 of risk scores. However, the high edible weed risk presented from *P. oleracea* reached a moderate risk score of 13. The final level outcome of edible weed species profit an accepted risk with low level except *P. oleracea* has a moderate risk score with scaling ranging from - 4 to 13 of the risk levels (Table 5).

Table 5. The AWRA for selected edible weeds

		C. intybus	*S. oleraceus*	*B. vulgaris ssp. maritima*	M. pariviflora	R. aegyptiacus	P. oleracea	*C. olitorius*	Chi-Square	Asymp. Sig.
1	1.01	Y	N	N	N	N	N	Y		
Domestication/cultivation	1.02								4.571	0.102
	1.03	Y	Y	Y	Y	Y				
2	2.01	1	1	1	1	1	1	1		
Climate and distribution	2.02	1	1	2	1	1	1	2	3.571	0.250
	2.03	Y	Y	Y	N	N	Y	N		
	2.04									
	2.05	N	N	N	N	N	Y	N		
3	3.01	N	N	N	N					
Weed elsewhere	3.02	N	N	Y	Y	Y	Y	Y		
	3.03	N	N	Y	Y	Y	Y	Y	6.243	0.034
	3.04	N	N	N	N	Y	Y	Y		
	3.05	N	N	N	N	N	N	N		
4	4.01	N	N	N	N	N	N	N		
Noxious traits	4.02	N	N	Y	Y	N	Y	N		
	4.03	N	N	N	N	N	N	N		
	4.04	N	N	N	N	N	N	N		0.027
	4.05	N	N	N	Y	N	Y	N	4.857	
	4.06	N	N	N	N	N	Y	N		
	4.07	N	N	N	N	N	N	N		
	4.08	N	N	N	N	N	N	N		
	4.09	Y	Y	Y	Y	Y	Y	N		
	4.10	N	Y	Y	Y	N	Y	Y		
	4.11	N	N	N	N	N	N	N		
	4.12	N	N	N	N	N	N	N		
5	5.01	N	N	N	N	N	N	N		0.368
Plant type	5.02	N	N	N	N	N	N	N	2.000	
	5.03	N	N	N	N	N	N	N		
	5.04	N	N	N	N	N	N	N		
6	6.01	Y	N	N	N	N	N	N		
Reproduction	6.02	N	N	Y	Y	N	Y	Y		
	6.03	N				y				
	6.04	N	N		Y		Y	Y		0.027
	6.05	N	Y	N	N		N	N	5.286	
	6.06	N	N	Y	N	N	Y	N		
	6.07	2	1	1	1	N	Y	N		
7	7.01	Y	N	Y	Y		Y	Y		
Dispersal	7.02	N	Y	N	N	N	Y	Y		
	7.03	N	N	N	Y	Y	N	Y		0.063
	7.04		N	N	N	N	N	N	5.714	
	7.05	N	N	N	N	N	N	N		
	7.06	N	N	N	N	N	N	N		
	7.07	N	N	Y	N	N	N	N		
	7.08	Y	Y	Y	Y	N	N	Y		
8	8.01	Y	N	Y	Y	Y	Y	N		
Persistence	8.02	Y	N	Y	Y	N	Y	Y		0.041
	8.03	Y	Y	Y	Y	Y	Y	Y	4.286	
	8.04	Y	Y	N	N	Y	N	Y		
	8.05	Y	Y	N	N	Y	N	N		
	Score	-4	-1	7	9	6	13	-1		

DISCUSSION

To conceptualize the values and the importance of wild edible weed species as a cultural component of the daily food intake, some nutritional aspects were assessed of the most used species in Egypt. These species play a critical role in the lives subsistence of the local rural and marginal peoples due to their nutritional values. Consequently, the risk assessment protocol was applied to clarify their priority for domestication as future food crop. These studies are supported by **Price and Ogle (2008),** they identify three sorts of uses-values for edible weeds; the direct use value of vegetables food, indirect use include the cultural and social value of the diversity of wild vegetables. The last kind of value is an option as a form of insurance for the future. Most of the edible weeds (91%) are consumed as vegetables **(Cruz-Garcia and Price 2012**). Wild plants are known to be used in ancient cultures for different purposes, such as food, medicines, production of goods, and magic and religious rituals and are mainly linked to periods of famine in Europe (**Petropoulos *et al.,* 2018**). So, it needs to identify and select palatable parts before eating wild vegetables have become a commercial crop with increasing market potential due to their nutritional importance, absence of residues from pesticides or fertilizers (**Weng *et al.,* 2001**).

Exploring the selected edible weed's nutritional potentials and uses

`Based on chemical analysis, the food composition and minerals content of the tested species seems fairly matched with the used cultivated vegetables. *C. olitorius* recorded the highest values as compared with other studied species. These results are supported by **Shad *et al.* (2013)** who found that wild edible weeds had higher contents of proteins, fats and carbohydrates, and minerals. *C. olitorius* leaf contains protein, calories, fibers and as well as antitumor promoters. It may reduce the risk of cancer. It has great importance in terms of human nutrition, health and beauty care (**Islam, 2013**). The consumption of antioxidant-rich wild plants is associated with a reduced risk of some chronic diseases (**Bahloul *et al.,* 2016**). *P. oleracia* L. leaves and stems could be a good supplement for some nutrients such as protein, carbohydrates, Ca, K, Zn and Na (**Aberoumand, 2009**). *C. intybus*, *B. vulgaris ssp. maritima*, *R. aegyptiacus* and *P. oleracea* plant fiber content can be considered as the source of fiber according to Regulation (EC) No. 1924/2006 and (EU) No 1229/2014, whereas, a 100 g portion of their leaves would provide over 50 % of the dietary nutritional intakes RDA for men for iron (**Tan *et al.,* 2017**).

The results indicated the higher levels of edible wild weed species from Mg, Ca, Na, K, Mn, Fe, and can be used as a rich and a potential source of macro and micro- elements in human nutrition. These species can provide a sufficient amount of human need from the dietary daily intake as compared with Table 6 (Recommended Dietary Allowances (RDAs) according to EU; No 1169/2011).

Table 6. The daily intake of adults according to EU; No 1169/2011 of some minerals and food composition (mg/ day)

Carbohydrate	Fat	Fiber	Protein	K	Ca	Mg	Fe	Mn
	g/ day					mg/day		
260	70	8	50	2000	800	375	14	2

The result is in agreement with **Harrington *et al.* (2019)** they found that chicory, narrow-leaved plantain, dandelion have significantly higher mineral contents such as magnesium, manganese, copper, zinc, boron, cobalt and selenium. Whereas, Calcium is necessary for bone and skeletal development and iron is essential for hemoglobin formation. Other minerals perform a variety of physical and physiological functions (**Khattak *et al.,* 2006**). Na and K play an important role in the transport of metabolites and their Na/K ratio is very important to control high blood pressure in the human body (**Akubugwo *et al.,* 2007**). Wild vegetables have very good nutritional potential to meet the recommended dietary allowances, **(Abdus Satter *et al.,* 2016**). Therefore, the selected wild edible species have a significant contributor to dietary nutritional intakes and can be considered as a good and the cheapest source for nutrition values, especially elements.

Edible Weeds development concerning risk assessment

To determine the current threats and predict the future impacts of the selected wild edible species, weed risk assessment protocols (**Gordon *et al.,* 2008; Pheloung *et al.,* 1999**) was applied to assess their capacity to become future crops and to enhance the collection of information (**Daehler, 2004)**. WRA analysis in both agriculture and environments revealed that *C. intybus*, *S. oleraceus* and *C. olitorius* had accepted risk levels. However, other studies had varied risks ranging from low to moderate potentials. The correlation analysis revealed that there was a strong positive correlation between mineral and risk by 0.822 and between risk and food composition by 0.63. While the correlation was identified weakly positive by 0.34 between mineral and food composition of edible weeds. The correlation analysis revealed a positive correlation between oxalate content and risk assessment of edible weeds (Correlation = 0.53). These scientific assessments are highly relevant indicators and as references for minimizing those risks during the domestication process. WRA is one of the simplest, most effective methods for weed discrimination (M**ack, 199**6). It is commonly used in decision-making methods **(Pheloung, 2001)** with other elements when novel crops are concerned (**Cousens, 2008**), which an inclusive cost-benefit analysis that addresses economic, ecological, and social advantages and disadvantages, an important step to evaluate the commercial values (**Yokomizo *et al.*, 2012**).

Contribution of edible weeds in food provision and their limitation

We summarize the evidence of edible wild weeds for the nutritional values such as *C. intybus, S.oleraceus, B. vulgaris ssp. Maritima, M. pariviflora, R. aegyptiacus, C. olitorius* and *P. oleracea* have a considerable amount of the proximate composition as well as macro- and micro-minerals that enable these plants to be potentially good candidates as food plants. On the other hand, there are some preserved for the user to avoid the disadvantages or side effects it's free as mineral sources. Edible wild weeds now continue to form a significant proportion of the global food, so, it is important to grow as pressures on agricultural productivity increase. Wild edible plants increase the nutritional quality of, micronutrients (vitamins and minerals) which are sometimes superior to those of domesticated varieties **(Msuya *et al.*, 2010**). Overlapping between food and medicine is well known in traditional societies (**Pieroni *et al.*, 2005**). Nevertheless, wild species can be toxic due to the high content of oxalic acid, nitrates, and sometimes, other toxic compounds **(Pinela et al., 2017**). While the Weedy vegetables are identified as sources of medicine (**Price, 2006**). Wild vegetables are a very good nutritional source and in some cases, they are better than those of some green cultivated vegetables **(Hussain *et al.*, 2011 and Khan *et al.*, 2013).** These wild edible species may open up new commercial opportunities in the countries of the Mediterranean area. Therefore, cultivation techniques can also be beneficial in controlling and limiting the accumulation of nitrates and oxalic acid (**Ceccanti *et al.*, 2018**).

Finally, this study represents the important values of the edible weeds to rural communities' subsistence over the world due to their ability to multiple uses not only as dietary food approaches but also as medicinal plants. The dietary and elemental analysis attributed to the rich resources as wild vegetables. However, the risk assessment studies were assigned to their priority for domestication. Which, there was a great ability of *C. intybus*, *S. oleraceus* and *C. olitorius* for intensive productions in Egypt. The research in edible wild weeds species high risk such as *B. vulgaris ssp. maritima, M. pariviflora R. aegyptiacus* species should continue to turn it to the low proportion of risk due to their high nutritive values. On the other hand, the use of these species as complementary nutritional resources in food products should be developed to the provision of people with nutrition's daily intake. The seven edible is species are capable of providing enough calories to the consumer. This means, it needs some agriculture enhancement breading programs and carefully considered policies towed domestication to be considered as future target crops.

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RESEARCH ARTICLE

Chemicals and Nutritional Properties of Some Edible Weeds Species as Potential Foods and Future Crops

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Appendix, 1: AWRA protocols		
1.01	Is the species highly domesticated?	y=-3, n=0
1.02	Has the species become naturalized where grown?	y=1, n=-1
1.03	Does the species have weedy races?	y=1, n=-1
2.01	Species suited to tropical or subtropical climate(s) (0-low; 1-intermediate; 2-high)	
2.02	Quality of climate match data (0-low; 1-intermediate; 2-high) see appendix 2	
2.03	Broad climate suitability (environmental versatility)	y=1, n=0
2.04	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0
2.05	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0
3.01	Naturalized beyond native range y = 1*multiplier (see Append 2), n= question 2.05	
3.02	Garden/amenity/disturbance weed y = 1*multiplier (see Append 2)	n=0
3.03	Agricultural/forestry/horticultural weed y = 2*multiplier (see Append 2)	n=0
3.04	Environmental weed y = 2*multiplier (see Append 2)	n=0
3.05	Congeneric weed y = 1*multiplier (see Append 2)	n=0
4.01	Produces spines, thorns or burrs	y=1, n=0
4.02	Allelopathic	y=1, n=0
4.03	Parasitic	y=1, n=0
4.04	Unpalatable to grazing animals	y=1, n=-1
4.05	Toxic to animals	y=1, n=0
4.06	Host for recognized pests and pathogens	y=1, n=0
4.07	Causes allergies or is otherwise toxic to humans	y=1, n=0
4.08	Creates a fire hazard in natural ecosystems	y=1, n=0
4.09	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0
4.1	Tolerates a wide range of soil conditions	y=1, n=0
4.11	Climbing or smothering growth habit	y=1, n=0
4.12	Forms dense thickets	y=1, n=0
5.01	Aquatic	y=5, n=0
5.02	Grass	y=1, n=0
5.03	Nitrogen fixing woody plant	y=1, n=0
5.04	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0
6.01	Evidence of substantial reproductive failure in native habitat	y=1, n=0
6.02	Produces viable seed.	y=1, n=-1
6.03	Hybridizes naturally	y=1, n=-1
6.04	Self-compatible or apomictic	y=1, n=-1
6.05	Requires specialist pollinators	y=-1, n=0
6.06	Reproduction by vegetative fragmentation	y=1, n=-1
6.07	Minimum generative time (years) 1 year = 1, 2 or 3 years = 0, 4+ years = -1	
7.01	Propagules likely to be dispersed unintentionally	y=1, n=-1
7.02	Propagules dispersed intentionally by people	y=1, n=-1
7.03	Propagules likely to disperse as a produce contaminant	y=1, n=-1
7.04	Propagules adapted to wind dispersal	y=1, n=-1
7.05	Propagules water dispersed	y=1, n=-1
7.06	Propagules bird dispersed	y=1, n=-1
7.07	Propagules dispersed by other animals (externally)	y=1, n=-1
7.08	Propagules survive passage through the gut	y=1, n=-1
8.01	Prolific seed production (>1000/m2)	y=1, n=-1
8.02	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1
8.03	Well controlled by herbicides	y=-1, n=1
8.04	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1
8.05	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1