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EVALUATION OF LEAFY AMARANTH *(Amaranthus cruentus* L.) AS A PROMISING NEW SUMMER VEGETABLE CROP IN EGYPT

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ABSTRACT

Leafy amaranth cultivated during 1997 and 1998 was investigated in terms of its acceptability and composition. Results indicated that the proximate composition of amaranth (as dwb) were: crude protein, (25.46 – 29.02%); total lipids (6.47 – 7.13%); ash (19.78- 22.71%); crude fiber (15.25 – 18.92%) and N-free extract (24.75-30.76%). Mineral elements were ranged as follows (mg/100, dwb): Na (1585- 1708); K (4877 – 5730); Ca (2088 – 2459); Mg (988- 1249); Fe (255-374) and P (375-421). Ascorbic acid varied from 279.2 to 337.8mg / 100g (dwb), while ββ-carotene ranged between 46-11 and 68-84 mg / 100. (dwb) . Nitrite and nitrate contents were (3.071 – 4.827 ppm) and (60.4-91.5 ppm), respectively, while cyanide and total oxalate ranged between 22.9 and 30.9 ppm; and between 1.444 and 1.613g / 100g (dwb), respectively. All panelists judjed cooked amaranth as spinach.In the light of data presented here , it can be concluded that leafy amaranth is quite comparable to spinach from the compositional point of view and it is a good ulternative of spinach during summer in Egypt.

Keywords: Leafy amaranth , gross composition , mineral elements , crude fibers, ascorbic acid, β-carotene, nitrite, nitrate , cyanide, total oxalate, acceptability.

INTRODUCTION

Increasing food production with high quality is the supreme goal to feed the constantly growing population in Egypt. National policy aims to increase vegetable crop production by introducing new cultivars and / or improving cultural practices (Gabr & Abdel –Razik, 1999). Leafy amaranth (*Amaranthus cruentus* L.) has been cultivated in many countries over the world especially in USA, Germany, Poland, Japan, Mexico, Russia, Turkey and India (Hirano, 1993; Mapes*,et al,* 1995; Acar, 1996;Bhaskar *et al,* 1996; Kaul *et al,* 1996; Lehman, 1996 and Zheleznov *et al*, 1997). The edible parts of leafy amaranth resemble leaves and young shoots of spinach (Tindall, 1983).

In contrary to the spinach as a winter crop, leafy amaranth is considered as a summer crop and so its cultivation in Egypt can overcome lack of fresh leafy vegetables during summer season. Successful experiments have been carried out to cultivate such a new vegetable crop in Egypt during seasons 1997 & 1998 (Gabr & Abdel – Razik, 1999).

From the nutritional point of view, leafy amaranth is similar to that of other leafy vegetables. However, due to their high dry matter content, an equivalent amount of fresh amaranth often provides form 2 to 3 times as other leafy vegetables do (Saunders and Becker , 1983) .

The present study was carried out to evaluate the leafy amaranth that was cultivated in Egypt by Gabr&Abdel–Razik (1999) during seasons 1997 and 1998.

MATERIALS AND METHODS

Materials

Leafy amaranth (*Amaranthus cruentus* L.) was cultivated at the Experimental Farm, Faculty of Agriculture, University of Alexandria, Damanhour Branch. The collected samples were belong to the sowing date of mid April during the two seasons 1997 and 1998. Since 4 nitrogen levels (0,20, 40 and 60kg ammonium sulfate /fed.) were applied as a source of nitrogen, four samples were collected from each season.
Other ingredients used to prepare cooked amaranth were purchased from local market in Alexandria. Egypt.

Methods

Each sample was divided into two portions: The first was dried at 65ºC untill constant weight was maintained, then milled to pass through 30 mesh sieve and kept in air-tight Kilner jar untill used for analysis. The second portion was mainly taken for cooking quality experiment and determination of ascorbic acid, ß- carotene, total oxalate, cyanide, nitrite and nitrate contents.

Analytical methods

Proximate chemical composition was determined for both raw and cooked amaranth .
Crude protein (N x 6.25) was determined by the micro Kjeldahl method (Egan *et al* , 1981) . Ash content was determined by igniting a weighed sample in a muffle furnace (Gallenkamp KM 106 GKP 172) at 550ºC to a constant weight (AOAC, 1980) . Total lipids content was determined by Folch *et al* (1957) method using a mixture of methanol and chloroform
(1: 2, V/V) . Crude fiber content was determined according to AOAC (1980). Non protein nitrogen (NPN) was determined in the supernatant after precipitation of protein with 10% TCA (Singh and Jambunathan, (1981). True protein and N-free extract were calculated by difference. Phosphorus was assessed colorimeterically (AOAC, 1980). Sodium and potassium were determined by flame photometer (Gallenkamp, England), while calcium, magnesium and iron were determined by atomic absorption (Pye Unicam SP 1900) as outlined by AOAC (1980). Total caloric value was calculated according to Davis and Kramer (1973). The volumetric method using potassium permanganate was followed to determine the total oxalate (AOAC, 1980). Ascorbic acid was determined using 2.6- dichlorophenolindophenol 0visual titration (AOAC, 1980). β -Carotene, nitrite, nitrate (after reduction by cadmium column), total oxalate and cyanide contents were determined as outlined by AOAC (1980).

Table 1: Ingredients of cooked leafy amaranth.

Ingredient		Quantity
Amaranth leaf	(gm)	700
Onion	(gm)	100
Tomato juice	(ml)	500
Coriander	(gm)	15
Ghee	(gm)	25
Salt	(gm)	15
Black papper	(gm)	5
Chicken soup	(ml)	250

Cooking of amaranth

Exactly the traditional method used for preparing cooked spinach was used to cook amaranth. Ingredients used in cooking are shown in Table 1(Nour , 1968).

Sensory evaluation

The four samples of cooked amaranth were presented simultaneosly to a panel of ten panelists who were asked to rank the samples on a hedonic scale of I (very poor); 2-4 (poor); 5-6 (fair); 7-8 (good) and 9-10 (excellent) for each of colour , flavour , consistency and overall acceptablility .

Statistical analysis

Data were subjected to analysis of variance and Duncan's Multiple Range test to separate the treatment means as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Proximate chemical composition:

Data for chemical composition of leafy amaranth are given in Table 2. Dry matter ranged between 10.38 and 13.42%. It was obvious that application of ammonium sulfate fertilizer led to a significant increase of dry matter for all application levels in season 1997 and for 40 and 60kg /feddan levels in Season 1998. Crude protein content was found to vary from 25.46 to 29.02%. The point of interest is that application of fertilizer at 40kg / feddan exhibited the highest crude protein content as compared to control and other treatments. This was true for both 1997 and 1998 seasons. However, the figures of 23.22 and 23.45% were reported for crude protein content in leafy amaranth (Stanimirovic *et al,* 1983 and Lotti *et al,* 1976). Total lipids ranged between 6.47 and 7.13 %. It was clear that fertilizer application significantly elevated total lipids content of leafy amaranth. Stanimirovic *et al,* (1983) found that the total lipids of leafy amaranth was 6.99%, while the mean of 10.6 % was reported by Lakshminaryana *et al,* (1984).

Ash content varied from 19.78 to 22.71%. No consistent trend was observed for ash content as related to fertilizer levels that were applied . Crude fiber content was found to vary between 15.25 and 18.92%. Again no obvious trend could be traced regarding crude fiber content as related to the

Table 2 : Proximate chemical composition of leafy amaranth (%, DWB)

Sample	Moisture content	Crude protein (Nx 6.25)	Total lipids	Ash	Crude fiber	N-free extract**
Season 1997:						
N_o	89.18 ±1.12^{a++}	25.93±0.41^{d}	6.47±0.11^{d}	22.71±0.32^{a}	17.81±0.26^{b}	27.08
N_1	87.64±2.07^{bc}	25.64±0.53^{d}	6.73±0.14^{bc}	21.80±0.41^{ab}	15.25±0.20^{d}	30.76
N_2	86.64±1.78^{c}	28.79±0.51^{a}	7.13±0.25^{a}	20.63±0.28^{c}	16.85±0.20^{c}	26.60
N_3	86.58±1.55^{c}	27.25±0.43^{c}	7.10±0.19^{a}	20.99±0.36^{bc}	18.92±0.29^{a}	25.74
:Season 1998						
N_o	89.32±1.88^{a}	27.25±0.48^{bc}	6.68±0.22^{cd}	19.78±0.24^{c}	17.55±0.22^{b}	28.45
N_1	88.16±1.36^{ab}	26.73±0.67^{c}	6.88±0.18^{b}	22.08±0.38^{a}	18.80±0.18^{a}	25.51
N_2	87.12±2.28^{bc}	29.02±0.59^{a}	6.89±0.30^{b}	21.71±0.32^{ab}	17.63±0.24^{b}	24.75
N_3	87.28±1.91^{bc}	28.45±0.63^{ab}	7.11±0.26^{a}	20.50±0.41^{c}	17.28±0.26^{bc}	26.66

*** Mean ± SD; DWB, Dry weight basis.**
**** Calculated by difference.**
+ N_0, control; N_1, N_2, N_3: 20, 40and 60 kg ammonium sulphate (20.5% N) / feddan fertilizer, respectively.
++ Means in a column not sharing the same letter are significantly different at p<0.05.

fertilizer levels. Data of N-free extract revealed a range of 24.75 - 30.76% (Table 2). In general, data for proximate chemical composition are in agreement with that published by Stanimirovic *et al,* (1983) and Lotti *et al,* (1976).

Non – protein nitrogen (NPN) , ascorbic acid and β-carotene :

Data presented in Table 3 indicate that non – protein nitrogen (NPN) content ranged between 0.82 and 0.99% . It was clear that application of ammonium sulphate fertilizer resulted in a significant increase in NPN content. True protein [total N–NPN) x 6.25] varied from 19.90 to 22.84% (Table 3) .

Table 3 : Non protein nitrogen , true protein, ascorbic acid and β-carotene contents of leafy amaranth (DWB)*

Sample	Non-protein nitrogen (NPN)	True protein**	Ascorbic acid (mg/100g)	β-Carotene (mg/100g)
Season 1997				
N0^{+}	0.82 ± 0.06^{d}	20.81	308.8± 2.3c	51.7 ± 0.95d
N1	0.89±0.04^{bc}	19.90	279± 3.8d	46.11 ± 1.32e
N2	0.97± 0.07^{a}	22.73	300.9± 2.4c	52.89 ± 1.60d
N3	0.93± 0.06^{b}	21.44	327.5± 3.0^{a}	51.81 ± 1.17d
Season 1998				
N0	0.87±0.07^{c}	22.11	326.7 ± 4 .1^{ab}	68.84 ± 1.80^{a}
N1	0.93± 0.04^{b}	20.92	318.7 ± 3.2^{b}	60.25 ± 1.13^{c}
N2	0.99 ± 0.05^{a}	22.84	337.8 ± 3.6^{a}	64.3 ± 1.29^{b}
N3	0.98± 0.07^{a}	22.33	330.2 ± 2.8^{a}	65.21 ± 1.44^{b}

***DWB: Dry weight basis**
****** by difference**
+ N_0, control; N_1, N_2, N_3: 20, 40and 60 kg ammonium sulphate (20.5% N) / feddan fertilizer, respectively.
++ Means in a column not sharing the same letter are significantly different at p<0.05.

Ascorbic acid ranged between 279.2 and 337.8mg /100g (Table 3). Consequently, leafy amaranth can be considered as a good source of vitamin C. The β - carotene content (mg / 100 g) was found to vary form 46.11 to 68.84 . No consistent effect could be traced for fertilizer application on neither ascorbic acid nor β- carotene contents. On fresh basis, ascorbic acid and β - carotene contents (34.5 – 43.5 mg/100 g and 5.69 – 7.36 mg / 100, respectively) are comparable to data published by Kader *et al* (1982) and Devadas *et al* (1980) for leafy amaranths .It is worth to mention that the aforementioned contents of ascorbic acid and β- carotene ensure 58-73% and 95-123% of Recommended Dietary Allowances (RDA) of ascorbic acid and vitamin A, respectively on wet basis (Williams , 1986).

Table 4 : Mineral element content of leafy amaranth

Sample	Mineral Elements (mg/100gm , DWB)*					
	Na	K	Ca	Mg	Fe	P
Season 1997						
N0**	1660	4877	2339	1102	366	383
N1	1588	5111	2088	988	328	390
N2	1708	5372	2179	1037	335	408
N3	1691	4980	2226	1151	374	421
Season 1998						
N0	1597	5605	2398	1240	309	401
N1	1630	5217	2196	1207	283	375
N2	1649	5730	2459	1188	255	386
N3	1585	5361	2180	1249	269	418

*** DWB: Dry weight basis**

**** N_0, control; N_1, N_2, N_3: 20, 40and 60 kg ammonium sulphate (20.5% N) / feddan fertilizer, respectively.**

Table 5 :Nitrite, nitrate, cyanide, and total oxalate contents of leafy amaranth (dwb).*

Sample**	Nitrite (ppm)	Nitrate (ppm)	Cyanide (ppm)	Total oxalate (g/100g)
Season 1997:				
N_o	3.071±0.025^{b+}	88.1±0.5^{a}	28.0±0.3^{b}	1.479±0.05^{b}
N_1	3.818±0.030^{c}	80.2±0.7^{b}	25.9±0.4^{c}	1.507±0.03^{b}
N_2	4.216±0.020^{a}	78.7±0.6^{b}	29.8±0.4^{a}	1.444±0.04^{b}
N_3	3.105±0.033^{b}	91.5±0.7^{a}	30.9±0.3^{a}	1.468±0.03^{b}
:Season 1998				
N_o	3.735±0.019^{d}	69.3±0.5^{c}	25.3±0.5^{c}	1.578±0.03^{a}
N_1	4.611±0.025^{e}	60.4±0.7^{d}	30.2±0.3^{a}	1.589±0.05^{a}
N_2	4.827±0.025^{c}	70.8±0.4^{c}	22.9±0.4^{d}	1.613±0.04^{a}
N_3	4.040±0.020^{b}	72.6±0.5^{c}	26.7±0.5^{c}	1.608±0.04^{a}

*** Mean ± SD; DWB, Dry weight basis.**

**** N_0 ; control; N_1, N_2, N_3: 20,40,and 60 kg Ammonium sulphate (20.5% N) / fertilizer, respectively.**

+ Means in a column not sharing the same letter are significantly different at p<0.05.

Table 6 : Organolyptic properties of cooked leafy amaranth .

Sample*	Colour ** (out of 10)	Flavour (out of 10)	Consistency (out of 10)	Overall acceptability (out of 10)
Season 1997				
N0	7.9 ± 0.8	8.0 ± 0.7	7.7 ± 0.8	7.8 ± 0.7
N1	8.2 ± 0.6	8.3 ± 0.8	8.2 ± 7.3	8.0 ± 0.7
N	7.8 ± 0.7	7.9 ± 0.8	7.3 ± 0.6	7.5 ± 0.9
N3	7.7 ± 0.7	7.4 ± 0.7	7.4 ± 0.8	7.5 ± 0.8
Season1998				
N0	7.6 ± 0.8	7.3 ± 0.6	7.3 ± 0.7	7.2 ± 0.6
N1	8.0 ± 0.7	7.6 ± 0.7	7.6 ± 0.8	7.5 ± 0.9
N2	8.2 ± 0.7	7.4 ± 0.6	7.2 ± 0.7	7.3 ± 0.8
N3	7.7 ± 0.6	7.7 ± 0.7	7.3 ± 0.6	7.6 ± 0.8

***N_0, control; N_1, N_2, N_3: 20, 40and 60 kg ammonium sulphate (20.5% N) / feddan fertilizer, respectively.**
**** Mean ± SD**

Table 7 : Chemical composition and energy of cooked amaranth.

Constituent %	Season 1997		Season 1998	
	WWB*	DWB*	WWB	DWB
Moisture	87.9 ± 0.9	-4	89.9 ± 0.7	-
Dry matter	12.1	100	10.1	100
Crude protein (N × 6.25)	2.68 ± 0.15	22.15 ± 0.98	2.45 ± 0.16	24.26 ± 1.47
NPN	0.09 ± 0.01	0.74 ± 0.07	0.08 ± 0.01	0.79 ± 0.08
True protein**	2.12	17.52	1.95	19.3
Total lipid	2.06 ± 0.06	17.02 ± 0.5	2.0 ± 0.08	19.8 ± 0.77
Ash	2.53 ± 0.04	20.9 ± 0.32	2.31 ± 0.06	22.8 ± 0.58
Crude fiber	1.23 ± 0.01	10.18 ± 0.08	1.02 ± 0.01	10.1 ± 0.10
N-free extract**	3.6	29.75	2.3	22.97
Energy (Cal / 100g)	41.42	-	35.08	-

***WWB = Wet weight basis , DWB : dry weight basis.**
**** by difference.**

Mineral elements:

Mineral element composition (mg / 100g, dwb) of leafy amaranth is given in Table 4. Sodium content ranged between 1588 and 1691. Potassium varied from 4877 to 5730, while calcium content ranged between 2088 and 2459. On the other hand, magnesium content varied from 988 to 1249. Iron content ranged between 255 and 374, while phosphorus content ranged between 375 to 421. In the light of data presented here, it can be concluded that leafy amaranth can be considered as a good source of the aforementioned mineral elements that determined in the present study. In accordance, similar mineral element content in leafy amaranth was reported by Lotti *et al,* (1976) and Kader *et al*(1982).

From the nutritional point of view , the mineral elements composition of leafy amaranth (per 100g wet basis) provide considerable percents of RDA belonging to the previously mentioned minerals as follows : Na (22%) , K (43%) , Ca (43%), Mg (50%) , Fe (357%) and P(52%) according to RDA values given by Williams (1986).

Toxic substances:

In the present study, it was quite important to elucidate the toxic substances that are naturally present in plants (Table 5). Nitrite content (ppm) ranged between 3.07 and 4.83 (dwb) and between 0.33 and 0.62 (wwb), while nitrate (ppm) varied from 60.4 to 91.5 (dwb) and from 7.15 to 12.20 (wwb). On the other hand, cyanide content (ppm) ranged form 22.9 to 30.9 (dwb) and from 2.94 to 4.05 (wwb). Total oxalate (g/100g) varied from 1.444 to 1.613 (dwb) and from 0.15 to 0.17 (wwb). The toxic substances content in leafy amaranth agree with data published by Kenny & Walshe (1975) and Vityakon & Standal (1989). In despite of the significant effect of fertilizer application on concentration of the aforementioned substances, no obvious clear trend could be correlated to application level of fertilizer. It is well known that many agricultural and environmental factors significantly affect concentration of such substances. For instance, a wide ranges being 2.5 – 4.7 ppm (nitrite) ,50-570 ppm (nitrate)and 1.1-6.7 g/100g (total oxalate);and a mean of 46.4ppm (cyanide) were reported for spinach (Kenny and Walshe ,1975; Huissen , 1984 ; Abd-El-Hadi *et al ,* 1985 and Teotia *et al*, 1988).It is noteworthy that NO_2 content of leafy amaranth is quite close to its corresponding of spinach while the former exhibited lower NO_3 , cyanide and total oxalate contents than the latter.

Organoleptic properties of cooked amaranth:

Table 6 shows the data of organoleptic properties of cooked leafy amaranth as judged by ten panelists. All samples are acceptable regarding colour, flavour, consistency and overall acceptability. No obvious significant differences among samples could be traced.

Composition of cooked amaranth:

In the light of taste panel data which obviously reflected quite comparable acceptability of all samples, a blend of cooked amaranth samples was subjected to chemical analysis. Data presented in Table 7 indicated that amaranth like other leafy vegetables is considered as a good source of mineral elements and fibers. From the nutritional point of view, cooked amaranth is considered as low energy food (35-41 Cal / 100g). Obviously, the nutritive value of this commodity will increase on its inclusion to the Egyptian diet. In other words, Egyptians eat bread and / or rice along with leafy vegetables.

In conclusion, leafy amaranth is a promising leafy vegetable crop and can be introduced to Egypt to be a good alternative of spinach in summer.

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تقييم الأمارانس الورقي كمحصول خضر صيفي جديد في مصر

حامد مرسى زينة

قسم علوم وتكنولوجيا الأغذية - كلية الزراعة (دمنهور) – جامعة الإسكندرية – جمهورية مصر العربية

تم دراسة الأمارانس الورقي كمحصول خضر جديد فى مصر خلال صيفي 1997 ، 1998 من حيث التقبل والتركيب الكيماوي.

وقد أوضحت النتائج التى أجريت على أوراق الأمارانس (على أساس وزن جاف) أن البروتين الخام تراوح بين 25.46- 29.02% والدهون الكلية 6.47-7.13% والرماد 19.78-22.71% والألياف الخام 15.25-18.92% والمستخلص الخالي من النتروجين 24.75- 30.76% بينما تراوحت العناصر المعدنية (ملجم /100 جم على أساس وزن جاف) فيما بين 1585-1708 للصوديوم ، 4877-5730 للبوتاسيوم ، 2088-2459 للكالسيوم ، 988-1249 للماغنسيوم ، 255-374 للحديد ، 375-421 للفوسفور ، أما حمض الأسكورييك فقد تراوح ما بين 279.2 – 337.8 ملجم /100 جرام جاف بينما تراوح محتوى بيناكاروتين ما بين 46.11- 68.84 ملجم/100 جرام جاف ، وقد تراوح محتوى النيتريت والنترات بين 3.071 – 4.827 جزء فى المليون وبين 60.4 – 91.5 جزء فى المليون (جاف) على التوالي بينما تراوح محتوى السيانيد والأوكسالات الكلية فيما بين 22.9- 30.9، بين 1.444 – 1.613 جم /100جم جاف على التوالي وقد حكم كل المتذوقين مطبوخ الأمارانس على أنه شبيه للسبانخ تماماً.

وعلى ضوء هذه النتائج فإنه يمكن القول بأن الأمارانس الورقي مشابه لحد كبير مع السبانخ وهو بديل جيد للسبانخ في الصيف بمصر .