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Autecology and Phytochemistry of Genus *Amaranthus* in the Nile Delta, Egypt

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Abstract: The present study deals with the ecology and phytochemistry of three *Amaranthus* species, namely: *Amaranthus graecizans*, *A. lividus* and *A. viridis*. The components of weed vegetation in the present investigation are classified by cluster analysis into four groups: group A is codominated by *Amaranthus graecizans* and *Portulaca oleracea*, group B is codominated by *Amaranthus lividus* and *Cynodon dactylon*, group C is codominated by *Alternanthera sessilis* and *Echinochloa crus-galli* and group D is codominated by *Aster squamatus*, *Conyza bonariensis* and *Paspalum disticum*. The ordination of the sampled stands applied by Detrended Correspondence Analysis (DCA) indicated that, the recognized vegetation groups are markedly distinguishable and having a clear pattern of segregation on the ordination planes. Also, the application of the Canonical Correspondence Analysis (CCA) showed that, soil texture, porosity, water-holding capacity, bicarbonate, sodium, soil reaction (pH), organic matter and electrical conductivity are the most effective soil variables which correlate with the distribution and abundance of weed vegetation in the study area. The seed germination under different levels of salinity, light, temperature and humidity is studied for the three investigated species. Phytochemically, the mean values of moisture, ash, total nitrogen, protein, total lipids, soluble sugars, glucose, sucrose, polysaccharides and total carbohydrates were determined. The elementary analyses together with qualitative and quantitative analyses of 16 amino acids were also carried out in the investigated plant species.

Key words: Autecology, phytochemistry, *Amaranthus*, vegetation analysis, seed germination

INTRODUCTION

Attention should be paid to increase our knowledge of the best conditions for propagation of economic plants. In this connection, the importance of studying plants in their natural habitats, the effect of each habitat factor upon growth, establishment and distribution must be emphasized.

Many investigators studied the main active constituents of several species belonging to family Amaranthaceae. Nodeide *et al.* (1996) reported that the green leaves of *Amaranthus viridis* were rich for water, energy, fats, proteins, minerals, amino acids and carotenoid. In some species of genus *Amaranthus*, sixteen phenolic acids were identified by Sokolowska-Wozniak (1996). Two comarins and three flavonoids were isolated from *Amaranthus paniculatus* by Bratoeff *et al.* (1997). Singh and Whitehead (1996) mentioned that *Amaranthus* species are commonly utilized as vegetable and consumed in Africa, China, India and Italy.

Jale *et al.* (1999) mentioned that grain amaranth was used as a partial substitute for barley in diets fermented in artificial rum. Syamdaya and Naidu (1999) studied the nutritive value of amaranth to sheep. One can expect the prime importance of the individuals belonging to this family as a source of substances that can be use for several industrial, medicinal and fodder purposes.

The present study aims at the description of the weed communities associated with the studied plant species in their natural habitats by using multivariate techniques of classification and ordination, analysis of soil samples to determine the variables controlling the distribution and abundance of the identified weed communities, seed germination under different environmental factors and physiochemical investigation to detect the main active constituents and amino acids in the studied plant species.

MATERIALS AND METHODS

In the present study, ten localities (sites) were chosen in three governorates of the Nile Delta region (Fig. 1). These governorates are Kafr El-Sheikh, El-Dakahlyia and Damietta. After regular visits to the different sites, forty stands representing the apparent physiognomic variations in the vegetation and environmental features were used for sampling vegetation of the different habitat types supporting the growth of

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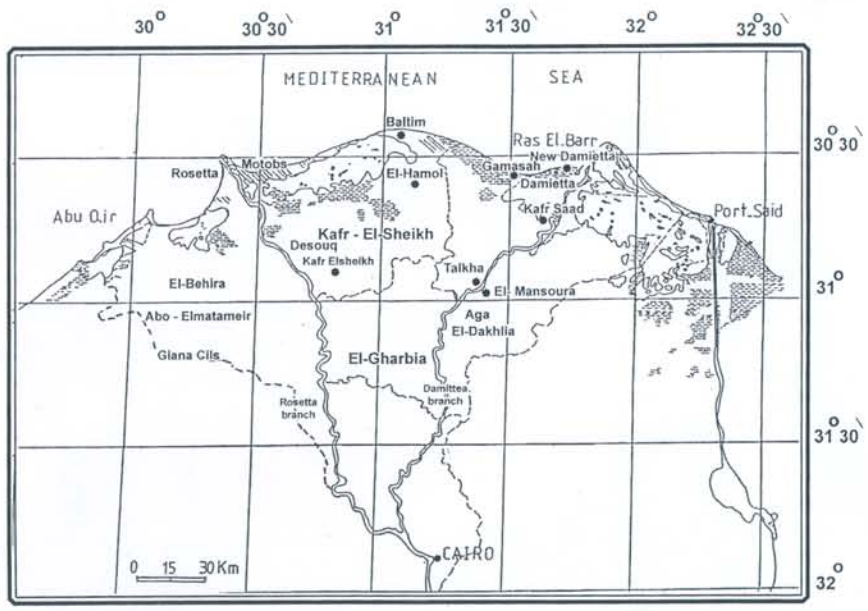

Fig. 1: Map of the Nile Delta region showing different localities (sites) as indicated by (●) in the study area

Amaranthus graecizans, *A. lividus* and *A. viridis*. The stands were distributed as follows: 7 stands in canal banks, 7 stands in orchards and 26 stands in cultivated lands. The sampling processes have been carried out during the years 2004-2006.

The density and plant cover of each species have been estimated in each stand using quadrat of 5 m^2. The relative values of density and cover were calculated for each species and summed up to give an estimate of its importance value (IV) in each stand, which is out of 200. The Nomenclature and identification of the species was according to Tackholm (1974) and Boulos (1999-2005).

Soil sample was collected from each stand at a depth of 0-25 cm for physical and chemical analyses. Soil texture was determined using the hydrometer method, while the water-holding capacity was estimated using the Hilgard-Pan box method of Piper (1947). Oxidizable organic carbon was estimated using the Walkely and Black rapid titration method (Black, 1979). The percentage of calcium carbonate was determined by addition of 100 mL 1 N HCl to 5 g soils and the excess of acid titrated against 1 N NaOH. Soil salinity (EC) and soil reaction (pH) were estimated in 1-5 water extract using the conductivity and pH meters, respectively. Chloride was determined by titration against N/35.5 silver nitrate, while sulphate was estimated gravimetrically using 5% barium chloride. Estimation of carbonate and bicarbonate were carried out by titration against 0.1 N HCl. The cations Na^+, K^+ and Ca^{++} in the soil solution were estimated using flame photometer as described by Allen *et al*. (1974).

Two trends of multivariate analysis of vegetation were applied, namely classification and ordination. Both trends have their merits in helping to understand the vegetation and environmental phenomena. Two-Way Indicator Species Analysis (TWINSPAN-a FORTRAN Program) was used for classification (Hill, 1979; Gauch and Wittaker, 1981), while the ordination techniques applied were the Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA) using CANOCO- a FORTRAN Program (Ter Braak, 1986, 1988). The relationships between the vegetation gradients and the environmental variables can be indicated on the ordination diagram produced by canonical correspondence analysis (CCA biplot), on which points represent species and arrows represent environmental variables. The statistical treatments applied in the present study were according to Snedecor and Cochoran (1968) and Anonymous (1993).

Germination experiments were conducted to find out the effect of salinity levels, light and dark, temperature and water spray (humidity) on the rate of seed germination of the three different *Amaranthus* species. For the first three experiments, germination was tested in equal sized Petri-dishes (13 cm) containing double layered filter paper moistened with distilled water or with different test solution. For each treatment, one hundred seeds were sown in each dish and two replicates Petri dishes were used. In case of water spray experiment, equal sized pots (14 cm height and 14 cm diameter) were filled with clean sand and one hundred seeds also sown at 0.5 cm depth.

Concerning the phytochemical analysis, the plant samples were handly cleaned, separated into roots, stems and leaves, air-dried, ground to fine powder and kept in a well stopper vessels to be ready for different phytochemical investigations. The mean values of moisture, ash, water-soluble ash, acid-insoluble ash and total lipid content were investigated according to AOAC (1970) methodology. Soluble sugars, glucose, sucrose, polysaccharides and total nitrogen content were estimated according to Naguib (1963, 1964). The protein content was determined colorimetrically as described by Waslein (1975). The preliminary phytochemical screening was carried out following the methods described by Wall *et al.* (1964), Claus (1967) and Markham (1982). Hundred grams of each plant powder was subjected to extraction with successive solvents using AOAC (1970) methodology. The macro and microelements were determined by atomic absorption spectrophotometer using the methods described by Allen *et al.* (1974). The identification and quantitative determination of amino acid in the plant powders were carried out using amino acid analyzer (Model, LC 3000) as described by Moore and Stein (1958).

RESULTS

Vegetation analysis

Classification of stands: The dendrogram obtained from cluster analysis based on the importance values of 65 species recorded in 40 sampled stands in the study area indicated the distinction of four vegetation groups (Fig. 2, Table 1). Group A comprises 12 stands codominated by *Amaranthus graecizans* (IV = 37.70) and *Portulaca oleracea* (IV = 29.42). The important species in this group include *Sonchus oleraceus* (IV = 13.99), *Cyprus rotundus* (IV = 13.98) and *Dactyloctenium aegyptium* (IV = 11.72). Group B includes 17 stands codominated by *Amaranthus lividus* (IV = 34.42) and *Cynodon dactylon* (IV = 26.29). In this group, the important species are numerous such as: *Sorghum vigratum* (IV = 18.51), *Cyprus rotundus* (IV = 14.42), *Ammi majus* (IV = 14.31), *Convolvulus arvensis* (IV = 13.87) and *Bidens pilosa* (IV = 10.25). Group C includes 9 stands codominated by *Alternanthera sessilis* (IV = 36.53) and *Echinchloa crus-galli* (IV = 27.15). The important species in this group are *Eclipta alba* (IV = 18.29) and *Phyla nodiflora* (IV = 10.25), group D consists of 2 stands codominated by *Aster squamatus* (IV = 40.18), *Conyza bonariensis* (IV = 27.67) and *Paspalum distichum* (IV = 31.04). The important species in this group comprise *Bassia indica* (IV = 26.65), *Phragmites australis* (IV = 25.94), *Pluchea dioscoridis* (IV = 15.50) and *Alternanthera sessilis* (IV = 13.75).

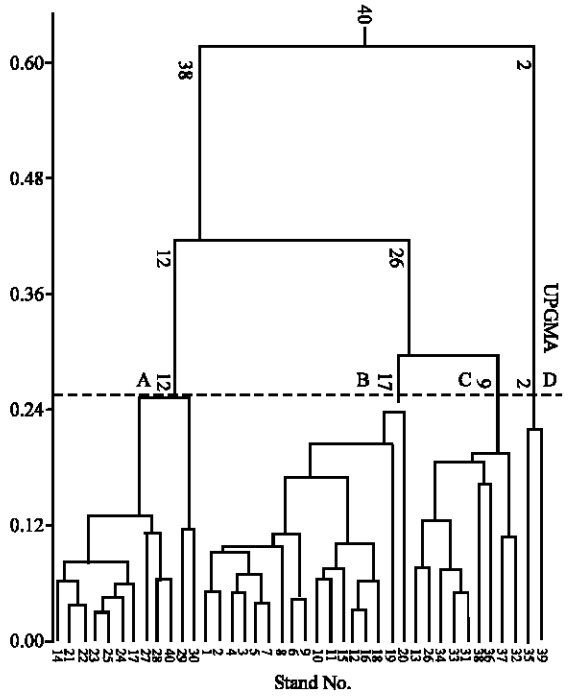

Fig. 2: The dendrogram resulting from cluster analysis of 40 sampled stands representing habitat types of some *Amaranthus* species. The dashed line denotes the level at which the dendrogram yields four distinct vegetation groups

Ordination of stands: The ordination of the sampled stands which obtained by detrended correspondence analysis (Fig. 3) indicated that, the vegetation groups yielded by cluster analysis are markedly distinguishable and having a clear pattern of segregation on the first and second axes of the ordination planes. Group A codominated by *Amaranthus graecizans* and *Portulaca oleracea* is separated at the central part of the DCA diagram. Group B codominated by *Amaranthus lividus* and *Cynodon dactylon* is segregated at the left side of the ordination diagram. On the other hand, group C codominated by *Alternanthera sessilis* and *Echinochloa crus-galli* is segregated at the right side of the DCA diagram. It is clear that, groups B and C are separately segregated at both sides of group A, where these three groups (A, B and C) are distinctly located on the positive and negative sides of the first and second axes of DCA diagram. However, group D codominated by *Aster squamatus*, *Conyza bonariensis* and *Paspalum distichum* is separated at the upper most right positive side of DCA diagram.

Vegetation-soil relationships

Soil analysis: It has been found that, most of the soil characteristics showed a little variation between the

Table 1: Mean value and coefficient of variation of the importance value of species in the vegetation groups resulting from cluster analysis of the sampled stands

	Vegetation group			
Species	A	B	C	D
Alternanthera sessilis (L.) DC.	5.37(3.47)	-	36.53(0.97)	13.75(0.27)
Amaranthus graecizans L.	37.70(1.04)	-	2.92(2.83)	-
Amaranthus lividus L.	3.94(2.09)	34.42(1.34)	0.37(1.86)	-
Amaranthus viridis L.	4.22(2.54)	4.96(1.40)	1.66(2.59)	-
Ammi majus L.	1.94(3.47)	14.31(1.43)	2.44(2.83)	-
Anagallis arvensis L.	1.91(2.49)	-	-	-
Aster squamatus (Spreng.) Hieron.	-	-	-	40.18(0.65)
Bassia indica (Wight) Scott	-	0.15(4.13)	-	26.65(0.38)
Beta vulgaris L. subsp. *maritima*	-	-	2.19(2.61)	-
Bidens pilosa L.	9.30(2.35)	11.58(1.66)	2.13(2.83)	-
Brachiaria eruciformis (Sm.) Griseb.	-	-	2.44(1.87)	-
Cakile maritima Scop. subsp. *maritima*	0.13(3.54)	-	-	-
Calendula arvensis L.	-	1.48(4.14)	-	-
Cenchrus biflorus Roxb.	1.71(2.37)	-	-	-
Chenopodium album L.	2.10(2.64)	7.57(1.65)	-	-
Chenopodium glaucum L.	-	-	3.76(2.83)	-
Chenopodium murale L.	4.79(1.66)	7.17(1.72)	1.73(2.82)	-
Cichorium endivia L. subsp. *pumilum*	-	0.69 (2.83)	-	-
Convolvulus arvensis L.	4.76(1.95)	13.87(2.01)	-	-
Conyza aegyptiaca (L.) Dryand.	-	-	0.85(2.12)	-
Conyza bonariensis (L.) Cronquist	0.51(3.47)	-	-	37.67(0.34)
Cynodon dactylon (L.) Pers.	7.62(2.51)	26.29(1.12)	4.96(1.48)	-
Cyprus alopecuroides Rottb.	-	-	4.33(1.62)	-
Cyprus difformis L.	1.98(2.38)	-	2.59(2.82)	-
Cyprus laevigatus L.	0.31(3.42)	-	-	-
Cyprus rotundus L.	13.98(1.32)	14.42(1.22)	2.69(2.83)	-
Dactyloctenium aegyptium (L.) Willd.	11.72(2.46)	-	-	-
Digitaria sanguinalis (L.) Scop.	6.46(3.10)	-	-	-
Dinebra retroflexa (Vahl) Panz.	-	-	0.84(1.88)	-
Echinochloa colona (L.) Link.	-	1.53(2.94)	3.79(1.42)	-
Echinochloa crus-galli (L.) Beauv.	3.46(1.42)	-	27.15(0.96)	-
Echinochloa stagnina (Retz.) Beauv.	-	-	6.88(2.83)	-
Eclipta alba (L.) Hassk.	-	-	18.29(1.56)	-
Eleusine indica (L.) Gaertn.	4.12(3.46)	-	8.22(2.83)	-
Euphorbia peplus L.	2.79(2.67)	8.98(1.85)	1.91(2.82)	-
Euphorbia prostrata Aiton	0.73(2.03)	-	-	-
Gnaphalium luteo-album L.	1.08(1.82)	-	0.49(2.84)	-
Inula crithmoides L.	-	-	2.71(2.82)	-
Lotus glaber Mill.	-	5.91(3.13)	-	-
Malva parviflora L.	0.87(3.01)	3.08(2.30)	3.69(2.83)	-
Medicago intertexta (L.) Mill.	0.91(3.47)	-	-	-
Medicago polymorpha L.	1.36(2.07)	-	-	-
Melilotus indicus (L.) All.	5.02(1.54)	0.28(4.11)	-	-
Mesembryanthemum crystallinum L.	-	-	5.10(2.83)	-
Oxalis corniculata L.	-	2.88(1.91)	-	-
Paspalum distichum L.	-	-	8.58(1.46)	31.04(0.140)
Phragmites australis (Cav.) Trin. ex Steud.	-	-	-	25.94(0.27)
Phyla nodiflora (L.) Greene	-	-	10.25(1.28)	-
Plantago major L.	3.59(2.35)	0.52(4.15)	0.26(2.81)	-
Pluchea dioscoridis (L.) DC.	0.69(3.46)	-	4.68(1.52)	15.50(1.00)
Polygonum plebeium R.Br.	-	0.50(3.18)	-	-
Polypogon monspeliensis (L.) Desf.	4.22(1.60)	1.98(1.72)	-	-
Polypogon viridis (Gouan) Brestr.	0.10(3.60)	-	-	-
Portulaca oleracea L.	29.42(1.12)	2.36(3.69)	4.59(2.52)	-
Pseuderucaria teretifolia (Desf.) Schulz	0.06(3.50)	-	-	-
Rumex dentatus L.	3.85(2.04)	5.83(1.37)	7.20(1.23)	-
Scirpus maritimus L.	-	-	7.42(2.02)	-
Senecio vulgaris L.	-	-	0.28(2.79)	-
Setaria verticellata (L.) Beauv.	-	3.46(1.60)	0.17(2.83)	-
Solanum nigrum L.	0.20(3.40)	5.59(3.11)	1.02(2.82)	-
Sonchus oleraceus L.	13.99(1.84)	0.38(2.92)	-	-
Sorghum virgatum (Hack.) Stapf	-	18.51(1.71)	3.39(2.83)	-
Spergularia marina (L.) Griseb.	-	0.13(4.00)	-	-
Urtica urens L.	3.41(3.47)	1.31(4.11)	1.53(2.83)	-
Xanthium strumarium L.	-	-	-	0.91(1.00)

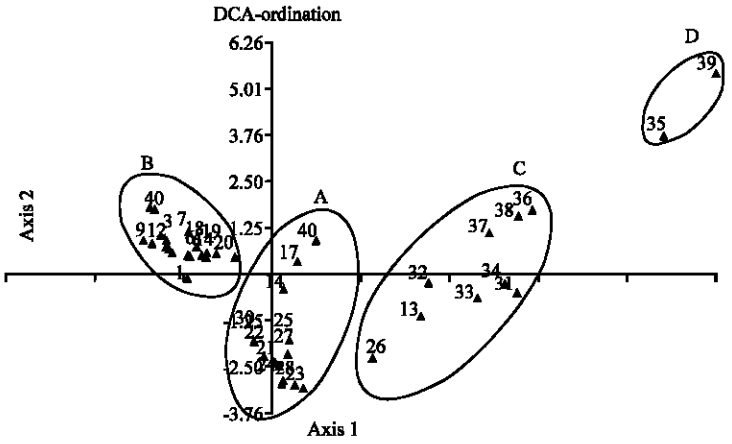

Fig. 3: Detrended Correspondence Analysis (DCA) ordination of the 40 sampled stands with four cluster groups

Table 2: Mean value and standard error (±) of the different soil variables in the sampled stands representing the four vegetation groups obtained by cluster analysis in the habitat types of *Amaranthus* species

	Vegetation group			
Soil variables	A	B	C	D
Sand (%)	98.25±0.37	97.23±0.42	97.11±0.73	95.00±0.00
Silt (%)	1.67±0.37	2.59±0.37	1.78±0.38	3.00±0.71
Clay (%)	0.08±0.09	0.18±0.08	1.11±0.40	2.00±0.71
Moisture content (%)	11.52±3.11	15.63±3.38	16.10±3.42	1.25±0.23
WHC (%)	48.36±3.80	48.51±1.86	55.40±2.38	48.21±8.12
Porosity (%)	53.43±1.83	52.05±1.28	57.58±1.19	61.37±4.25
$CaCO_3$ (%)	5.32±1.91	7.88±1.89	10.89±2.09	3.75±0.71
Organic carbon (%)	0.33±0.05	0.29±0.04	0.14±0.02	0.26±0.04
pH	7.38±0.15	7.34±0.13	7.43±0.11	7.80±0.05
EC (mmhos cm^{-1})	0.45±0.06	0.62±0.06	2.95±2.37	0.79±0.09
Cl^- (%)	0.03±0.00	0.03±0.00	0.35±0.29	0.13±0.01
SO_4^- (%)	0.10±0.01	0.14±0.03	0.17±0.08	0.15±0.00
HCO_3^- (%)	0.06±0.01	0.08±0.00	0.05±0.00	0.06±0.00
Na^+ (ppm)	212.58±36.34	493.12±95.64	453.90±199.75	1465.00±223.40
K^+ (ppm)	24.09±5.710	19.55±1.720	284.83±94.94	494.25±305.50
Ca^{++} (ppm)	89.67±27.01	150.37±12.26	71.59±23.86	111.70±5.82

WHC: Water-Holding Capacity, EC: Electrical Conductivity

different groups of the sampled stands. The soil texture is mainly formed of coarse fraction (sand) and partly of fine fractions (silt and clay). The mean values of water-holding capacity and soil porosity are obviously comparable in all groups. The mean values of calcium carbonate content are higher in groups C (10.89%) and B (7.88%) than in groups A (5.32%) and D (3.75%), while those of organic carbon content are higher in groups A (0.33%), B (0.29%) and D (0.26%) than in group C (0.14%). The pH values indicated that, the soil reaction is neutral or slightly alkaline and it ranged between 7.38 in group A and 7.80 in group D (Table 2). The Electrical Conductivity (EC), chloride and sulphate attained higher mean values in groups C and D than in groups B and A. The soluble bicarbonate is detected in traces. The concentration of extractable cations: Na^+, K^+ and Ca^{++} attained their highest mean values in group D (1465.00, 494.25 and 111.70 ppm, respectively).

The correlation between vegetation and soil variables: The relationship between vegetation and edaphic variables is indicated on the ordination diagram produced by Canonical Correspondence Analysis (CCA) of the biplot of species-environment as shown in Fig. 4. It is obvious that, the values of clay, bicarbonate, porosity, sodium cation, sand fraction, water-holding capacity, organic matter, soil reaction (pH) and electrical conductivity are the most effective soil variables which showed a distinct significant correlations with the first and second axes of the CCA biplot diagram.

Seed germination: The seed germination capacity of *Amaranthus* species is investigated under different levels of salinity, light and dark, temperature and water spray (Table 3). The effect of different salinity levels on the seed germination of the three studied *Amaranthus* species showed that, the rate of germination is reached its highest

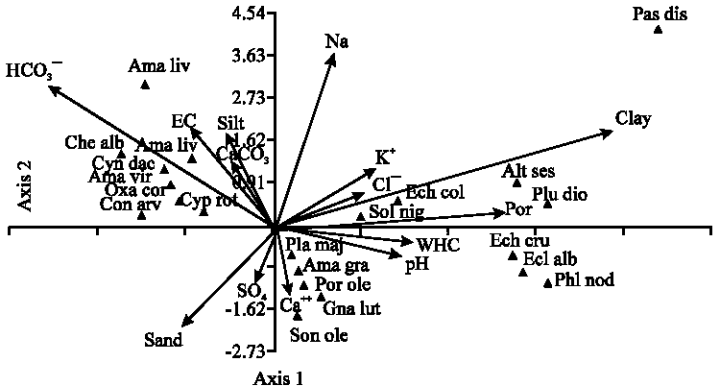

Fig. 4: Canonical Correspondence Analysis (CCA) ordination diagram with soil variables represented by arrows. The indicator and preferential species are abbreviated to the first three letters of each of the genus and species

Table 3: No. of germinated seed of *Amaranthus* species under different levels of temperature, water spray (humidity), salinity and light/dark

		Temperature (°C)								Water spray (mm)						
Day	Species	5	10	15	20	25	30	35	40	5	10	15	20	25	30	Saturated
3	*Amaranths graecizans*	0	0	0	0	9	10	13	11	0	0	0	0	1	1	1
6		0	0	0	0	19	23	25	24	0	1	1	6	10	11	22
9		0	0	0	0	30	33	38	36	0	7	9	13	20	21	23
12		0	0	0	0	30	40	46	41	0	10	12	20	37	43	56
15		0	0	0	0	30	41	49	47	0	20	27	29	38	45	65
18		0	0	0	0	30	41	49	47	0	33	47	49	53	56	75
21		0	0	0	0	30	41	49	47	0	34	38	50	55	56	75
3	*Amaranthus lividus*	0	0	0	0	0	4	8	17	0	0	0	0	0	4	10
6		0	0	0	0	0	12	16	26	0	0	0	0	6	14	20
9		0	0	0	8	16	18	46	58	0	0	0	13	26	35	39
12		0	0	0	15	28	50	80	90	0	0	6	17	44	55	66
15		0	0	0	20	50	80	82	98	0	0	13	19	51	76	80
18		0	0	0	20	50	80	82	98	0	0	23	26	62	78	90
21		0	0	0	20	50	80	82	98	0	0	23	46	72	79	90
3	*Amaranthus viridis*	0	0	0	0	0	18	10	1	0	0	0	3	18	20	28
6		0	0	0	5	8	25	14	6	0	0	0	17	33	40	47
9		0	0	0	9	14	52	32	16	0	0	10	35	56	60	62
12		0	0	0	19	23	72	58	28	0	0	18	39	77	80	83
15		0	0	0	31	32	78	72	30	0	0	24	45	82	89	92
18		0	0	0	31	32	78	72	30	0	0	38	51	86	91	95
21		0	0	0	31	32	78	72	30	0	0	46	63	87	91	96

		Salinity level (NaCl M)									Light/dark		
Day	Species	Dist H_2O	0.02	0.03	0.04	0.1	0.2	0.3	0.4	0.5	L	D	L/D
3	*Amaranthus graecizans*	31	28	26	20	18	17	3	0	0	0	0	0
6		53	40	30	26	23	19	9	0	0	16	0	4
9		69	50	36	30	26	22	10	0	0	44	36	38
12		74	69	39	37	34	28	13	6	0	66	58	62
15		91	83	50	40	37	29	20	11	2	72	62	68
18		100	91	63	55	37	33	25	12	6	78	65	69
21		100	92	77	57	37	34	27	12	9	90	65	70
24		100	92	77	57	37	34	27	12	9	90	65	70
3	*Amaranthus lividus*	0	0	0	0	0	0	0	0	0	8	3	5
6		16	12	6	0	0	0	0	0	0	11	7	8
9		68	56	42	29	12	2	0	0	0	14	9	13
12		89	60	49	36	25	4	1	0	0	26	12	16
15		93	78	57	43	32	11	8	4	0	52	22	28
18		96	86	80	57	42	20	11	10	5	78	31	32
21		96	86	80	57	42	20	11	10	5	95	52	58
24		96	86	80	57	42	20	11	10	5	98	58	74
3	*Amaranthus viridis*	0	0	0	0	0	0	0	0	0	10	4	6
6		34	32	29	26	20	0	0	0	0	42	26	38
9		46	42	34	31	25	0	0	0	0	52	44	46
12		72	64	62	44	40	8	0	0	0	66	52	58
15		82	80	78	52	43	16	6	2	0	72	58	62
18		91	85	80	56	44	20	18	9	4	72	58	64
21		94	94	80	58	46	21	18	10	4	72	58	64
24		96	94	80	68	46	21	18	11	5	72	58	64

Table 4: Mean value of chemical constituents in different organs of *Amaranthus* species

	Amaranthus graecizans				*Amaranthus lividus*				*Amaranthus viridis*			
Constant	Leaves	Stems	Roots	Mean	Leaves	Stems	Roots	Mean	Leaves	Stems	Roots	Mean
Moisture content (%)	6.37	10.18	7.36	7.97	8.7	8.11	11.73	9.51	9.29	8.1	8.7	8.7
Ash content (%)	24.2	17.3	9.9	17.13	21.5	27.5	13	20.67	15.5	14.5	15.5	15.17
Water- soluble ash (%)	5	15.75	9.05	9.93	9.5	15.5	8.5	11.17	0.5	7	10	5.83
Acid- insoluble ash (%)	7.15	0.015	0.05	2.45	2	0.5	0.5	1	3.5	1.5	0.5	1.83
Total nitrogen (mg/100 mg dry wt.)	359.7	136.3	128.5	208.2	239	144.1	115.9	242	438.4	217.4	158.5	271.14
Total protein (mg/100 mg dry wt.)	232	173.3	204.6	203.3	246.6	208.3	189.6	214.8	277.6	158.3	254	144.8
Total lipid (%)	11.69	17.54	10.05	13.09	14.26	13.92	13	13.73	11.76	18.81	1.09	10.55
Carbohydrates (mg g^{-1} dry wt.)												
Total soluble sugar	43.95	62.64	71.2	59.25	18.56	36.96	70.64	42.05	20.16	14.96	12.16	15.76
Glucose	0.9	1.93	0.18	1	0.31	0.89	0.97	0.72	0.2	0.26	0.18	0.21
Sucrose	2.06	4.06	1.94	2.69	8.26	2.44	2.18	4.29	1.31	1.15	1.04	1.17
Polysaccharides	139.2	121.3	128.2	29.56	135.7	142.4	114.8	131	148.1	136.2	143.7	142.65
Total carbohydrates	186	190	211.6	196.5	162.8	182.7	188.5	178	163.8	158.6	157.9	160.09

Table 5: A preliminary phytochemical screening of active constituents of the different organs of *Amaranthus* species

	Amaranthus graecizans			*Amaranthus lividus*			*Amaranthus viridis*		
Test	Leaves	Stems	Roots	Leaves	Stems	Roots	Leaves	Stems	Roots
Alkaloids	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Glycosides and/or carbohydrates	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Flavonoids	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Sterols	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Tannins	+ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	ve
Saponins	-ve	-ve	-ve	+ve	-ve	-ve	+ve	+ve	-ve
Sulphates	-ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Chlorides	-ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	+ve

+ve: Present, -ve: Absent

values of 97% with distilled water treatment. When the low salinity levels of 0.02, 0.03 and 0.04 M NaCl solution are used, the percentages of germination attained 92, 77 and 57% for *A. graecizans*, 86, 80 and 57% for *A. lividus* and 94, 80 and 68% for *A. viridis*, respectively. But at salinity levels of 0.1, 0.2, 0.3, 0.4 and 0.5 M NaCl solutions, the percentages of germination decreased gradually and the minimum rate of germination at 0.5 M NaCl solution attained 9% for *A. graecizans* and 5% for both *A. lividus* and *A. viridis*. The results obtained from the effect of light and darkness on seed germination of the studied species showed that, the highest values of germination attained 90, 98 and 70% under continuous light for *A. graecizans*, *A. lividus* and *A. viridis*, respectively. The minimum numbers of germinated seeds are 65% for *A. graecizans* and 58% for both *A. lividus* and *A. viridis*. The seeds of the investigated plant species had the capacity of germination between 20-40°C for both *A. lividus* and *A. viridis* and 25-40°C for *A. graecizans*. It is evident that, the optimum temperature for the seed germination of the three selected species are 35°C (49%), 40°C (98%) and 30°C (78%) for *A. graecizans*, *A. lividus* and *A. viridus*, respectively. It is also obvious that, the decreased amount of water spray is badly affected on the rate of seed germination of the three plant species. In case of *A. graecizans*, seed germination is started at 10 mm water spray being 34%. At 5 and 10 mm water spray, both *A. lividus* and *A. viridis* seeds are failed to germinate and started at 15 mm water spray being 23 and 46%, respectively. At the highest level of applied water spray (saturated), the germination percentages reached 75, 90 and 96% for the seeds of *A. graecizans*, *A. lividus* and *A. viridis*, respectively.

Phytochemical analysis

Determination of chemical constituents: The data analysis showed that, *A. lividus* contained a relatively high percentage of the mean values of moisture content (9.51%), ash content (20.67%), water-soluble ash (11.17%), total protein (214.8 mg/100 g dry wt.) and total lipid (13.73%). *A. graecizans* contained a relatively high percentage of the mean values of acid insoluble ash (2.45%) and total carbohydrates (196.5 mg/100 g dry wt.). The highest mean value of total nitrogen content (271.14 mg/100 g dry wt.) is recorded in *A. viridis* (Table 4).

Preliminary phytochemical screening: The presence of alkaloids, carbohydrates, flavonoids, sterols and tannins in all organs of the studied species. Saponins is detected only in the leaves of both *A. lividus* and *A. viridis* as well as in the stems of *A. viridis*. Sulphates are recorded in all organs of the studied species except in the leaves of *A. graecizans*. Chlorides are recorded in all investigated plant organs except in the leaves and roots of *A. graecizans* (Table 5).

Table 6: Extraction of the different fractions of *Amaranthus* species with successive organic solvents

	Amaranthus graecizans			*Amaranthus lividus*			*Amaranthus viridis*		
Solvent used	Leaves g% remark	Stems g% remark	Roots g% remark	Leaves g% remark	Stems g% remark	Roots g% remark	Leaves g% remark	Stems g% remark	Roots g% remark
Petroleum ether	0.90 yellow	2.45 yellow	1.20 yellow	29 dark green	31.55 yellow	46.90 yellow	29.6 dark green	34.06 green	0.16 yellow
Ether	4.35 green	4.95 yellow	2.50 yellow	39.7 green	15.6 orange	1.60 yellow	0.77 brown	2.90 yellow	4.50 yellow
Chloroform	1.30 green	0.70 yellow	2.05 yellow	1.25 brown	3.30 yellow	1.65 yellow	0.50 green	0.73 brown	11.53 yellow
Acetone	7.55 green	2.90 yellow	1.10 yellow	9.50 black	1.65 yellow	0.90 yellow	11.73 green	26.83 yellow	20.03 green
Alcohol	26.55 brown	4.65 brown	1.15 yellow	7.90 yellow	2.90 yellow	17.85 yellow	4.47 green	1.90 yellow	1.53 yellow
Water	3.15 brown	5.55 brown	7.25 yellow	9.1 yellow	38.65 yellow	16.20 yellow	4.00 brown	10.27 yellow	6.20 yellow
Total	43.8	21.2	15.25	96.45	93.65	85.1	51.07	76.69	43.95

Table 7: Mean value of amino acid concentrations (μg mg^{-1}) in *Amaranthus* species

	Species			
Amino acid	*Amaranthus graecizans*	*Amaranthus lividus*	*Amaranthus viridis*	Mean
Aspartic acid	51.659	37.272	35.957	41.629
Threonine	17.422	11.512	7.391	12.108
Serine	21.529	19.142	3.738	18.136
Glutamic	104.254	50.562	50.562	68.459
Proline	124.179	73.733	69.339	89.084
Glycine	16.442	13.959	14.871	15.091
Alanine	21.445	14.257	15.898	17.200
Valine	26.079	9.246	14.325	16.550
Leucine	12.859	5.969	10.209	9.679
Isoleucine	25.391	15.779	21.318	20.829
Phenylalanine	4.162	3.617	1.209	2.996
Tyrosine	15.373	9.728	10.641	11.914
Histidine	8.822	7.314	8.164	8.100
Lysine	18.869	10.285	16.025	15.060
Arginine	17.457	7.581	10.184	11.741
Cystine	0.012	0.000	0.000	0.004

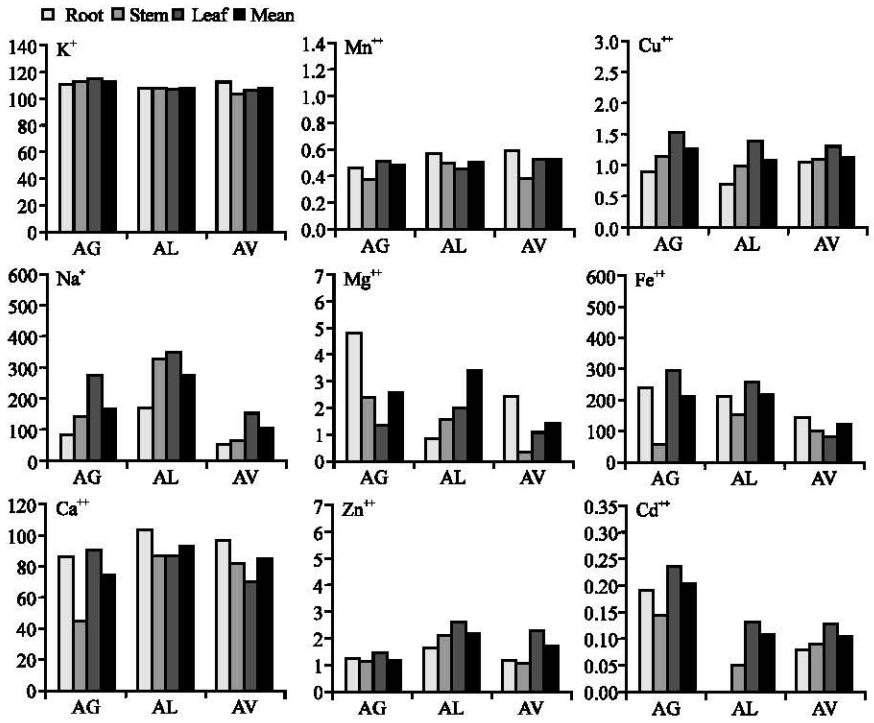

Fig. 5: Variation in cation concentrations (K^+, Mn^{++}, Cu^{++}, Na^+, Mg^{++}, Fe^{++}, Ca^{++}, Zn^{++} and Cd^{++}) of root, stem and leaf of *Amaranthus* species, AG: *Amaranthus graecizans*, AV: *Amaranthus viridis*, AL: *Amaranthus lividus*

Extraction with successive solvents: The results indicated that, the leaves of *A. lividus* attained a relatively high percentages of total extractives being 96.45 g%, while the lowest one (15.25 g%) is recorded in the roots of *A. graecizans* (Table 6).

Elementary analysis: It is clear that, the highest values of potassium ion concentration (112.6 mg/100 g dry wt.), iron (198.5 mg/100 g dry wt.), copper (1.17 mg/100 g dry wt.) and cadmium (0.19 mg/100 g dry wt.) are recorded in *A. graecizans*. The sodium ion concentration (276.74 mg/100 g dry wt.), calcium (93.14 mg/100 g dry wt.), magnesium (3.34 mg/100 g dry wt.), manganese (0.45 mg/100 g dry wt.) and zinc (2.03 mg/100 g dry wt.) are recorded in *A. lividus* (Fig. 5).

Amino acids investigation: The data obtained from the amino acids investigations are shown in Table 7. Fifteen amino acids are detected in each of the studied species, namely: aspartic, threonine, serine, glutamic, proline, glycine, alanine, valine, leucine, isoleucine, phenylalanine, tyrosine, histidine, lysine and arginine, in addition to cystine which is detected only in *A. graecizans*.

DISCUSSION

Amaranthus is a cosmopolitan genus comprises almost 65 species, distributed in the tropical, subtropical and warm regions of the world (Boulos, 1999). In the present study, the chosen species, namely: *Amaranthus graecizans*, *A. lividus* and *A. viridis* have high medicinal and nutritive values (El-Morsy, 2001). The habitat types supporting the growth of these plants are mainly ruderal habitats including orchards, cultivated lands and canal banks, which predominate in the agricultural areas of the Nile Delta region. According to the map of the world distribution of the arid regions (UNESCO, 1977), in the Nile Delta, summer is warm with an average temperature ranges between 20 and 30°C, while winter is mild with an average temperature ranges between 10 and 20°C. Most of rainfall occurs during winter.

The weed vegetation is classified by cluster analysis into four groups, each group comprises a number of stands which are similar in their vegetation and characterized by dominant and/or codominant species as well as by a number of indicator and/or preferential species. The recognized groups are: Group A is codominated by *Amaranthus graecizans* and *Portulaca oleracea*, group B is codominated by *Amaranthus lividus* and *Cynodon dactylon*, group C is codominated by *Alternanthera sessilis* and *Echinochloa crus-galli* and group D is codominated by *Aster squamatus*, *Conyza bonariensis* and *Paspalum distichum*. These groups may be related to alliance of *Digitarietalia sanguinalis* described by Zohary (1973). The associations of weed vegetation recognized in the present study might be similar to those described by El-Fahar (1989), El-Ashri (1996) and Omar (2006). The ordination of the sampled stands by DCA indicated that, group A (*Amaranthus graecizans* and *Portulaca oleracea*) and group C (*Alternanthera sessilis* and *Echinochloa crus-galli*) are more closely related to each other than group B (*Amaranthus lividus* and *Cynodon dactylon*) and group D (*Aster squamatus*, *Conyza bonariensis* and *Paspalum distichum*). This may be due to the distinct similarities of the floristic composition in these vegetation groups. The application of CCA biplot between the vegetation groups and soil variables indicated that, fine fraction (clay), bicarbonate, porosity and sodium ions are the most effective soil variables controlling the distribution and richness of the weed vegetation in the study area, followed by coarse fraction (sand), salinity (EC), water-holding capacity and soil reaction (pH). These findings are in accordance with those of Mashaly and Awad (2003) and Omar (2006).

With regard to seed germination, it is denoted that, *Amaranthus graecizans* is more salt tolerant than the other two species, also *A. viridis* is more sensitive for salinity than *A. lividus*. The seed germination showed distinct sensitivity to continuous darkness, while in continuous light, the seeds attained their highest values of germination. These observations, may give an indication that these species are long-day plants. The seeds had the capacity to germinate between wide ranges of temperature. This may explain why these species prefer to flourish at early and mid-summer. The percentage of seed germination of the studied species increased with rise of water spray or humidity level.

Dealing with the phytochemical investigation, it is notable that the leaves of the studied species are usually higher in their chemical constituents than the stems and roots. The highest value of total protein content was observed in *A. viridis*, that of total lipid in *A. lividus* and that of total carbohydrates in *A. gracezans*. It may be concluded from the results of the preliminary phytochemical screening that *Amaranthus* plants may be used as sources of potentially useful products. and that they deserve further investigation to explore the nature of these products. The results of amino acids investigation provide evidence that the genus *Amaranthus* being rich in proteins with essential amino acids like lysine which is considered as a good candidate for food supply both as grain crop and as vegetable. In this connection,

Amarantin as storage protein of *Amaranthus* was isolated by Romero *et al.* (1996). Sena *et al.* (1998) reported that, *A. viridis* being an excellent source of protein. The phytochemical results in the present study, seemed to be comparable with those obtained by Raja *et al.* (1997), El-Morsy (2001) and Omar (2006). Consequently, the selected plant species appeared a promising weeds as a renewable natural resources and raw materials for different uses in industrial, food, forage and pharmaceutical purposes.

REFERENCES

Allen, S.E., H.M. Grimshaw, J.A. Parkinson, C. Quarmby and J.D. Roberts, 1974. Chemical Analysis of Ecological Materials. Black Well Science Publication Osney, Oxford, London, pp: 565.

Anonymous, 1993. SPSS Program, for Windows. Base System User's Guide Release 5.0.2 Marija. J., Norsis INC.

AOAC., 1970. Official Methods of Analysis. 9th Edn. AOAC. Washington, DC., USA.

Black, C.A., 1979. Methods of soil analysis. Am. Soc. Agron., 2: 771-1572.

Boulos, L., 1999-2005. Flora of Egypt. Al Hadara Publication, Cairo, Vol. 1-4.

Boulos, L., 1999. Flora of Egypt. Al-Hadara Publication, Cairo, 1: 419.

Bratoeff, E.M., C. Perez-Amador, E. Ramirez, G. Flores and N. Valenica, 1977. Xanthones, flavones and coumarins from *Amaranthus paniculatus* Schinz (Amaranthaceae). Phyton (Buenos Aires), 60 (112): 103-107.

Claus, E.R., 1967. Pharmacognosy. 5th Edn. Henry Kimptom, London.

El-Ashri, N.N., 1996. Ecological studies on the seasonal fluctuation on the flora in El-Dakhlia Province. M.Sc. Thesis, Mansoura University, Egypt.

El-Fahar, R.A., 1989. A phytosociological study on weed vegetation in the Nile Delta region. M.Sc. Thesis, Tanta University, Tanta.

El-Morsy, E.R., 2001. Ecological studies on the weed flora of the orchards in the Nile Delta and their nutritive potentialities. M.Sc. Thesis, Mansoura University, Egypt.

Gauch, H.G. and R.H. Wittaker, 1981. Hierarchical classification of community data. J. Ecol., 69: 537-557.

Hill, M.O., 1979. TWINSPAN-a Fortran program for arranging multivariate data in an ordered two-way table by classification of individual and attributes. Section Ecology and Systematic, Cornell University Ithaca, New York.

Jale, D., M.B. Aran and P. Siroka, 1999. Use of grain amaranth (*Amaranthus hypochondriacus*) for feed and its effect on rumen fermentation in vitro. Czech J. Anim. Sci., 44 (4): 163-167.

Markham, K.R., 1982. Techniques of Flavonoid Identification. Academic Press, London.

Mashaly, I.A. and E.R. Awad, 2003. Ecological perspectives on the weed flora of orchards in the Nile Delta, Egypt. J. Environ. Sci. Mansoura Univ., 25: 1-37.

Moore, S. and H.W. Stein, 1958. Chromatography of amino acids on sulfanated polystyrene resins. Anal. Chem., 30: 1185.

Naguib, M.I., 1963. Colorimetric estimation of plant polysaccharides. Zucker, 16: 15-23.

Naguib, M.I., 1964. Effect of sevin on the carbohydrates and nitrogen metabolism during the germination of cotton seeds. Indian J. Exp. Biol., 2: 149-155.

Nodeide, M.B., A. Hatloy, M. Folling, E.O. Lied and A. Shaug, 1966. Nutrient composition and nutritional importance of green leaves and wild. Food Resources in an Agricultural District. Koutiala, in Southern Mali. Int. J. Food Sci. Nutr., 47 (6): 455-468.

Omar, G., 2006. Plant life of the different habitats in the North Nile Delta Of Egypt: Ecology and fodder potentialities. Ph.D Thesis, Mansoura University, Egypt.

Piper, C.S., 1947. Soil and Plant Analysis. Interscience Publishers, Inc., New York.

Raja, T.K., O.C. Othman and T.E. Bahemuka, 1997. Levels of crude proteins and some inorganic elements in selected green vegetables of Dar el Salaam. J. Food Sci. Technol. Mysore, 34 (5): 419-422.

Romero, Z., L. Paredes and A. Octavio, 1996. Isolation and characterization of amarantin, the amaranth seed globulin. J. Food Biochem., 19 (5): 329-339.

Sena, L.P., D.J. Vander, C. Rivera, A.T.C. Tsin, I. Muhamadu, O. Mahamadu, M. Millson, H. Pustuszyn and R.H. Glew, 1998. Analysis of nutritional components of eight famine foods of the Republic of Niger. Plant Foods Hum. Nutr., 52 (1): 12-24.

Singh, B.P. and W.F. Whitehead, 1996. Management Methods for Producing Vegetable Amaranth. Janick, J. (Ed.). Progress in New Crops. ASHS Press, Arlington, A., pp: 511-515.

Snedecor, G.W. and W.G. Cochoran, 1968. Statistical Methods. 6th Edn. Iowa State University Press. USA.

Sokolowska-Wozniak, A., 1996. Phenolic acids in the some species from the genus *Amaranthus* L. Herba Pol., 42 (4): 283-288.

Syamdaya, J. and M.M. Naidu, 1999. Nutritive value of amaranth in sheep. Indian Vet. J., 76 (7): 666-667.

Tackholm, V., 1974. Students' flora of Egypt. 2nd Edn. Cairo University, Press.

Ter Braak, C.J., 1986. Canonical correspondence analysis: A new eigenvector technique for multivariate direct gradient analysis. Ecology, 67: 1167-1179.

Ter Braak, C.J., 1988. CANOCA- a FORTRAN program for canonical community ordination by partial detrended correspondence analysis, principal component analysis and redundancy analysis (Version 2.1). Agric. Math. Group Wageninigen, Netherlands.

UNESCO., 1977. Map of the world distribution of arid regions. MAB Technical Notes.

Wall, M.E., M.M. Kreider, C.F. Kremson, G.R. Eddy, J.J. William, D.S. Corell and H.S. Gentry, 1964. Steroidal sapogensis. VIII. Survey of lants for steroidal sapogensis and other constituents. J. Pharm. Soc., 34: 1-3.

Waslein, C.I., 1975. Unusual sources of protein for man. Crit. Rev. Food Sci. Nutr., 16: 77.

Zohary, M., 1973. Geobotanical Foundations of the Middle East. Stuttgart, Gustv Fischer Verlag.