Relationship of Plant Proteins and Amino Acids within Taxonomic Categories in Qatari Range Plants

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Proteins and amino acids of sixty-eight range plants growing wild in Qatar belonging to fifty-six genera and twenty-three families are studied to evaluate their nutritive values. Variation of amino acid pattern is extensively consistent with taxonomic groupings. The proteins content varied from 2.5 to 23.9%.

Key Words: Proteins, Amino acids, Taxonomic categories, Qatari plants.

INTRODUCTION

As has been observed, certain amino acids are as a rule deficient in some proteins. In recent years and with the greater knowledge of both the values of the amino acids and "The Know How" technology of fortification, diets are supplemented by the addition of amino acids. The reasons are many but they focus on diet improvement, taste and general acceptance. It is estimated that 32,000 t/annum of L-lysine are utilized as a feed ingredient and 180,000 t/annum of D,L-methionine are produced and traded annually as synthetic.

Lysine is deficient in plant and cereal proteins, methionine is deficient in bovine, milk and meat proteins and threonine is deficient in wheat and rye proteins. Fortification by the addition of amino acids could improve bitter taste to a sweet taste as in the case of tryptophan fortification.

Equally, the plastein reaction has been utilized to improve the biological value of a protein by enabling peptide fragments of a hydrolysate to join enzymatically through peptide bonds to together form polypeptides. Further, in recent years genetic engineering played an important role in the improvement of various crops by the incorporation or by enhancing the content of essential amino acids, *e.g.*, high lysine barley, corn, etc.

Amino acids and proteins are essential building blocks for protein biosynthesis. There are 20 known amino acids in protein hydrolysate, though about 300 amino acids occur in nature[1]. These amino acids, whether polar or non-polar, charged *vs.* uncharged side chain, play an important role in the general health and well being of the living organism, whether they are plants or animals.

Quantitative and qualitative enumeration of the amino acid content of plants is an excellent means of assessing their nutritive values. Several studies have been reported on the proteins and amino acids composition of range plants[2]. So far only 2 plant species growing in Qatar *viz. Glossonema edule* and *Schanginya aegyptia* were analyzed for their amino acid composition[3, 4].

Recently, the proximate composition of 34 species growing in Qatar has been reported[5]. The present study deals with the amino acid composition of fifty-six species for their nutritional value and their potential utilization.

Sixty-eight species belonging to 56 genera and 25 families have been studied. These include Gramineae (14 genera, 17 species), Compositae (5 genera, 6 species), Fabaceae (5 genera, 5 species), Chenopodiaceae (9 genera, 10 species) and Convolvulaceae (2 genera, 5 species) (Table-1).

As can be seen certain families have a comparatively high species representation, whereas others are represented by only a single species in the flora of Qatar.

TABLE-1
FAMILIES OF FLOWERING PLANTS, WHICH POSSESSES COMPARATIVELY HIGH SPECIES REPRESENTATION IN QATAR

Family	Samples	Genera	Species
Chenopodiaceae	13	9	10
Compositae	6	5	6
Convolvulaceae	7	2	5
Fabaceae	7	5	5
Gramineae	27	14	17

EXPERIMENTAL

Ninety-two samples (wild and agricultural weeds, known as range or fodder plants) were collected at their observed best time of growth from various locations in Qatar (Table-2). These were air dried under shade, ground and analyzed. For the amino acids content the OJEC method[6] was used to determine amino acids except tyrosine by using Beckman-System 7300-high performance analyzer. For proteins, AOAC official method of analysis was performed[7], using KJCL Auto Analyzer Tecator 0100. The values obtained are calculated as percentages of the total weight (Table-3). These data were further analyzed to indicate taxonomic relationships.

TABLE-2
LIST OF STUDIED PLANTS AND THEIR LOCATIONS

Class	Species	Location
I. Aizoaceae	1. *Aizoon canariense*	Um Solal Mohammad
II. Amaranthaceae	2. *Aerva javanica*	Doha
III. Asclepiadaceae	3. *Leptadenia pyrotechnica*	Emirates Road
IV. Avicenniaceae	4. *Avicennia marina*	Thuailib
	5. *Avicennia marina*	Al-Markhya
V. Capparidaceae	6. *Capparis spinosa*	40 Km North Doha
VI. Chenopodiaceae	7. *Anabasis setifera*	Thuailib
	8. *Arthrocnemum glaucum*	Thuailib
	9. *Atriplex leucoclada*	Thuailib
	10. *Chenopodium murale*	Thuailib
	11. *Halocnemum strobilaceum*	Thuailib
	12. *Halopeplis perfoliata*	Thuailib
	13. *Haloxylon salicornicum* (*Hammada elegans*)	Al-Shahaniya
	14. *Haloxylon salicornicum* (*Hammada elegans*)	Al-Karaana
	15. *Salsola imbricata* (*S. baryosoma*)	Thuailib
	16. *Salsola imbricata* (*S. baryosoma*)	Thuailib
	17. *Suaeda aegyptiaca* (*Schanginia aegyptiaca*)	Ras Ushairij
	18. *Suaeda vermiculata*	Bu Samara
	19. *Suaeda vermiculata*	Thuailib
VII. Compositae	20. *Calendula arvensis*	Um Bab
	21. *Ifloga spicata*	Um Bab
	22. *Launaea capitata*	North Road
	23. *Launaea mucronata*	Ras Ushairij
	24. *Rhanterium epapposum*	Al-Kharrara
	25. *Sonchus oleraceous*	Thuailib
VIII. Convolvulaceae	26. *Cressa cretica*	Doha
	27. *Convolvulus arvensis*	Doha
	28. *Convolvulus deserti*	North Road
	29. *Convolvulus glomeratus*	Ras Ushairij
	30. *Convolvulus pilosellifolius*	Um Bab
	31. *Convolvulus pilosellifolius*	North Road
	32. *Convolvulus pilosellifolius*	Doha
IX. Cyperaceae	33. *Cyperus capitatus*	Al-Waab
	34. *Cyperus conglomeratus*	Al-Kharrara

Class	Species	Location
X. Fabaceae	35. *Indigofera articulata*	Um Bab
	36. *Indigofera articulata*	Musaeed
	37. *Medicago laciniata*	Musaeed
	38. *Medicago laciniata*	North Khalifa town
	39. *Melilotus indicus*	Doha (Airport Rd.)
	40. *Taverniera aegyptiaca*	Al-Zubara
	41. *Trigonella hamosa*	Al-Shahaniya
XI. Frankeniaceae	42. *Frankenia pulverulenta*	Dukhan
	43. *Frankenia pulverulenta*	Doha
XII. Geraniaceae	44. *Erodium glaucophyllum*	Al-Kharrara
XIII. Gramineae	45. *Aeluropus lagopoides*	North Road
	46. *Aeluropus lagopoides*	Thuailib
	47. *Aeluropus lagopoides*	Doha
	48. *Aeluropus lagopoides*	Un Taga
	49. *Cenchrus ciliaris*	Um Bab
	50. *Cenchrus pennisetiformis*	Doha
	51. *Chrysopogon aucheri*	Msaieed
	52. *Chrysopogon aucheri*	Al-Obara
	53. *Cymbopogon commutatus* (*C. parkeri*)	Al-Zubara
	54. *Cymbopogon commutatus* (*C. parkeri*)	North Road
	55. *Cymbopogon commutatus* (*C. parkeri*)	Msaieed
	56. *Cynodon dactylon*	Al-Shahaniya
	57. *Dactyloctenium aegyptium*	Al-Shahaniya
	58. *Echinocloa colona*	Al-Shahaniya
	59. *Lasiurus sindicus* (*L. hirsutus*)	Thuailib
	60. *Lasiurus sindicus* (*L. hirsutus*)	Al-Obara
	61. *Ochthochloa compressa* (*Eleusine compressa*)	Um Bab
	62. *Pennisetum divisum*	Al-Kharrara
	63. *Polypogon monospeliensis*	North Khalifa Town
	64. *Setaria verticilata*	Al-Shahaniya
	65. *Sporobolus ioclades* (*S. arabicus*)	Ras Laffan
	66. '*Sporobolus ioclades* (*S. arabicus*)	Thuailib
	67. *Sporobolus spicatus* (*S. obtusa*)	Al-Shahaniya
	68. *Sporobolus spicatus* (*S. obtusa*)	Al-Zubara
	69. *Stipagrostis obtusa*	Msaieed
	70. *Stipagrostis plumosa*	Thuailib

Class	Species	Location
Gramineae (*Contd.*)	71. *Stipagrostis plumosa*	Ras Ushairij
	72. *Stipagrostis spicatus*	Un Taga
XIV. Juncaceae	73. *Juncus rigidus*	Ras Ushairij
XV. Malvaceae	74. *Malva parviflora*	Doha
XVI. Mimosaceae	75. *Acacia tortilis*	Al-Shahaniya
XVII. Neuradaceae	76. *Neurada procumbens*	Um Bab
XVIII. Plantaginaceae	77. *Plantago amplexicaulis*	Al-Shahaniya
	78. *Plantago ciliata*	Um Bab
XIX. Plumbaginaceae	79. *Limonium axillare* (leaves)	Doha
	80. *Limonium axillare* (whole plant)	Fwairit
	81. *Limonium axillare* (Inflorescences)	Doha
XX. Polygonaceae	82. *Rumex dentatus*	Doha
	83. *Rumex vesicarius*	Un Solal Mohammad
XXI. Rhamnaceaea	84. *Ziziphus nummularia*	Al-Shahaniya
XXII. Solanaceae	85. *Lycium shawii*	Al-Shahaniya
XXIII. Tamariaceae	86.. *Tamarix aucheriana*	Thuailib
XXIV. Typhaceae	87. *Typha domingensis*	Al-Shahaniya
	88. *Typha domingensis*	Al-Obara
XXV. Zygophyllaceae	89. *Fagonia indica*	Fwairit
	90. *Fagonia ovalifolia*	Fwairit
	91. *Zygophyllum qatarense*	Ras Laffan
	92. *Zygophyllum qatarense*	Thuailib

RESULTS AND DISCUSSION

The study showed that variation in both amino acids and proteins exists between and within the same species collected from different locations; this is represented in the following species: *Avicennia marina*, *Haloxylon salicornicum* (*Hammada elegans*), *Salsola imbricata* (*S. barysoma*), *Suaeda vermiculata*, *Convolvulus pilosellifolius*, *Indigofera articulata*, *Medicago lacinata*, *Frankenia pulverulenta*, *Aeluropus lagopoides*, *Chrysopogon aucheri*, *Cymbopogon commutatus* (*C. parkeri*), *Lasiurus sindicus* (*L. hirsutus*), *Sporobolus oclados* (*S. arabicus*), *Sporobolus spicatus* (*S. obtusa*), *Stipagrostis plumosa*, *Typha domingensis* and *Zygophyllum qatarense* (Table-3).

The values obtained in this study were compared with those reported in literature for the same species. *Capparis spinosa* growing in Spain contained 5.8% protein[8], which is lower than the same species growing in Qatar (7.3%). *Atriplex leucoclada* was reported to contain 8.4% protein[9], which is higher than that found in the species collected from Qatar (3.9%). The protein contents of *Haloxylon salicornicum*, growing in the eastern province of Saudi Arabia (11.3%)[9] was close to that growing in Qatar (12.6%).

TABLE-3
AMINO ACIDS AND PROTEINS VALUES OF SOME QATARI RANGE PLANTS

Class	Species	Essential Amino acids									Other amino acids								Protein
		Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Asp	Ser	Glu	Pro	Gly	Ala	Cys	Tyr	
I. Aizoaceae	1. *Aizoon canariense*	0.46	0.15	0.25	0.54	0.34	0.12	0.34	0.32	0.36	0.75	0.39	0.11	0.46	0.57	0.45	0.12	0.28	9.7
II. Amaranthaceae	2. *Aerva javanica*	0.39	0.12	0.31	0.57	0.36	0.10	0.36	0.33	0.39	0.82	0.37	0.97	0.88	0.46	0.41	0.10	0.29	11.8
III. Asclepiadaceae	3. *Leptadenia pyrotechnica*	0.27	0.07	0.16	0.33	0.20	0.08	0.26	0.19	0.20	0.44	0.23	0.55	0.22	0.28	0.22	0.15	0.14	5.6
IV. Avicenniaceae	4. *Avicennia marina*	0.31	0.10	0.22	0.45	0.26	0.08	0.28	0.27	0.30	0.70	0.30	0.65	0.27	0.34	0.34	0.11	0.14	9.3
	5. *Avicennia marina*	0.48	0.14	0.37	0.78	0.26	0.15	0.45	0.43	0.51	0.93	0.44	0.99	0.44	0.54	0.53	0.10	0.23	13.8
V. Capparidaceae	6. *Capparis spinosa*	0.76	0.33	0.52	1.00	0.75	0.26	0.93	0.57	0.84	1.83	0.72	1.64	0.70	0.88	0.83	0.22	0.60	7.3
VI. Chenopodiaceae	7. *Anabasis setifera*	0.17	0.06	0.11	0.21	0.15	0.05	0.15	0.13	0.16	0.30	0.17	0.37	0.14	0.27	0.18	0.07	0.09	5.6
	8. *Arthrocnemum glaucum*	0.20	0.06	0.10	1.91	0.14	0.05	0.13	0.13	0.14	0.28	0.15	0.33	0.16	0.18	0.16	0.04	traces	5.9
	9. *Atriplex leucoclada*	0.09	0.04	0.10	0.17	0.13	0.04	0.11	0.13	0.14	0.26	0.15	0.27	0.14	0.21	0.15	0.05	0.04	3.9
	10. *Chenopodium murale*	0.09	0.24	0.36	0.66	0.49	0.17	0.45	0.37	0.43	0.91	0.44	1.41	0.41	0.66	0.46	0.20	0.25	11.9
	11. *Halocnemum strobilaceum*	0.18	0.05	0.10	0.21	0.15	0.05	0.13	0.12	0.15	0.28	0.13	0.30	0.15	0.18	0.16	0.06	0.03	5.2
	12. *Halopeplis perfoliata*	0.09	0.06	0.09	0.18	0.11	0.04	0.11	0.09	0.12	0.24	0.10	0.32	0.13	0.17	0.15	0.05	traces	4.9
	13. *Haloxylon salicornicum (Hammada elegans)*	0.55	0.24	0.42	0.76	0.60	0.14	0.48	0.38	0.57	1.30	0.48	1.10	0.39	0.48	0.56	0.35	0.34	12.6
	14. *Haloxylon salicornicum (Hammada elegans)*	0.31	0.22	0.28	0.51	0.34	0.11	0.31	0.30	0.37	0.70	0.37	0.75	0.32	0.56	0.39	0.14	traces	12.6
	15. *Salsola imbricata (S. baryosoma)*	0.17	0.07	0.15	0.29	0.19	0.04	0.19	0.18	0.23	0.41	0.21	0.48	0.18	0.30	0.23	0.06	0.08	6.1
	16. *Salsola imbricata (S. baryosoma)*	0.16	0.08	0.15	0.31	0.21	0.07	0.22	0.18	0.21	0.46	0.21	0.52	0.18	0.30	0.25	0.07	0.04	7.9
	17. *Suaeda aegyptiaca (Schanginia aegyptiaca)*	0.24	0.10	0.23	0.43	0.30	0.08	0.33	0.26	0.17	0.53	0.33	0.63	0.20	0.47	0.31	0.30	0.18	23.7

Class	Species	Essential Amino acids									Other amino acids								Protein
		Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Asp	Ser	Glu	Pro	Gly	Ala	Cys	Tyr	
	18. *Suaeda vermiculata*	0.19	0.10	0.12	0.32	0.21	0.08	0.21	0.21	0.28	0.48	0.22	0.55	0.22	0.40	0.26	0.12	0.16	10.3
	19. *Suaeda vermiculata*	0.21	0.10	0.18	0.35	0.24	0.08	0.23	0.22	0.25	0.50	0.25	0.58	0.24	0.36	0.27	0.04	0.09	9.6
VII. Compositae	20. *Calendula arvensis*	0.67	0.27	0.49	1.00	0.74	0.27	0.81	0.58	0.69	1.21	0.68	1.75	0.68	0.78	0.74	0.17	0.52	12.9
	21. *Ifloga spicata*	0.36	0.17	0.34	0.64	0.44	0.19	0.39	0.40	0.46	1.08	0.43	1.13	0.54	0.49	0.47	0.11	0.30	9.5
	22. *Launaea capitata*	0.39	0.22	0.31	0.58	0.43	0.08	0.38	0.29	0.42	1.25	0.39	1.26	0.68	0.55	0.47	0.18	0.43	12.4
	23. *Launaea mucronata*	0.18	0.07	0.17	0.30	0.16	0.08	0.18	0.18	0.24	0.44	0.20	0.48	0.28	0.25	0.23	0.06	0.13	5.6
	24. *Rhanterium epapposum*	0.11	0.06	0.15	0.27	0.15	0.04	0.17	0.16	0.19	0.35	0.18	0.39	0.22	0.22	0.20	0.06	0.15	4.4
	25. *Sonchus oleraceous*	0.48	0.18	0.30	0.54	0.41	0.11	0.42	0.34	0.43	1.54	0.41	1.27	0.56	0.41	0.40	0.09	0.19	5.6
VIII. Convolvulaceae	26. *Cressa cretica*	0.29	0.10	0.23	0.44	0.31	0.10	0.29	0.23	0.28	0.59	0.24	0.61	0.26	0.34	0.33	0.15	0.08	7.9
	27. *Convolvulus arvensis*	0.84	0.34	0.63	1.20	0.84	0.27	0.87	0.73	0.92	3.78	0.75	1.80	0.69	0.85	0.85	0.19	0.61	22.6
	28. *Convolvulus deserti*	0.28	0.16	0.30	0.54	0.32	0.15	0.34	0.32	0.38	0.76	0.34	0.78	0.30	0.38	0.37	0.08	0.26	7.0
	29. *Convolvulus glomeratus*	0.27	0.11	0.24	0.47	0.27	0.10	0.30	0.25	0.30	0.80	0.30	0.75	0.30	0.37	0.35	0.10	0.24	8.2
	30. *Convolvulus pilosellifolius*	0.37	0.14	0.29	0.55	0.40	0.14	0.37	0.33	0.37	1.11	0.35	0.92	0.31	0.41	0.40	0.14	0.27	8.4
	31. *Convolvulus pilosellifolius*	0.34	0.13	0.27	0.55	0.37	0.14	0.42	0.32	0.36	0.81	0.40	0.81	0.34	0.42	0.41	0.10	0.26	9.9
	32. *Convolvulus pilosellifolius*	0.40	0.16	0.36	0.67	0.45	0.18	0.43	0.41	0.50	1.28	0.43	1.02	0.41	0.53	0.50	0.10	0.38	10.7
IX. Cyperaceae	33. *Cyperus capitatus*	0.23	0.10	0.22	0.44	0.25	0.10	0.28	0.28	0.28	1.15	0.33	0.34	0.26	0.29	0.35	0.08	0.17	7.4
	34. *Cyperus conglomeratus*	0.05	0.02	0.05	0.09	0.05	0.02	0.06	0.06	0.06	0.34	0.06	0.15	0.06	0.07	0.08	0.02	0.04	2.5
X. Fabaceae	35. *Indigofera articulata*	0.12	0.06	0.06	0.21	0.18	0.04	0.14	0.16	0.18	0.38	0.18	0.33	0.22	0.18	0.18	0.04	0.08	4.2
	36. *Indigofera articulata*	0.38	0.18	0.37	0.73	0.53	0.10	0.46	0.36	0.45	1.32	0.42	1.00	0.60	0.48	0.50	0.15	0.34	10.6

Class	Species	Essential Amino acids									Other amino acids							Protein
		Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Asp	Ser	Glu	Pro	Gly	Ala	Cys	Tyr	
	37. *Medicago laciniata*	1.00	0.41	0.71	1.27	1.01	0.24	0.84	0.72	0.92	1.92	0.76	1.98	0.10	0.96	0.90	0.33	0.57	19.6
	38. *Medicago laciniata*	0.10	0.35	0.66	1.14	0.92	0.22	0.81	0.64	0.92	2.90	0.70	1.90	1.07	0.77	0.83	0.33	0.56	20.0
	39. *Melilotus indicus*	1.06	0.38	0.89	1.63	1.21	0.33	0.21	0.83	0.21	2.20	0.74	2.63	1.00	1.06	1.28	0.46	0.74	23.4
	40. *Taverniera aegyptiaca*	0.23	0.12	0.15	0.29	0.37	0.10	0.30	0.19	0.27	1.64	0.27	0.70	0.54	0.24	0.31	0.10	0.74	9.1
	41. *Trigonellc hamosa*	0.90	0.35	0.50	0.86	0.70	0.20	0.71	0.54	0.57	3.14	0.72	1.40	0.16	0.72	0.67	0.21	0.44	18.8
XI. Frankeniaceae	42. *Frankenia pulverulenta*	0.33	0.12	0.33	0.60	0.35	0.17	0.36	0.31	0.43	0.91	0.30	0.78	0.63	0.41	0.40	0.15	0.24	9.0
	43. *Frankenia pulverulenta*	0.35	0.27	0.40	0.68	0.53	0.10	0.52	0.39	0.65	1.01	0.50	3.03	2.13	0.52	0.53	0.12	0.33	14.0
XII. Geraniaceae	44. *Erodium glaucophyllum*	0.8	0.21	0.28	0.52	0.34	0.09	0.35	0.28	0.34	1.00	0.34	1.32	0.44	0.47	0.40	0.11	0.23	13.2
XIII. Gramineae	45. *Aeluropus lagopoides*	1.00	0.24	0.32	0.60	0.54	0.11	0.38	0.34	0.40	1.30	0.50	1.50	0.50	0.60	0.42	0.17	0.36	8.9
	46. *Aeluropus lagopoides*	0.18	0.05	0.11	0.25	0.15	0.06	0.17	0.12	0.18	0.41	0.11	0.42	0.24	0.22	0.24	0.10	0.09	4.5
	47. *Aeluropus lagopoides*	0.21	0.15	0.22	0.44	0.26	0.10	nd	0.25	0.30	0.71	0.29	0.74	0.35	0.36	0.40	0.10	traces	8.0
	48. *Aeluropus lagopoides*	0.32	0.09	0.27	0.54	0.25	0.11	0.33	0.28	0.38	0.88	0.31	0.82	0.45	0.40	0.45	0.12	0.16	8.9
	49. *Cenchrus ciliaris*	0.28	0.12	0.23	0.44	0.33	0.07	0.27	0.22	0.27	0.78	0.28	0.85	0.33	0.31	0.34	0.09	0.20	7.5
	50. *Cenchrus pennisetiformis*	0.38	0.15	0.27	0.55	0.39	0.14	0.42	0.33	0.40	1.71	0.44	1.18	0.41	0.41	0.52	0.21	0.24	13.1
	51. *Chrysopogon aucheri*	0.29	0.10	0.20	0.40	0.26	0.09	0.27	0.26	0.28	1.02	0.35	0.80	0.34	0.29	0.39	0.08	0.19	8.7
	52. *Chrysopogon aucheri*	0.21	0.08	0.19	0.44	0.20	0.10	0.22	0.20	0.26	0.57	0.24	0.85	0.50	0.24	0.33	0.06	0.15	6.2
	53. *Cymbopogon commutatus* (*C. parkeri*)	0.29	0.15	0.22	0.41	0.33	0.10	0.28	0.23	0.38	0.62	0.30	0.66	nd	0.47	0.34	0.13	0.30	14.4
	54. *Cymbopogon commutatus* (*C. parkeri*)	0.13	0.05	0.11	0.25	0.11	0.05	0.13	0.13	0.16	0.32	0.15	0.38	0.31	0.15	0.21	0.03	0.08	4.1
	55. *Cymbopogon commutatus* (*C. parkeri*)	0.20	0.06	0.14	0.28	0.20	0.06	0.20	0.17	0.19	0.57	0.19	0.45	0.21	0.20	0.26	0.07	0.11	5.1

Class	Species	Essential Amino acids									Other amino acids								Protein
		Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Asp	Ser	Glu	Pro	Gly	Ala	Cys	Tyr	
	56. *Cynodon dactylon*	0.44	0.17	0.40	0.71	0.46	0.21	0.60	0.41	0.59	2.49	0.50	1.10	0.48	0.48	0.61	0.12	0.30	12.9
	57. *Dactyloctenium aegyptium*	0.18	0.09	0.07	0.33	0.18	0.10	0.24	0.17	0.28	0.71	0.20	0.73	0.40	0.22	0.33	0.12	0.08	5.6
	58. *Echinocloa colona*	0.43	0.19	0.31	0.58	0.43	0.15	0.50	0.42	0.50	1.94	0.49	1.25	0.80	0.42	0.53	0.13	0.23	13.4
	59. *Lasiurus sindicus* (*L. hirsutus*)	0.12	0.08	0.10	0.22	0.16	0.06	0.17	0.15	0.16	0.62	0.17	0.40	0.18	0.16	0.20	0.05	0.09	5.1
	60. *Lasiurus sindicus* (*L. hirsutus*)	0.22	0.08	0.19	0.48	0.20	0.09	0.24	0.22	0.26	0.47	0.24	0.37	0.31	0.25	0.38	0.06	0.12	5.9
	61. *Ochthochloa compressa* (*Eleusine compressa*)	0.24	0.10	0.19	0.37	0.28	0.14	0.24	0.23	0.29	1.26	0.30	0.66	0.45	0.32	0.37	0.18	0.17	8.4
	62. *Pennisetum divisum*	0.18	0.06	0.16	0.33	0.16	0.09	0.19	0.19	0.22	0.46	0.22	0.52	0.24	0.23	0.28	0.05	0.13	5.3
	63. *Polypogon monospeliensis*	0.41	0.14	0.30	0.26	0.44	0.14	0.41	0.33	0.40	0.76	0.35	1.05	0.48	0.44	0.52	0.14	0.22	8.1
	64. *Setaria verticillata*	0.63	0.20	0.33	1.00	0.62	0.21	0.68	0.55	0.75	2.41	0.71	1.38	0.67	0.68	0.86	0.20	0.42	16.9
	65. *Sporobolus ioclades* (*S. arabicus*)	0.17	0.07	0.12	0.28	0.18	0.06	0.16	0.16	0.17	0.57	0.18	0.55	0.34	0.22	0.26	0.10	0.09	4.5
	66. *Sporobolus ioclades* (*S. arabicus*)	0.09	0.03	0.07	0.15	0.10	0.03	0.09	0.10	0.10	0.26	0.12	0.25	0.20	0.14	0.15	0.05	0.03	3.6
	67. *Sporobolus spicatus* (*S. obtusa*)	0.25	0.12	0.21	0.38	0.28	0.10	0.26	0.26	0.32	1.33	0.30	0.65	0.51	0.32	0.37	0.14	0.15	9.3
	68. *Sporobolus spicatus* (*S. obtusa*)	0.23	0.13	0.17	0.35	0.23	0.10	0.40	0.20	0.24	2.26	0.25	0.76	0.28	0.26	0.31	0.10	0.16	10.4
	69. *Stipagrostis obtusa*	0.32	0.14	0.32	0.75	0.35	0.23	0.39	0.36	0.45	1.16	0.44	1.37	0.52	0.40	0.55	0.09	0.27	9.3
	70. *Stipagrostis plumosa*	0.21	0.10	0.23	0.54	0.23	0.18	0.27	0.26	0.32	0.71	0.25	0.83	0.42	0.30	0.41	0.09	0.19	7.1
	71. *Stipagrostis plumosa*	0.34	0.12	0.10	0.37	0.30	0.09	0.26	0.25	0.31	0.63	0.33	0.93	1.05	0.34	0.32	0.12	0.18	8.1
	72. *Stipagrostis plumosa*	0.35	0.13	0.28	0.55	0.37	0.13	0.34	0.33	0.38	1.73	0.44	0.92	0.34	0.36	0.45	0.09	0.23	9.9
XIV. Juncaceae	73. *Juncus rigidus*	0.14	0.06	0.17	0.32	0.15	0.10	0.19	0.18	0.21	0.41	0.17	0.44	0.30	0.23	0.24	0.15	0.13	4.2
XV. Malvaceae	74. *Malva parviflora*	0.93	0.34	0.61	1.20	0.89	0.27	0.83	0.62	0.85	3.84	0.58	1.93	1.22	0.81	0.87	0.47	0.48	22.9

Class	Species	Essential Amino acids									Other amino acids								Protein
		Arg	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Asp	Ser	Glu	Pro	Gly	Ala	Cys	Tyr	
XVI. Mimosaceae	75. *Acacia tortilis*	0.44	0.16	0.39	0.69	0.55	0.14	0.49	0.45	0.48	1.06	0.45	1.00	0.53	0.48	0.48	0.17	0.31	12.8
XVII. Neuradaceae	76. *Neurada procumbens*	0.50	0.24	0.41	0.70	0.50	0.19	0.50	0.34	0.48	2.16	0.43	1.46	1.24	0.53	0.54	0.25	0.32	14.5
XVIII. Plantaginaceae	77. *Plantago amplexicaulis*	0.44	0.16	0.33	0.58	0.34	0.17	0.36	0.35	0.44	0.80	0.38	1.21	0.33	0.47	0.45	0.12	0.25	8.6
	78. *Plantago ciliata*	0.50	0.20	0.36	0.65	0.45	0.20	0.60	0.41	0.48	1.41	0.42	1.35	0.42	0.47	0.50	0.21	0.30	10.1
XIX. Plumbaginaceae	79. *Limonium axillare* (leaves)	0.13	0.10	0.11	0.20	0.16	0.06	0.13	0.13	0.15	0.27	0.15	0.34	0.30	0.31	0.16	0.05	0.08	5.4
	80. *Limonium axillare* (whole plant)	0.19	0.08	0.15	0.29	0.20	0.08	0.17	0.17	0.19	0.34	0.20	0.43	0.24	0.31	0.21	0.11	0.15	5.3
	81. *Limonium axillare* (Inflorescences)	0.32	0.15	0.23	0.43	0.31	0.12	0.28	0.25	0.29	0.58	0.31	0.74	0.34	0.41	0.30	0.09	0.22	8.4
XX. Polygonaceae	82. *Rumex dentatus*	1.05	0.47	0.61	1.19	0.92	0.30	1.01	0.68	0.92	1.58	0.76	3.75	1.16	0.83	0.92	0.22	0.63	23.9
	83. *Rumex vesicarius*	0.38	0.15	0.26	0.50	0.28	0.12	0.32	0.24	0.35	0.59	0.27	0.99	0.31	0.39	0.37	0.19	0.12	9.1
XXI. Rhamnaceaea	84. *Ziziphus nummularia*	0.40	0.16	0.40	0.69	0.42	0.16	0.42	0.38	0.53	1.05	0.37	1.27	0.41	0.45	0.49	0.12	0.28	9.6
XXII. Solanaceae	85. *Lycium shawii*	0.38	0.14	0.29	0.53	0.39	0.10	0.35	0.28	0.35	1.10	0.33	0.71	0.21	0.35	0.37	0.18	0.25	9.9
XXIII. Tamariaceae	86. *Tamarix aucheriana*	0.41	0.11	0.19	0.39	0.29	0.09	0.23	0.22	0.26	0.47	0.24	0.54	0.34	0.30	0.29	0.08	0.16	6.9
XXIV. Typhaceae	87. *Typha domingensis*	0.45	0.16	0.36	0.63	0.50	0.18	0.06	0.39	0.51	1.64	0.36	1.31	0.34	0.56	0.51	0.26	traces	14.1
	88. *Typha domingensis*	0.17	0.06	0.16	0.33	0.15	0.07	0.20	0.16	0.20	0.44	0.17	0.59	0.19	0.24	0.25	0.10	0.11	5.2
XXV. Zygophyllaceae	89. *Fagonia indica*	0.54	0.20	0.41	0.77	0.52	0.20	0.50	0.38	0.50	1.11	0.40	1.30	0.55	0.61	0.57	0.30	0.41	11.3
	90. *Fagonia ovalifolia*	0.45	0.14	0.30	0.53	0.37	0.91	0.35	0.30	0.35	0.77	0.33	0.90	0.44	0.47	0.40	0.14	0.32	8.4
	91. *Zygophyllum qatarense*	0.30	0.10	0.14	0.30	0.21	0.07	0.22	0.15	0.20	0.60	0.16	0.82	0.26	0.27	0.26	0.13	0.15	6.2
	92. *Zygophyllum qatarense*	0.26	0.10	0.15	0.32	0.22	0.08	0.25	0.15	0.23	0.60	0.19	0.75	0.45	0.28	0.27	0.14	0.15	6.3

As regards the Compositae species, the protein of *Rhanterium epapposum* growing in Qatar (4.4%) is within the range of that reported for the species collected from the eastern province of Saudi Arabia[9]. However, in the Gramineae, *Cynodon dactylon* (Bermuda grass) growing in Qatar contained 12.9% protein, which is much higher than that reported for the same species studied from lower and Upper Bermuda (4.25 and 6.16%)[10] and is also higher than the Venezuelan species (4.7%)[11] and the Brazilian one too (8.8%)[12].

Table-4 shows a comparison of the amino acids of *Cynodon dactylon* growing in Qatar as compared to that growing in Australia[13].

TABLE-4
COMPARISON OF THE AMINO ACIDS OF CYNODON DACTYLON

Amino acids	Qatar*	Australia*	Amino acids	Qatar*	Australia*
Thr	3.18	5.3	Ile	3.10	3.6
Ser	3.88	5.6	Leu	5.50	9.3
Gly	3.72	5.4	Try	2.32	4.5
Ala	4.73	7.8	Phe	4.65	5.6
Cys	0.93	1.0	His	1.32	2.0
Val	4.57	4.6	Arg	3.41	3.9
Met	1.63	1.7			

*Per cent of total protein.

The following amino acids were reported in the leaves of *Echinocloa colona* growing in India: Gly (0.01%), Ala (0.01%), Thr (0.5%) and Leu (0.18%)[14]; whereas their percentages in the whole plant of the species growing in Qatar are: (0.42, 0.53, 0.42 and 0.58%) respectively, which indicated that the Qatar species is more nutritional. The protein content of *Lasiurus sindicus* growing in Pakistan was reported to be (6.3–8.7%)[15], which is higher than the values reported for the same species in Qatar (5.1–5.9%). Similarly, the protein content reported for *Pennisetum divisum* from the eastern province of Saudi Arabia (7.4%)[9] was higher than that found for the one growing in Qatar (5.3%). The protein value reported for *Stipagrostis plumosa* growing in the eastern province of Saudi Arabia (7.3%)[9] falls within the range found in the three specimens studied in Qatar (7.1, 8.1 and 9.9%).

Analysis of taxa within each family was focused on selected features within their representatives. In general, tribal and sub-tribal classification is known for all studied species. However, the species were sub- divided according to whether they are grasses on non-saline sandy soils (wild), common agricultural weeds (or on irrigated land) or grasses of salt flats. In the Chenopodiaceae, the species were split into three categories: halophytes, xerophytes or weeds. In the Fabaceae, the species were grouped according to their known tribal classification. In the Compositae, the largest family is represented in the flora of Qatar by a number of agricultural weeds and some common wild plants. Composites form two natural groups distinguished by the composition of their inflorescence head. The genera *Launaea* and *Sonchus* have heads of ray florets; *Ifloga* has head of disc florets only, whereas the genera *Calendula* and *Rhanterium* have heads of both ray and disc florets. Except for *Rhanterium*, a perennial, all other genera in this study are annual.

In general, for all the species analyzed, the highest protein value for the dicotyledonous species (> 20%) in *Rumex dentatus* (23.9%), *Suaeda aegyptiaca* (23.7%), *Melilotus indicus* (23.4%), *Convolvulus arvensis* (22.6%) and *Medicago laciniata* (20.0%), (Table-3). In the monocotyledons, the grass *Setaria verticilata* had a value of 16.9% followed by the reed *Typha domingensis* with 14.1%.

As can be seen, the high protein values are not family-specific but were demonstrated over a wide range of unrelated families. One character links all these taxa and that is their habitat since all occurred in soils rich in organic matter (fields).

According to Yeoh and Watson[16], the nutritional status of the protein in grains of non-cereal growing in arid regions is considered as better compared to cereal crops. Of the studied species of the Gramineae five are common weeds, five are common desert grasses and two are known salt flat plants (salt-tolerant species). Table-5 gives the average protein values of monocots studied species.

TABLE-5
AVERAGE PROTEIN VALUES OF MONOCOTYLEDONES SPECIES
(GRASSES AS COMPARED TO SEDGES AND REEDS

Agricultural weeds	Protein value	Wild (desert/arid) species	Protein value	Salt flats	Protein value	Monocot sledges and reeds	Protein value
Cynodon	12.9	*Cymbopogon*	7.83	*Aeluropus*	7.57	*Cyperus* *(Sledge)*	4.95
Dactylo ctenium	5.6	Lasiurus	5.50	*Sporobolus ioclada*	4.05	*Juncus* *(Reed)*	4.2
Echinocloa	13.4	*Stipagrostis* *(Annual)*	8.60			*Typha* *(Reed)*	9.85
Polypogon	8.1	*Pennisetum*	5.3				
Setaria	16.9						

The protein values of the grasses from rich soils were comparatively of higher percentage for all: least 5.6%, average 11.8% and highest protein content 16.9% as compared with 7.1, 6.81 and 8.60% for grasses of sandy soils. The least value was 3.6%, average 5.81% and the highest 8.9%; as compared to reeds and sedges (minimum 2.5%, average 6.27% and maximum 14.1%).

The Chenopodiaceae are quite common in Qatar since the 563 km of its coastline is a typical saline coastline supporting halophytic vegetation (salt-tolerant species). The studied species of Chenopodiaceae fall into 3 main categories (Table-6).

TABLE-6
PROTEIN VALUES OF DIFFERENT CATEGORIES OF THE CHENOPODIACEAE

Salt tollerant	Protein	Desert xerophytes	Protein	Weed species	Protein
Arthrocnemum glaucum	5.9	*Anabasis setifera*	5.6	*Chenopodium murale*	11.9
Halocnemum strobilaceum	5.2	Atriplex leucoclada	3.9		
Halopeplis perfoliata	4.9	*Haloxylon salicornicum (Hammada elegans)*	12.6		
Suaeda aegyptiaca	23.7	*Salsola imbricata*	6.1–7.9		
Suaeda vermiculata	9.6–10.3				

It is apparent from Table-6 that the genus *Suaeda* has higher protein values as compared to other studied genera. *Suaeda* are shrubby species with succulent leafy shoots, whereas *Arthrocenmum*, *Halocnemum*, *Halopeplis*, with protein value of 4.9–5.9, are all succulent with rudimentary leaves.

The data obtained were compared to world's recognized standards (fish protein concentrate, soya protein isolate and whole egg g/100g protein edible proteins). The values obtained in some cases exceeded the standards while in others they equated to them or fell below them (Table-7).

TABLE-7
COMPARISON OF WORLD STANDARDS PROTEIN WITH GRAMINEAE, CHENOPODS, COMPOSITES, LEGMES AND CONVOLVES FROM QATAR

Amino acids	Standards[17]			Range of grasses				
	Fish protein concen-trate	Soya protein isolate	Whole egg g/100 g protein edible	Grami-neae	Cheno-pods	Compo-sites	Legmes	Con-volves
Arg	7.05	7.45	0.84	0.30	0.18	0.36	0.53	0.40
His	2.31	2.66	0.31	0.11	0.95	0.16	0.26	0.16
Ile	5.44	5.20	0.85	0.21	0.16	0.29	0.48	0.33
Leu	8.79	6.73	1.13	0.44	0.42	0.56	0.88	0.63
Lys	10.68	5.81	0.68	0.30	0.22	0.39	0.70	0.42
Thr	4.94	3.58	0.51	0.26	0.18	0.33	0.50	0.37
Val	5.88	4.97	0.95	0.32	0.21	0.41	0.52	0.44
Met	2.80	1.25	0.40	0.08	0.06	0.13	0.18	0.15
Cys	0.91	1.78	0.30	0.11	0.20	0.11	0.23	0.12
Phe	4.30	4.29	0.74	0.29	0.20	0.39	0.50	0.43

Amino acids	Standards[17]			Range of grasses				
	Fish protein concentrate	Soya protein isolate	Whole egg g/100 g protein edible	Gramineae	Chenopods	Composites	Legmes	Convolves
Tyr	3.94	3.34	0.55	0.18	0.08	0.29	0.58	0.30
Ala	6.27	4.08	0.71	0.39	0.20	0.42	0.67	0.46
Asp	11.13	11.51	1.20	0.94	0.44	0.98	1.93	0.82
Glu	17.14	16.94	1.58	0.80	0.51	1.04	1.42	0.96
Gly	4.42	4.88	0.45	0.39	0.30	0.45	0.63	0.64
Pro	3.80	6.27	0.54	0.48	0.19	0.49	0.53	0.37
Ser	4.59	5.45	0.92	0.31	0.22	0.38	0.54	0.40

Amino acid weight % composition standards as compared to 5 families of Qatar Range plants.

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