Asian Journal of Chemistry; Vol. 30, No. 3 (2018), 529-532

ASIAN JOURNAL OF CHEMISTRY

https://doi.org/10.14233/ajchem.2018.20940

Chemical Composition of Three Nitraria Species Fruits

YUAN-YUAN YUAN[1,2], JING SUN[1], YU-BI ZHOU[1], JIE WANG[1,2], JUAN DENG[1,2], RUN-RONG YE[1], MIN PENG[1] and XUE-FENG LU[1,*]

[1]Qinghai Key Laboratory of Qinghai-Tibet Plateau Biological Resources, Northwest Institute of Plateau Biology, Chinese Academy of Sciences, Xining 810008, Qinghai Province, P.R. China
[2]Graduate University of Chinese Academy of Sciences, Beijing 100049, P.R. China

*Corresponding author: Tel/Fax: +82 971 6143282; E-mail: LXF@nwipb.cas.cn

Received: 24 July 2017; *Accepted*: 18 October 2017; *Published online*: 31 January 2018; AJC-18737

In this study, the chemical compositions of fruits *Nitraria roborowskii* Kom., *Nitraria sibirica* Pall., *Nitraria tangutorum* Bobr. were investigated. The highest total flavonoids content were observed in *Nitraria sibirica*, which had the highest crude protein content (6.60 %), followed by *Nitraria tangutorum* (3.07%) and *Nitraria roborowskii* (2.65 %). The total sugar content of Nitraria species varied between 4.66 % and 5.31 %, total fat between 0.143 and 0.537 %, pH 3.81 and 4.29, respectively. Mineral compositions of the Nitraria species were 4530.2 mg/g Na, 3778.9 mg/g K, 681.0 mg/g Ca, 349.0 mg/g Mg, 301.8 mg/g P, 25.2 mg/g Fe, 4.3mg/g B, 2.6 mg/g Sr, 1.1 mg/g Co and 0.6 mg/g Cr.

Keywords: Nitraria species, *Nitraria roborowskii* Kom., *Nitraria sibirica* Pall., *Nitraria tangutorum* Bobr., Chemical composition.

INTRODUCTION

The Nitraria belongs to genus Nitraria L. of the family Zygophyllaceae. The genus has 11 species distributed in Asia, Europe, Africa and Australia. China has six species including *Nitraria roborowskii* Kom., *Nitraria sibirica* Pall., *Nitraria tangutorum* Bobr. *etc*., which are widely spread through north-west regions, mainly in Gansu, Inner Mongolia and other places [1-4]. These plants are important populations for the endangered desert vegetation which played a key role in improving the ecological environment [5,6].

The fruits of Nitraria genus (*Nitrariaceae*) are desert rare wild fruit, tatse sweet and sour, and their foliage is usually to feed the livestock. On the other hand, it has also been effectively used in folklore medicines to treat disease including indigestion, neurasthenia, stomach, fever and cold [7-9]. In addition, the products of Nitraria fruits have played an essential role in the local soft drink market. The fresh fruits could be eaten directly or used to produce marmalades, juices, vinegar, liquors and flavour food which are popular in the north-west of China [10-12].

Nitraria Tangutorum Bobr. grows only in China, whose fruits are rich in amino acids, vitamins and mineral elements [13-16]. Meanwhile, *N. sibirica* and *N. roborowskii* also contains various kinds of flavonoids, anthocyanins, crude proteins, sugars, *etc*. [17-19]. Thus, it shows the fruits of Nitraria specis are of great value for human health due to the content of flavonoids, sugar and minerals.

A detailed research in the composition analysis of fatty acids, alkaloids and flavonoids were conducted [20-24]. However, there are rather few study focused on the content of total sugar, total flavonoids and mineral elements in *Nitraria roborowskii*. In this paper, the comparative studies on the chemical composition of Nitraria species, namely *Nitraria roborowskii*, *Nitraria sibirica* and *N. tangutorum*, which grown under the different ecological conditions, has been employed to fulfill the aim of variability in chemical characteristics of Nitraria species.

EXPERIMENTAL

Collection and preparation of Nitraria fruit samples: Nitraria fruits were collected in Gansu and Inner Mongolia, China in 2014. All the berries were picked at the commercially ripe stage between July and August. The berries were selected according to uniformity of shape and colour. Then the fruits were juiced and separated the seed and sarcocarps, then stored in bottles at -20 ºC for further analyses. Three replicates were used per analysis.

Fruit weight was measured by using a digital balance with a sensitivity of 0.001 g (Scaltec SPB31). The pH were measured with a digital pH meter (WTW Inolab Level 1, Germany) calibrated with pH 3 and 5 buffer. The crude protein were determined according to the methods of National Standards of People's Republic of China (GB1994) [25].

The levels of total sugar and total fat were determined according to the methods of National standards of People's Republic of China (GB1994) [26]. Total flavonoid contents of Nitraria fruits were determined using modified aluminum chloride colorimetric method as described by Liu *et al*. [27], with some modifications. An aliquot (2.0 mL) of extracts and standard solution of rutin (10, 20, 30, 50, 60, 70, 80 and 100 mg/L) was added to 10 mL volumetric flasks containing 4 mL of deionized water followed by the addition of 5 % $NaNO_2$ (1.0 mL) to the flask. After 5 min, 10 % $AlCl_3$ (1.0 mL) was added. At 6th min, 1 mL of 10 % NaOH was added and the total volume was made upto 10 mL with deionized water. The solution was mixed well and the absorbance was measured against prepared blank solution at 510 nm. The results were carried out in triplicate.

Determination of mineral contents: The modified literature methods [28] were employed to determinate the mineral contents. About 0.5 g of weighed sample was placed in a PTFE digestion vessel, then 8 mL of HNO_3 were added and left to stand for about 2 h, before the vessel was sealed. Sample dissolution was carried out in a microwave digestion system. The digest was transferred to a volumetric flask (50 mL) and made up to the mark with deionized water. Blank experiments (n = 3) were performed in the same way as for samples.The absorbance of the extract was measured by inductively coupled plasma optical emission spectrometer (ICP-OES). The amounts of minerals were calculated with a standard curve of each element.

Statistical analysis: The experiment was a completely randomized design with three replications. All statistical calculations were performed by SPSS 18.0 software package for Windows (SPSS Inc., Chicago, IL, USA). The studies of significant differences were carried out by T-test with significant p-level below 0.05.

RESULTS AND DISCUSSION

The juice yield, crude protein and pH of Nitraria species are given in Table-1, where statistical differences in the amounts of these components, both within three Nitraria species can also be interpreted. Fruit juice yield of Nitraria species was found to be in the range from 73.9 to 44.1 %. The average crude protein of Nitraria species ranged between 2.65 % (*N. tangutorum*) and 6.60 % (*N. sibirica*). The pH were ranged between 4.17 (*N. roborowskii*) and 4.29 (*N. tangutorum*); juice yield ranged are found to be in between 44.1 % (*N. roborowskii*) and 73.9 % (*N. tangutorum*). Due to higher juice yield, *N. tangutorum* fruits may be recommended for processing used as fresh fruit production.

TABLE-1
FRUIT WEIGHT, COLOUR, FRUIT JUICE YIELD, pH OF NITRARIA SPECIES

Species	Samples	Crude protein (%)	pH	Juice yield (%)
N. tangutorum	K1	2.65	4.29	73.9
N. sibirica	S1	4.69	4.41	64.5
	S2	13.94	4.40	30.0
	S3	3.44	4.21	52.9
	S4	4.32	3.64	50.2
Mean value		6.60a	4.17a	49.4a
N. roborowskii	R1	2.33	3.64	16.40
	R2	2.91	3.75	60.50
	R3	2.70	3.91	42.70
	R4	4.41	4.10	43.50
	R5	3.12	4.02	57.23
	R6	2.96	3.45	44.10
Mean value		3.07a	3.81a	44.10a

Values in the same column with different lower case letters are significantly different at $p < 0.05$.

The pH of *N. sibirica* and *N. Tangutorum* were found to be 1.19-2.76 [29]. Present pH results in general were within the limits of these studies. Previous studies had shown that different regions crude protein in *N. sibirica* and *N. tangutorum* was between 1.86 and 2.07 % [30], respectively, which is lower than present results.

Total flavonoid, total sugar and total fat contents in Nitraria fruits: The total sugar, total flavonoid and total fat contents of Nitraria species are shown in Table-2. The total flavonoid content of Nitraria species were found to range from 0.07 % (*N. Tangutorum*) to 0.49 % (*N. sibirica*). The total sugar contents of Nitraria species were between 4.66 (*N. Tangutorum*) and 5.31 % (*N. roborowskii*), while *N. sibirica* had the highest content of total fat (0.537 %), followed by *N. roborowskii* (0.172 %) and *N. tangutorum* (0.143 %).

TABLE-2
TOTAL SUGAR, TOTAL FLAVONOID AND TOTAL FAT OF NITRARIA SPECIES

Species	Samples	Total flavonoid (%)	Total sugar (%)	Total fat (%)
N. tangutorum	K1	0.072	4.66	0.143
N. sibirica	S1	0.300	4.18	0.598
	S2	0.910	1.88	0.892
	S3	0.180	7.50	0.443
	S4	0.540	6.29	0.213
Mean value		0.480a	4.96a	0.537a
N. roborowskii	R1	0.21	7.35	0.132
	R2	0.28	6.60	0.121
	R3	0.71	6.56	0.149
	R4	0.14	3.12	0.142
	R5	0.62	2.96	0.411
	R6	0.33	5.27	0.074
Mean value		0.38a	5.31a	0.172b

Shu *et al*. [30] reported that the content of total flavonoid in stems, leaves, flowers of *N. roborowskii* were 0.66, 1.24 and 1.43 %, respectively. The total content of flavonoid of *N. tangutorum* in stems was 1.444 % while in leaves 4.243 % [31]. However, present results of the total flavonoid contents of Nitraria species fruits juices are found to be lower than the reported literatures [31]. The total sugar contents of Nitraria species were found to be lower as compared to Nitraria of Qinghai origin (6.81-7.06 %). A higher total fat range (3.86-4.12 %) was reported previously [32]. The overall results showed that the fruit could be a potential source of sugar, flavonoid and total fat. The results are in good agreement with the reported literature [33,34].

Mineral elements: Differences among the Nitraria species are observed based on the mineral compositions (Table-3). So far, the mineral elements content of *N. roborowskii* was determined for the first time. In this study, 10 elements were determined in all Nitraria species, Na was predominant, followed by K, Ca, Mg, P, Fe, B, Sr, Cr and Co. It was previously showed that

TABLE-3
CONTENTS OF MINERAL ELEMENTS PRESENT IN DIFFERENT NITRARIA SPECIES

Species	Samples	Na	B	Fe	Mg	P	Co	Cr	Sr	K	Ca
N. tangutorum	K1	2042.3	1.4	4.6	372.0	176.6	0.3	0.5	3.0	2108.0	846.8
N. sibirica	S1	5158.4	10.8	15.7	667.1	484.6	0.3	0.6	7.3	3736.5	1459.5
	S2	10819.6	8.3	41.7	646.9	936.7	0.3	0.7	4.5	5111.5	876.9
	S3	5743.7	9.6	52.0	447.3	294.5	0.2	1.2	3.4	3928.3	838.6
	S4	6616.4	3.0	46.8	178.7	222.4	0.2	0.7	1.4	4254.6	487.7
Mean value		7084.5a	7.9a	39.0a	485.0a	484.6a	0.2a	0.8a	4.2a	4257.7a	915.7a
N. roborowskii	R1	3210.6	2.5	37.3	434.5	199.6	0.3	0.8	4.3	2447.1	683.7
	R2	1791.1	2.6	6.3	200.9	255.1	0.2	0.5	1.0	4033.6	358.5
	R3	3478.0	2.6	26.6	177.5	240.7	9.8	0.4	0.1	3894.4	587.5
	R4	5227.3	2.0	12.1	297.8	178.1	0.5	0.2	2.5	3727.2	755.1
	R5	2514.2	2.2	14.0	255.1	158.5	0.2	0.5	0.7	3965.5	317.2
	R6	3230.2	2.2	19.9	160.9	172.4	0.2	0.6	0.5	4361.5	280.0
Mean value		3241.9b	2.3b	19.4b	254.4a	200.7a	1.9a	0.5a	1.5a	3738.2a	497.0a

Values in the same column with different lower case letters are significantly different at $p < 0.05$.

the mineral composition of fruits influenced, not only on the species or varieties, but also on the growing environment, such as soil, climate and geographical conditions [35].

The concentrations of Na, B and Fe in fruits of different Nitraria species were significantly different ($p < 0.05$). The sodium values of Nitraria species varied from 10819.6 mg/kg (*N. Sibirica*) to 1791.1 mg/kg (*N. roborowskii*). In previous studies, it was found that Na contents of *N. Sibirica* and *N. tangutorum* was 8700 mg/kg and 1800 mg/kg [36,37], which are within present results limitation. The boron values were in the range of 10.8 mg/kg to 1.4 mg/kg (Table-3). The highest value was found for *N. sibirica* and the lowest was for *N. Tangutorum*. The Fe contents of Nitraria species were between 52.0 mg/kg (*N. sibirica*) and 24.6 mg/kg (*N. tangutorum*). Gao *et al*. [37] reported that Fe contents of different Nitraria species were 216.00-18.55 mg/kg. Present Fe results are also within these limits.

According to present analyses of Nitraria species, Mg and P contents of species varied between 254.4 mg/kg (*N. roborowskii*) and 485.0 mg/kg (*N. sibirica*); and 176.6 mg/kg (*N. tangutorum*) and 484.6 mg/kg (*N. sibirica*) (Table-3). Compared to the previous study, the values for Mg in *N. sibirica* and *N. Tangutorum*, are found to be lower than the results of present study.

The cobalt, chromium and stronium contents were found to be 0.2-1.9 mg/kg, 0.5-0.8 mg/kg, 1.5-4.2 mg/kg, respectively (Table-3). The contents of chromium in *N. tangutorum* and *N. sibirica* were close to the results of Suo *et al*. [9]. The potassium and calcium contents of Nitraria species were 4257.7 mg/kg (*N. sibirica*)-2108.0 mg/kg (*N. tangutorum*), 497.0 mg/kg (*N. roborowskii*)-915.7 mg/kg (*N. sibirica*). Geng *et al*. [38] also reported that potassium and calcium contents of fruits in different Nitraria species were 2895.4-5255.6 mg/kg and 517.4-967.7 mg/kg.

Conclusion

In conclusion, it can be said that Nitraria fruits are of great value, based on their rich and beneficial nutrient composition. The weight, pH, total fat content, total sugar content, mineral elements contents were significantly different among Nitraria species fruits. The results of the study also demonstrated that Nitraria species fruits are full of nutrients and the further investigation would be meaningful and valuable.

ACKNOWLEDGEMENTS

This project received financial support from the Development Project of Qinghai Key Laboratory (No. 2017-ZJ-Y10).

REFERENCES

1. Y.M. Liu and S. Imam, Pharmacography of Uyghur, Xinjiang People's Publishing House, Urumqi, China, vol. 1 (1999).
2. Y. Yang, R. Shi, X. Wei, Q. Fan and L. An, *Plant Cell Tissue Organ Cult.*, **102**, 387 (2010); https://doi.org/10.1007/s11240-010-9745-1.
3. S. Wang and X. Kang, *Zhiwu Yichuan Ziyuan Xuebao*, **6**, 231 (2004).
4. Y.J. Zeng, Y.R. Wang, J. Zhang and Z.B. Li, *Seed Sci. Technol.*, **38**, 537 (2010); https://doi.org/10.15258/sst.2010.38.3.02.
5. Z. Kefu, F. Hai and I.A. Ungar, *Plant Sci.*, **163**, 491 (2002); https://doi.org/10.1016/S0168-9452(02)00160-7.
6. Y. Yang, X. Wei, R. Shi, Q. Fan and L. An, *J. Plant Growth Regul.*, **29**, 465 (2010); https://doi.org/10.1007/s00344-010-9158-8.
7. Y.M. Liu, Pharmacography of Uighur: Part II, Science/Technology and Health Publishing House of Xinjiang, p. 206 (1999).
8. F. Senejoux, C. Girard, H.A. Aisa, M. Bakri, P. Kerram, A. Berthelot, F. Bévalot and C. Demougeot, *J. Ethnopharmacol.*, **141**, 629 (2012); https://doi.org/10.1016/j.jep.2011.08.012.
9. Y.R. Suo, H.L. Wang and H.Q. Wang, *Nat. Prod. Res. Dev.*, **16**, 54 (2004).
10. C.Z. Lu, Y.K. Shan and H.Z. Liu, *Liquor Making*, **36**, 83 (2009).
11. Y.D. Wang, N.L. Chen, C.X. Li, H.N. Gao and Y. Zhang, *Food Sci. Technol.*, **38**, 111 (2012).
12. C.Y. Li, Z.J. Ma and P. Guo, *Chem. Ind. Forest Prod.*, **3**, 225 (1991).
13. S.D. Wang and X.Y. Kang, *J. Plant Gene. Resour.*, **6**, 231 (2005).
14. Y.Q. Guo, X.M. Bai, C.X. Ding, L.Y. Wang and Y.R. Suo, *Guangdong Trace Elem. Sci.*, **15**, 34 (2008).
15. M.R. Yang, Y.R. Suo and H.L. Wang, *Nat. Prod. Res. Dev.*, **24**, 985 (2012).
16. H.L. Wang, C.X. Ding, Y.L. Li, Y.J. Liu and Y.R. Suo, *Guangdong Trace Elem. Sci.*, **14**, 36 (2007).
17. J. Ming, *Ying Yang Xue Bao*, **16**, 338 (1994).
18. A.J. Zhang, J.H. Shen and H.Q. Shi, *China Food Additives*, **5**, 105 (2006).
19. X.D. Mei and Y.B. Shen, *Zhong Yao Cai*, **35**, 2045 (2012).
20. H. Wang, Y. Suo, X. Wang, Y. Li, J. You and X. Zhao, *Separ. Purif. Tech.*, **56**, 371 (2007); https://doi.org/10.1016/j.seppur.2007.02.008.
21. Y. Suo and L. Wang, *Eur. J. Lipid Sci. Technol.*, **112**, 390 (2010); https://doi.org/10.1002/ejlt.200900062.
22. T.S. Tulyaganov and F.K. Allaberdiev, *Chem. Nat. Compd.*, **39**, 292 (2003); https://doi.org/10.1023/A:1025482821368.
23. M. Bakri, Q. Chen, Q. Ma, Y. Yang, A. Abdukadir and H.A. Aisa, *J. Chromatogr. B Analyt. Technol. Biomed. Life Sci.*, **1006**, 138 (2015); https://doi.org/10.1016/j.jchromb.2015.10.038.

24. J. Hadj Salem, I. Chevalot, C. Harscoat-Schiavo, C. Paris, M. Fick and C. Humeau, *Food Chem.*, **124**, 486 (2011); https://doi.org/10.1016/j.foodchem.2010.06.059.
25. National Food Safety Standard Determination of Protein in Foods (1994).
26. Determination of Total Sugar and Crude Fat in Food Safety National Standard Food (1994).
27. J.R. Liu, P. Yan, Y. Li. F.S. Jiang and J. Zhou, *Chinese J. Modern Appl. Pharm.*, **19**, 385 (2002).
28. C. Chen, Y. Shao, Y. Li and T. Chen, *Spectrosc. Lett.*, **48**, 775 (2015); https://doi.org/10.1080/00387010.2013.856324.
29. Y.R. Suo, Nitraria Resources in Qaidam Basin and Their Utilization, Science Press, pp. 156-157 (2009).
30. Z.Z. Shu, X.J. Jiang, Q.Y. Meng and L. Zhang, *J. Anhui Agric. Sci.*, **38**, 2936 (2010).
31. Z. Gao, J. Wang, B.-Q. Te and Y.-C. Wang, *Chinese J. Grassland*, **3**, 116 (2014).
32. Y.X. Chang, G.E. Su and Y.C. Wang, *NMGKJYJJ*, **14**, 21 (2005).
33. X.Y. Yang, H.X. Zhang, X. Tang, Z.X. Liu, S. Yang, J.W. Ni and J.F. Zhu, *World Forest. Res.*, **26**, 64 (2013).
34. A.A.K. Abou-Arab and M.A. Abou Donia, *J. Agric. Food Chem.*, **48**, 2300 (2000); https://doi.org/10.1021/jf990508p.
35. X. Cui, J. Sun, X.Y. Ling, C.F. Zhao, Z.J. Liu and G.F. Xu, *Trace Elem. Electrolytes*, **24**, 28 (2007); https://doi.org/10.5414/TEP24028.
36. H.L. Wang, C.X. Ding, Y.L. Li, Y.J. Liu and Y.R. Suo, *Guangdong Trace Elem. Sci.*, **14**, 36 (2007).
37. H. Gao, T.X. Li and Y.R. Suo, *Guangdong Trace Elem. Sci.*, **9**, 52 (2002).
38. Q.Z. Geng, S.-X. Du, Y.-X. Shang, H.-X. Zhang, C.-X. Li and Y. Zhang, *Food Sci. Technol.*, **34**, 101 (2008).