CHEMICAL CHARACTERISTICS AND ANTIOXIDANT ACTIVITIES OF FOUR NATIVE GOJI (*LYCIUM BARBARUM* L.) GENOTYPES

PROPRIETĂȚILE CHIMICE ŞI ACTIVITATEA ANTIOXIDANTĂ A PATRU GENOTIPURI LOCALE DE GOJI (*LYCIUM BARBARUM* L.)

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Abstract Abstract. *Since the beginning of the 21st century, goji berries have become increasingly popular in Turkey and Europe and have been promoted in advertisements and in the media as an anti-aging remedy. In this study, chemical properties (total soluble solid contents, pH, titratable acidity, vitamin C, antioxidant activity and total phenolic) of goji (Lycium barbarum) fruits grown in the Denizli province of Turkey were investigated. The total soluble solids content of goji varied between 15.2% (G1) and 19.8% (G3), titratable acidity between 0.9% (G1) and 1.5% (G4), pH between 3.25 (G2) and 4.36 (G3), respectively. Ascorbic acid (vitamin C) was in the range from 18.26 (G4) to 32.18 (G2) mg/100 g fresh weight (FW). The highest total phenolic contents were found 62.3 (G2) to 85.6 (G4) mg of gallic acid equivalent (GAE) 100 g^{-1} fresh weight. Antioxidant capacity (DPPH) was in the range from 32.28% (G1) to 87.48% (G3).*

Key words: goji berry, antioxidant, phenolic, vitamin C, Turkey

Rezumat. *Începând cu secolul al 21-lea fructele de goji devin din ce în ce mai populare în Turcia şi în Europa fiind promovate prin reclame comerciale cât şi în presă ca având un efect anti-îmbătrânire. În acest studiu sunt investigate proprietățile chimice (conținutul total de substanțe solide solubile, pH-ul, aciditatea titrabilă, conținutul de vitamina C, activitatea antioxidantă şi fenolii totali) ale fructelor de goji (Lycium barbarum) cultivate în provincia Denizli, Turcia. Conținutul total de substanțe solide solubile din fructele de goji a variat între 15,20% (G1) şi 19,80% (G3), aciditatea titrabilă între 0,9% (G1) şi 1,5% (G4), pH-ul între 3,25 (G2) şi 4,36 (G3). Acidul ascorbic (vitamina C) a avut valori situate în intervalul 18,26 (G4) până la 32,18 (G2) mg/100 g masă proaspătă (FW). Conținutul de fenoli totali a fost de 62,3 (G2) la 85,6 (G4) mg echivalent acid galic (GAE) 100 g^{-1} masă proaspătă. Capacitatea antioxidantă (DPPH) a avut valori între 32,28% (G1) şi 87,48% (G3).*

Cuvinte cheie: fructe de goji, capacitate antioxidantă, fenoli, vitamina C, Turcia

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INTRODUCTION

Goji berry is a Solanaceous deciduous shrubbery that grows in China,Tibet, and other parts of Asia, and its fruits are 1–2 cm long, bright orange-red ellipsoid berries (Potterat, 2010). Goji grows up to 3 m high, while *L. chinense* is some what smaller, and its gray-green leaves are alternate, lanceolate, and gradually narrow to the petiole. The species presents one to three axillary flowers. The calyx and pistils are fused: the calyxisbilabial witha double-too the dlowerlip. The corolla isfunnel-shaped, light purple or violet with afive-lobedmargin. There are four stamens, which are hairy at the base. The ovary is two-chambered with one style (Amagase *et al*., 2009).

Goji fruit, generally called Goji berry or wolfberry, isawell-knownherbintraditional Chinesemedicine. Nowadays, Goji berries are being used not only in China but also worldwide as a popular health food ingredient in various forms such as soups, drinks and a variety of solid foods (Amagase and Farnsworth, 2011; Potterat, 2010).

Goji berry has shown a wide range of health benefits such as the functions and activities associated with the liver, kidney, eyesight, sex, immune system, circulation and longevity (Tang *et al*., 2012).

The objective of the present study is to determine the content and composition of goji fruit (vitamin C, total phenolics and total anthocyanin) in four native goji genotypes and evaluate their antioxidant activities. The results obtained were compared with those of the four *Lycium barbarum* L. genotypes.

MATERIAL AND METHOD

Fruit material

Four native goji genotypes were harvested in region of Çivril, Central Aegean, Turkey, in July 2015 years, and the harvested fruits were then transported to the laboratory for analysis.

Physicochemical properties

Total soluble solid content (TSS) was measured with a digital refractometer (Model HI-96801 Hanna, German) at 20 ºC. pH measurements were done by using Hanna-HI 98103. pH meter calibrated with pH 4.0 and 7.0 buffers. Titratable acidity was determined potentiometrically by titrating the sample with 0.1 NaOH until the pH reached 8.01 and expressed as citric acid.

Determination of total phenolics

Total phenolic content were determined with Folin-Ciocalteu assay (Singleton and Rossi, 1965). For this, flesh+peels (10 g) were centrifuged at 6000 rpm after homogenized in 40 ml ethanol solution. After, diluted (1/10) 1000 µl Folin-Ciocalteu and 800 µl Na2CO3 solution was added upon supernatant. After a 2-h incubation period, the samples were read at 750 nanometer wavelength in spectrophotometer. Water-ethanol mixture was used as blank. Gallic acid is used as a standard in the calculation.

Determination of total anthocyanins

For total anthocyanin analysis, 10 g flesh+peels were homogenized in methanol solution that 1% HCL included. Samples were filtered with filter paper after a night standing. Supernatant were incubated in tampon solution (pH 1.0 and pH 4.5). Samples were read against the blank at 530 and 700 nanometer wavelengths (Giusti and Wrolstad, 2001).

Determination of vitamin C

For vitamin C analysis, pureeing and filtering obtained fruit juice samples. The samples were homogenized by centrifuge and 400 μL oxalic acid (0.4%) and 4.5 ml 2,6- diklorofenolindofenol solution were added upon supernatant. Data were read against the blank at 520 nanometer wavelength in spectrophotometer.

Determination of total antioxidant activity

In the 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay, antioxidants were capable to reduce the stable radical DPPHº to the yellow coloured diphenylpicrylhydrazine (DPPH-H). The test is based on the reduction of an alcoholic solution of DPPH in the presence of a hydrogen donating antioxidant due to the formation of the non-radical form DPPH-H (Gulcin, 2007). The DPPH° radical-scavenging activity of the peach fruit extracts was estimated as described by Blois (Blois, 1958). Briefly, 0.1 mL of each sample extract was mixed with 0.9 mL of 0.04 mg/mL methanolic solution of DPPH. The mixtures were left for 20 min at room temperature and its absorbance then measured at 517 nm against a blank. All measurements were carried out in triplicate. The percentage of DPPH radical-scavenging activity was calculated using the following equation:

$$\% \text{ DPPH radical-scavenging} = [(Ac - As)] \times 100$$

where Ac was the absorbance of the negative control (contained extraction solvent instead of the sample), and As was the absorbance of the samples.

Statistical analysis

Five replicates including 20 fruits per replicate were used. Descriptive statistics of total soluble solid contents, pH, titratable acidity, vitamin C, antioxidant activitiy, total phenolic, extracted from eight goji genotypes were represented as Mean ± SE. The phytochemical characteristics were statistically analyzed with One-way ANOVA with five replicates. Duncan Test determined significant differences between the evaluated genotypes. All statistical evaluations were performed using SPSS 20.

RESULTS AND DISCUSSIONS

Table 1 shows the results of pH, TSS (%) and titratable acidity composition and table 2 shows Vitamin C, total phenolic and DPPH composition 4 native goji genotypes collected from Çivril district in Denizli province. ANOVA indicated that the genotype had a major influence on all parameters under evaluation (p<0.05).

Table 1.

Titratable acidity and pH, composition of goji genotypes, TSS (%)

Genotypes	Total Soluble Solids	Titratable Acidity	pH
G1	15.20 ± 1.34	0.9 ± 0.04	3.57 ± 0.13
G2	16.20 ± 1.27	1.1 ± 0.15	3.25 ± 0.17
G3	19.80 ± 0.84	1.3 ± 0.26	4.36 ± 0.20
G4	18.30 ± 0.93	1.5 ± 0.21	4.21 ± 0.18

Total soluble solids value in goji genotypes were between 15.20 (G1) and 19.80 (G3) %. Previous studies had shown that total soluble solid content of goji fruits are between 14.7-19.3 % (Zhang *et al.*, 2016 ; Navarro *et al.*, 2016), and our TSS results are generally within limits of these studies. The variation of TSS in goji fruits may be due to different species, types, environmental conditions and nutritional status of orchards. The titratable acidity of goji genotypes was between 0,9 % (G1) and 1.5% (G4). Previous studies had shown that titratable acidity content of goji fruits are between 0.8-2.7 % (Zhang *et al.*, 2016).

pH of goji fruits was between 3.25 % (G2) and 4.36 % (G3). Previous studies had shown that pH value of goji fruits average are 3.4 % (Navarro *et al.*, 2016).

Table 2

Vitamin C, total phenolic and DPPH composition of goji genotypes

Genotypes	Vitamin C	Total Phenolic (mg GAE/g FW)	DPPH
G1	22.64 ± 1.19	72.8 ± 2.34	32.28 ± 0.09
G2	32.18 ± 1.24	62.3 ± 3.49	56.82 ± 1.67
G3	26.44 ± 1.06	66.2 ± 2.14	87.48 ± 4.82
G4	18.26 ± 0.81	85.6 ± 1.28	65.14 ±2.17

Vitamin C value in goji genotypes were between 18.26-32.18. The average vitamin C of goji genotypes was 48.94, which is a higher then has been reported for goji genotypes (Kulczyński and Gramza-Michałowska, 2016). Total phenolic value in goji genotypes were between 62.3-85.6. For all goji genotypes, the TP levels ranged from 62.3 to 85.6 mg GAE/g FW. In the earlier work conducted on the northeast Ningxia of China, Zhang *et al*. (2016) reported TP contents of goji genotypes varied from 26.9 to 73.4 mg GAE/g FW. The DPPH free radical-scavenging activities of extracts from fruits of the goji genotypes ranged from 32.28 to 87.48 μM TE/g FW. DPPH value in goji genotypes were between 32.28-87.48 (Zhang *et al*., 2016).

CONCLUSIONS

In conclusion, the results clearly indicate the difference between the cultivars used grown in the same way.

Antioxidant activity also varies among the different cultivars of goji, and this is a reflection of the phytochemical differences between cultivars.

Goji genotypes have high vitamin C, total phenolic, and antioxidant capacity in fruit. It is known, positive effect on human health of these substances.

This genotypes can be used for future breeding activities to obtain more healthier goji.

Acknowledgments*: This study funded by The Scientific Research Fund of Uşak University (Uşak, Turkey, Project No: 2015/MF013).*

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