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Physico-chemical properties, fatty acid composition and mineral contents of goji berry (*Lycium barbarum* L.) fruit

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Abstract

Physico-chemical properties (fibre, moisture, crude oil, crude protein, total phenol, antioxidant activity and total sugar) of Goji berry (*Lycium barbarum* L.) fruits were determined. In addition, mineral contents of fruits were determined by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES). Goji berry fruits contain 7.3 % fibre, 10.34% moisture, 4.11% crude oil, 3.44 mg GAE/100 ml total phenol, 8.9% crude protein and 487.29 g/100 ml total sugar. Its antioxidant activity value of goji berry fruit was determined as 20.78%. Goji fruit oil contained linoleic acid (60.77%), oleic (21.69%), palmitic (8.23%) and stearic (2.91%) acids. K , Mg, Fe, P, Ca and Na contents of goji berry fruit were found as 13447.35 mg/Kg, 806.88 mg/Kg, 45.77 mg/Kg, 1103.30 mg/Kg, 1003.40 mg/Kg and 28.27 mg/Kg, respectively. Potassium was found as the highest element, and followed by P, Ca and Mg in descending order.

Keywords: Goji berry, total phenol, antioxidant activity, mineral, fatty acid, ICP-AES, GC

1. Introduction

There are several plants that rich in antioxidant content such as flavonoids, phenolics and tocopherols. Phenolics are natural antioxidants which has powerful effect to retard oxidation process [1]. Goji berry (*Lycium barbar um*) is type of fruit which are rich in antioxidant content. Recent studies showed that extracts from *L.barbarum* possess biological activities including anti-aging, anti-tumor, immune stimulatory and cytoprotection. Most of these studies emphasized that the protective function of *L.barbarum* is due to its antioxidative effects [2,3]. *Lycium barbarum* fruit can be used to produce various type of health products and foods for example medicinal beverages and drink, and health dietary soups [1,3-5]. Various small molecules such as betaine, various vitamin and mineral are also present in goji berry [6]. In addition, goji berry are nutritionally rich fruit which are usefull for body requirements [1,4]. Horticulture products play a significant role in the human diet providing protection against oxidative cellular damages [7]. Several researchers have studied the relationship between total phenol and different methods antioxidant capacity assay [8-12].

The aim of current study was to determine physico-chemical properties, fatty acid composition and the concentrations of heavy metal and mineral nutrients present in goji berry fruits collected from gren house of S.Ü. Çumra High Vocational College in Konya in Turkey.

2. Material and methods

2.1.Material. Goji berry (*Lycium barbarum*) fruits were collected from S.Ü. Çumra Vocational college's green house in Turkey in 2013. Fruits were transported to the laboratory in polypropylene bags and held at refrigerator. They are cleaned in an air

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screen cleaner to remove all foreign matter such as dust, dirt and immature and crushed fruits were dischareded as well. Fruits were preserved until ground using a hummer mill. After drying, ground fruit flour was analysed.

2.2.Physical and Chemical Analyses. Crude protein, oil, fibre and total sugar was determined according to the Association of Official Analytical Chemists [13,14]. Protein content was determined by the Dumas Nitrogen Analyzer (DNA) (Velp NDA 701- Monza, Brianza-Italy). Protein was calculated using the general factor (6.25).

Working conditions of DNA:
O_2 flow rate: 400 ml/min
He flow rate : 195 ml/min
Combustion reactor: 1030 ^oC
Reduction reactor : 650
Pressure (mbar) : 881.0

2.2.1.Oil content. About 5 g of the dried samples were ground in a ball mill and extracted with petroleum ether in a Twisselmann apparatus for 4 h. The solvent was removed by a rotary evaporator at 40 °C and 25 Torr. The oil was dried by a stream of nitrogen and stored at – 20 °C until used.

*2.2.2.Total phenol.*Total phenolic contents of Goji fruits were estimated using Folin Ciocalteu (FC) reagent as described by Yoo et al. [15] with some modifications. About a 0.5 ml aliquot of the aqueous Goji extract was mixed with 2.5 ml of 1:10 Folin Ciocalteu reagent and 1.5 ml of 20 % Na_2CO_3. Absorbance was measured at 517 nm after 30 min standing at room temperature. Gallic acid was used as a standard and the total phenolics were expressed as mg/g gallic acid equivalents (GAE).

2.2.3.Radical Scavenging Assay. Free radical scavenging activity of the sample extract was determined spectrophotometrically using the method of Lee et al. [16]. This method is depend on the measurement of the reducing ability of antioxidants toward the 2,2-diphenyl-1-picrylhydrazyl (DPPH). 1 ml solution of the extract was mixed with 2 ml of 10 mg/L methanolic solution DPPH. The mixture was shaken vigorously and absorbance was recorded at 517 nm via spectrophotometer.

2.2.4.Determination of mineral contents. Collected goji samples were dried at 70 ºC in a drying cabinet with air-circulation until they reached constant weight. Later, about 0.5 g dried and ground sample was digested by using 5ml of 65% HNO_3 and 2 ml of 35% H_2O_2 in a closed microwave system (Cem-MARS Xpress) at 200 ˚C. The volumes of the digested samples were completed to 20 ml with ultra-deionized water and mineral concentrations were determined by inductively coupled plasma-optical emission spectroscopy (ICP AES; Varian-Vista, Australia). Distilled deionized water and ultrahigh-purity commercial acids were used to prepare all reagents, standards, and samples. After digestion treatment, samples were filtrated through Whatman Ashless No 42. The filtrates were collected in 50 ml flasks and analysed by ICP-AES. The mineral contents of the goji berry sample was quantified against standard solutions of known concentrations which were analysed concurrently [17].

2.2.5.Determination of Fatty acids. Fatty acid composition for goji berry fruit oil was determined using a modified fatty acid methyl ester method as described by Hışıl [18]. The oil was extracted three times for 2 g air-dried seed sample by homogenization with petroleum ether. About 50-100 mg oil sample was converted to fatty acid methyl esters (FAME). The methyl esters of the fatty acids (1 µl) were analysed in a gas chromatography (HP 6890) equipped with a flame ionising detector (FID), a fused silica capillary column (60 m x 0.25 mm i.d.; film thickness 0.20 micrometer). It was operated under the following conditions: oven temperature program. 175 ^oC for 7 min. Raised to 250 ^oC at a rate 5 ^oC/min and than kept at 250 ^oC for 15 min); injector and detector temperatures, 250 and 250 ^oC, respectively, carrier gas; nitrogen at flow rate of 1.51 ml/min; split ratio; 1/50 ml/min.

2.3.Statistical analyses. Results of the research were analysed for statistical significance by analysis of variance [19].

3. Results and Discussion

Physico-chemical properties, fatty acid and mineral contents of goji berry fruits were presented in Table 1. Generally, goji berry has 7.3 % fibre, 10.34% moisture, 4.11% crude oil, 3.44 mg GAE/100 ml total phenol, 8.9% crude protein and 487.29 g/100 ml total sugar. In addition, its antioxidant activity value was established as 20.78%. In fruit oil, palmitic, oleic, linoleic acids were found as major fatty acids. Goji fruit oil contained linoleic acid (60.77%), oleic (21.69%), palmitic (8.23%) and stearic (2.91%) acids. Mineral contents of goji berry fruit were determined by ICP-AES. K., Mg, Fe, P, Ca and Na contents of goji berry fruit were found as 13447.35 mg/Kg, 806.88 mg/Kg, 45.77 mg/Kg, 1103.30 mg/Kg, 1003.40 mg/Kg and 28.27 mg/Kg, respectively. The content of total phenol was lower than data reported by Ionica et al. [9]. Antioxidant capacity of dried goji fruits changed between 2.88 and 91.75%. The solvent concentration affects the antioxidant capacity, fact which is according with the results presented by Turkmen et al. on mate tea [20]. Rodrigues et al.[21] reported that *Physalis* presented high contents of ashes and total lipids, 0.8 and 3.16 g/100 g, respectively. The same researchers determined 80.97% moisture, 3.16% total lipids, 1.85% protein and 0.80 % ash in *Physalis peruviana* L. The significantly highest content of dry matter (16.73%) and of ascorbic acid (25.66 mg/100 g) was determined in *Physalis peruviana* L. fruits. Ramadan and Mörsel [22] found a palmitic acid content of 8.62% in *P.peruviana* cultivated in Germany. In addition, fatty acid composition of *P. peruviana* were determined as 9.38 % palmitic, 2.67% stearic, 10.03% oleic, 74.42% linoleic acids. The lipidic fraction presented predominance of the linoleic acid (72.42%) in its composition [21]. Rodrigues et al. [21] determined 1.47 g/100 g Fe, 34.70 g/100 g Mg, 9.00 g/100 g Ca, 347.0 g/100 g K and 1.10 g/100 g Na in *P.peruviana* L. While oleic content of goji fruits is found higher than *P.peruviana* value, linoleic acid content was found low according to literature valuess. The mineral variations in fruits can in general show considerable variations not only between the species and the varieties but also within the same varieties cultivated under different agroclimatic conditions [24].

Table 1. Composition and bioactive properties of Goji berry (*Lyceum barbarum*) fruit (n:3)

Parameters		**Fatty acids**	**(%)**
Moisture (%)	10.34±1.32*	Myristic	0.11±0.03
Crude oil (%)	4.11±0.38	Palmitic	8.23±0.67
Crude protein (%)	8.90±1.56	Stearic	2.91±0.43
Fibre (%)	7.30±0.98	Oleic	21.69±0.78
Total sugar (g/100ml)	487.29±12.56	Linoleic	60.77±2.37
Total phenol (mgGAE/100 ml)	3.44±0.37	Linolenic	1.11±0.07
Antioxidant activity(%)	20.78±1.29	Arachidic	1.83±0.05
Minerals (mg/Kg)			
B	34.99±1.46	Mo	0.41±0.09
Ca	1003.40±13.57	Na	28.27±1.27
Cr	0.394±0.08	Ni	0.58±0.07
Cu	10.10±0.89	P	1103.3±16.8
Fe	45.77±1.49	Pb	1.30±0.11
K	13447.4±23.8	S	493.58±12.39
Mg	806.88±12.49	Se	2.22±0.13
Mn	5.28±0.52	Zn	8.27±0.83

*mean±standard deviation

According to Booij et al. [23], the mineral composition of goji berry fruit varies according with their geographical origin. Those differences according to our studies may be attributed to the variability of the studied cultivars and also to the variability of the climatic conditions, different regions, the differences in time of harvest, post-harvest treatments, and the use of fertilizers.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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