TEMPERATURE EFFECT ON ANTIOXIDANT ACTIVITY OF GOJI FRUITS

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Abstract: The antioxidant components of goji fruit stored at 0.5, 10 and 20^{0}C for 4 days were studied. Overall fruit quality declined more rapidly at 20^{0}C. Weight loss of fruit was negligible for 2 days at all temperatures, it increased rapidly from day 3 at 20^{0}C. Soluble solid concentrations (SSC) decreased at higher storage temperatures. Total phenolic compounds were slightly higher at 20^{0}C than at other temperatures. Total ascorbic acid concentrations of the fruit remained similar for the first 2 days of storage, then declined in fruit stored at 0.5 and 20^{0}C, but remained unchanged at 10^{0}C.The total antioxidant activity of fruit was higher at 10^{0}C than at 0.5 and 20^{0}C on day 3. In conclusion, while the best temperature for long-term storage is 0.5^{0}C, quality could be maintained at 10^{0}C for acceptable periods of time for marketing and may be associated with better nutritional quality.
Keywords: Lycium barbarum, Solanaceae, free radical scavenging activity, DPPH radical

Introduction

Lycium barbarum (LB) belongs to the plant family Solanaceae. Red-colored fruits of *Lycium barbarum*, also called *Fructus lycii* or *Gouqizi*, have been used as a traditional Chinese herbal medicine for thousands of years [1]. There are many ways that people consume this fruit for example; eating raw, drinking juice and/or smoothies, mixed with tea, and added to trail mix, cereals, muffins, energy bars or soups [2]. LB has been widely used as nutritional food product with a large variety of beneficial effects, such as reducing blood glucose and serum lipids, antioxidant, immune-modulation, neuroprotection, and anti-inflammatory activity [3-6]. However, the mechanism of the beneficial effect of LB has not been studied. LB contains 18 types of amino acids, including taurine, a non-essential free amino acid, which is one of the chemical components abundantly present in LB [7]. Goji fruit also possesses potent antioxidant and cardio-protective effects [8].

Lipid peroxidation is the principal cause of the organoleptic deterioration of food staffs during processing, distribution and storage. Thus, the protection of foods against such deterioration is of great economic and nutritional importance to the food industry [9]. Therefore, antioxidants may be considered an important tool to protect susceptible products from oxidative deterioration [10]. There are two categories of antioxidants: synthetic and natural. The use of synthetic antioxidants is restricted because of their carcinogenicity [11]. Therefore, the development and utilization of more effective antioxidants of natural origin are desired.

Much attention has been paid to plants and other organisms as sources of natural antioxidants. There is a study on evaluation of the antioxidant effects of polysaccharides extracted from *Lycium barbarum* [12].

The aim of this study is to evaluate the effect of the storage temperature (0.5, 10 or 20^{0}C) on the antioxidant capacity of goji fruits.

2. Materials and methods

2.1. Plant Material

Fruits of *Lycium barbarum* were purchased from a local market. They were from Jing He county in Xin Jing province, which is the largest producer of *Lycium barbarum* in China. Fruit samples were selected for uniform size, colour and absence of mechanical damage. Goji fruits were divided in three groups and stored at 0.5, 10 and 20^0C for 4 days.

2.2. Extraction procedure

Plant materials were sieved and 30 g was extracted with ethyl acetate in a Soxhlet apparatus. All the extracts were freeze-dried after evaporation in vacuum and stored at 0.5, 10 and 20^0C. A further 30 g ground material was macerated with 200 mL of 70% aqueous methanol for 24 h and then filtered. This maceration procedure was repeated with fresh solvent for 5 days. All the macerates were combined and freeze-dried after removal of methanol and stored at 0.5, 10 and 20^0C.

2.3. Weight loss determination

Weighed samples are placed in an oven for 4 days at 0.5, 10 and 20^0C.

2.4. Determination of soluble solids concentrations

The soluble solid concentration was determined by refractometry.

2.5. Ascorbic acid determination

Determination of vitamin C content in goji fruit was cut by titration with 2.6-diclorophenolindophenol (reagent Tillmans). The method is based on color change of the reagent, oxidation or reduction. Thus, the ionized form of 2,6-diclorophenolindophenol is red in acid and blue in basic medium. Dehydroascorbic acid is obtained through reaction with vitamin C, and after reducing the identification reactive, 4-(p-hidroxiphenilamino)-2.6-dichlorophenol. This method is commonly used, due to the fact that it is easy to use and to the reagent sensitivity.

2.6. Total phenolics

Total phenols were determined according to the method of Swain and Hillis (1959), using the Folin-Ciocalteau reagent. 100 mL sample was transferred to a volumetric flask, to which 500 mL undiluted Folin-Ciocalteau reagent was subsequently added. After 1 min, 1.5 mL 20% ($w \cdot v^{-1}$) Na_2CO_3 was added and the volume made up to 10.0 mL with H_2O. After 2 h incubation at 25^0C, the absorbance was measured at 760 nm and compared to a gallic acid calibration curve. Total phenols were determined as gallic acid equivalents.

2.7. 2,2-Di (4-tert-octylphenyl)-1-pycrilhydrazyl (DPPH) scavenging capacity assay

The method described by Hatano, Kagawa, Yasuhara and Okuda (1988) was used for determining the antioxidant activity of goji extracts on scavenging 2,2-Di (4-tert-octylphenyl)-1-picrylhydrazyl (DPPH) radicals. The decrease in absorbance was measured at 515 nm against a blank without extract, using a spectrophotometer. Using a calibration curve with different amounts of DPPH, the IC_{50} was calculated. The IC_{50} is the concentration of an antioxidant that is required to quench 50% of the initial DPPH radicals under the experimental conditions given.

3. Results and discussion

3.1. Weight loss determination

In Table 1 weight loss values for goji fruit samples at temperatures of 0.5, 10 and 20^0C are presented.

Table 1. Weight loss of goji fruit

	Weight loss (%)			
	1 day	**2 day**	**3 day**	**4 day**
0.5^{0}C	0.2	0.4	0.7	1.1
10^{0}C	0.5	0.6	2.1	3.8
20^{0}C	0.6	0.8	5.2	9.6

As seen from the data presented in Table 1, weight loss of fruit was negligible for 2 days at all temperatures it increased rapidly from day 3 at 20^0C.

3.2. Determination of soluble solids concentrations

Table 2 presents the values for soluble solids concentrations of goji fruits at temperatures of 0.5, 10 and 20^0C.

Table 2. Soluble solid concentrations of goji fruit

	Soluble solid concentrations (%)			
	1 day	**2 day**	**3 day**	**4 day**
0.5^{0}C	82.11	82.16	81.91	82.12
10^{0}C	81.66	81.21	81.56	81.46
20^{0}C	80.56	80.44	80.28	80.21

As seen from the data presented in Table 2, soluble solid concentration decreased at higher storage temperatures.

3.3. Ascorbic acid determination

Ascorbic acid concentrations of the fruit remained similar for the first 2 days of storage, then they declined in fruit stored at 0.5 and 20^0C, but remained unchanged at 10^0C (*Figure 1*).

The variation of ascorbic acid throughout the storage period (*Figure 1*) showed that the vitamin content can be affected by temperature. Storage at 0.5^0C and 10^0C was an effective way to maintain the initial level of total ascorbic acid for additional days, but it did not increase the vitamin content significantly.

There are reports [13] of the positive influence of low temperature in the maintenance of vitamin C content during storage of fruit and vegetables.

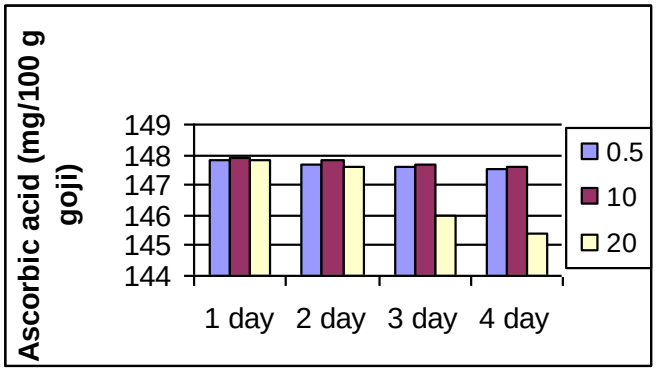

Fig. 1. Ascorbic acid concentrations (■ – 0.5^{0}C; ■ – 10^{0}C; □ – 20^{0}C)

3.4. Total phenolics

Total phenolics content of goji fruit is not altered by storage (*Figure 2*). The total phenolics content was assayed using the Folin-Ciocalteau reagent method and is expressed as $mg_{gallic\ acid.}/g^{-1}$extract.

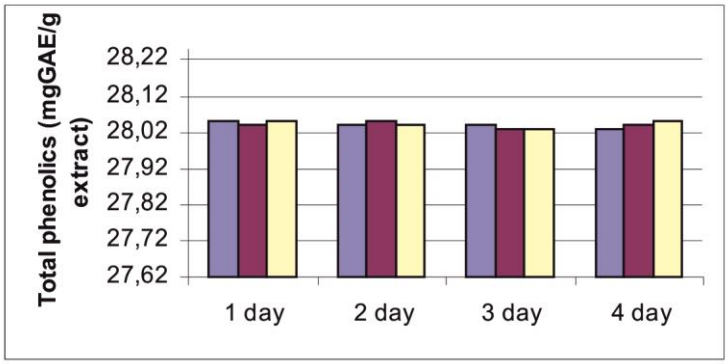

Fig. 2. Total phenolics of goji fruits (■ – 0.5^{0}C; ■ – 10^{0}C; □ – 20^{0}C)

3.5. 2,2-Di (4-tert-octylphenyl)-1-pycrilhydrazyl (DPPH) scavenging capacity assay

In Figure 3 the IC_{50} values are indicated. The lowest IC_{50} value indicates the highest free radical scavenging activities. Free radicals are involved in the process of lipid peroxidation and are considered to play a cardinal role in numerous chronic pathologies, such as cancer and cardiovascular diseases among others, and are involved in the aging process. Therefore, the extracts were assessed against DPPH radicals to determine their free radical scavenging properties. In this assay, the DPPH radical serves as the oxidizing substrate, which can be reduced by an antioxidant compound to its hydrazine derivative via hydrogen donation, and as the reaction indicator molecule.

The total antioxidant activity of fruit was higher at 10^{0}C than at 0.5 and 20^{0}C on day 3.

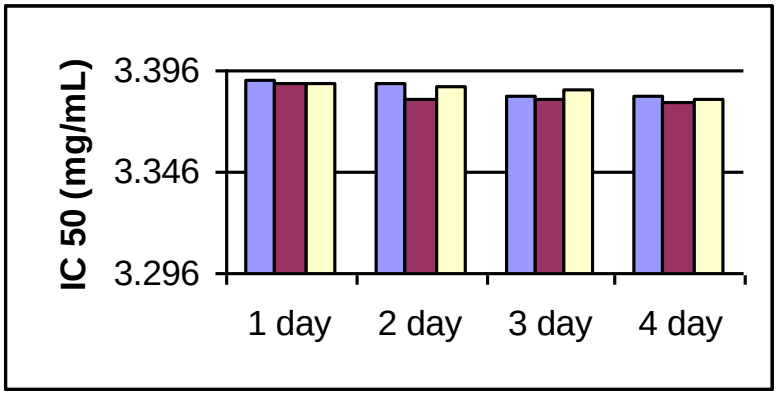

Fig. 3. Free Radical Scavenging Activities of Extract of goji fruit
(□ – 0.5^{0}C; ■ – 10^{0}C; □ – 20^{0}C)

Conclusion

Exotic fruits have various bioactive components with potential health benefits, including anti-diabetic, anti-obese, anti-oxidant and anti-inflammatory.

In conclusion, the data presented in this paper indicated that the storage temperatures affect the antioxidant capacity of goji fruits. The content of total phenolics was not affected by the temperature lowering, while ascorbic acid was affected by temperature. The total antioxidant activity of fruit was higher at 10^{0}C than at 0.5 and 20^{0}C on day 3. The free radical scavenging property may be one of the mechanisms by which this drug is useful as health food and traditional Chinese medicine as well.

While the best temperature for long-term storage is 0.5^{0}C, quality could be maintained at 10^{0}C for acceptable periods of time for marketing and may be associated with better nutritional quality. This finding is not only of sensorial or health relevance, but also economical, because of the additional costs involved in the maintenance of lower temperatures.

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