Evaluation of coenzyme Q_{10} addition and storage temperature on some physicochemical and organoleptic properties of pomegranate juice

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ABSTRACT

Today, in parallel to growing in acceptance of functional products, various additives are used to improve the characteristics of functional food products. The coenzyme Q_{10} plays a vital role in cellular energy production. It also increases the body's immune system via its antioxidant activity. The aim of this study was to evaluate the addition of coenzyme Q_{10} on physicochemical properties of pomegranate fruit juice. The variables were concentrations of coenzyme Q_{10} (10 or 20 mg in 300 ml) and storage temperature (25°C and 4°C) and the parameters were pH, titrable acidity, brix, viscosity, turbidity and sensory evaluation during three months of storage. By increasing time and temperature, pH was decreased and with increasing concentration of coenzyme Q_{10}, pH was increased. Time and temperature had direct influence on acidity, and the concentration of coenzyme Q_{10} had the opposite effect on the acidity. With increasing storage time and concentration of coenzyme Q_{10}, Brix, viscosity and turbidity levels were increased and with increasing time and concentration of coenzyme Q10, the Brix, viscosity and turbidity were increased. The addition of coenzyme Q_{10} in grape juice showed no negative effect on the physicochemical and sensory properties.

Keywords: Coenzyme Q_{10}; Pomegranate juice; Physicochemical properties; Sensory evaluation

INTRODUCTION

Coenzyme Q_{10} is a mediated electron transfer between flavoproteins and cytochromes in mitochondrial respiratory chain and has a cofactor role in three mitochondrial enzymes. Coenzyme Q_{10} in addition to energy transfer, as an antioxidant, protects the oxidation of membrane phospholipids and mitochondrial membrane protein and low-density lipoprotein particles [1]. The chemical name of Coenzyme Q_{10} is 2,3-dimethoxy-5-methyl-6-polyisoprene parabenzoquinone. The letter 'Q' refers to quinone chemical group and the digit '$_{10}$' indicates the number of isopernil chemical subunits [2].

Needed resources of coenzyme Q10 in the body can be obtained in three ways, synthesis within the body, food and food supplements, or a combination of these factors [2]. Due to the complexity of the biosynthesis of this substance, deficiency of coenzyme Q_{10} is possible [3]. Food can usually provide in average 10 mg of needed coenzyme Q_{10} in the body, while it have been reported that the sufficient intake for a healthy body is 30 mg per day [4]. Therefore, the obtained results show the need to use coenzyme Q_{10} as a drug or dietary supplement [5]. The results obtained about stability of coenzyme Q_{10} in fortified dairy products is consenting so that any changes in the microbial, chemical and physical components of the type has not seen yet [6-8]. Research in 2010 showed that use of fruits juice such as grape fruit juice increased the absorption of coenzyme Q_{10} in the human intestine [9]. Also, use of coenzyme Q_{10} increased the vitamin content in the liver and serum of rats [10].

According to the survey results, fruit juice can be suitable to be enriched with this invaluable coenzyme. Among the juices, Pomegranate juice has more antioxidant capacity, anti-microbial and anti-fungal activity and contains significant amounts of vitamin C, tannins and estrogen. Therefore, this fruit has many medicinal and functional effects [11]. There are many reports showing that consumption of this juice can control the disease such as atherosclerosis, diarrhea, stomach ulcers and venereal diseases [12]. Pomegranate juice inhibits proliferation of human cancer cells even up to 90% [13]. It also reduces plasma LDL cholesterol [14] and limits Platelets clots [15]. Pomegranate juice has been shown to have positive effects on recovery-related diseases, prostate, colon, and intestinal tissues of mice [16]. Pomegranate can also reduce oxidative stress in human placenta [17], has positive role in the prevention and improvement of Alzheimer's disease [18] and improves the inflammation and joint damage in rheumatoid arthritis [19]. Food and Drug Administration (FDA) has confirmed pomegranate as a safe food (GRAS) and in Europe, these products are classified as natural products. This fruit is mentioned in the Quran three times. The aim of this study was to investigate the effects of adding coenzyme Q_{10} into pomegranate juice on its some physicochemical properties and sensory attributes.

MATERIALS AND METHODS

Sample preparation

Coenzyme Q_{10} (Sensus, Netherlands) added into 300 ml pomegranate juice (Takdaneh, Iran) at three levels: 0, 10 and 20 mg. The samples filled into sterile bottles and were pasteurized at 90˚C for 5 min. Pomegranate juice packs were kept in refrigerated temperature at two temperatures (4 or 25±2˚C) for 3 months, per one-month intervals.

Physicochemical analysis and sensory evaluation

Measurement of the pH were done with a pH meter (Crison, Spain), Brix with a refractometer (Optech, Germany), viscosity with a viscometers (Brookfield, America), and turbidity with a spectrophotometer (Cromtech, Taiwan). Titrable acidity was measured via titration method. Sensory characteristics of the samples were examined using a 5-point Hedonic test. The total sensory acceptance was calsulated and compared among treatments as final sensory parameter.

Statistical analysis

Experiments were performed in triplicate, and significant differences between means were analyzed using two-way ANOVA test from Minitab software. The design of experiment was completely randomized design (full Factoriel).

RESULTS AND DISCUSSION

Effects Q_{10} addition on pH and titrable acidity

Figures 2-7 shows the average pH, titrable acidity, Brix, viscosity, turbidity and general sensory acceptance of pomegranate juice treatments during storage. Concentration of coenzyme Q_{10} and dual effect of temperature and time showed a significant effect on pH of pomegranate juice. With increasing temperature and time, the pH was decreased. This may be due to the growth of acid-producing bacteria in fruit juice. Coenzyme Q_{10} concentrations also had a direct effect on the pH of juice and the reason may be the higher pH of Q_{10} and other accompanying materials (pH = 7) [8, 21]. Q_{10} concentration had a direct effect on pH (Figure 2). The results obtained revealed that the highest pH was for treatment A1B2C3 (containing 20 mg of coenzyme Q_{10} in 300 ml of juice and stored at 4 ˚C for 1 month) and the lowest pH was for treatment A2B4C1 (stored at 25 ˚C for 3 months with no coenzyme Q_{10}).

It was found that the factors of temperature, time and concentration of coenzyme Q_{10} had significant effect on the titrable acidity of the juice (Figure 3). Storage time and temperature had a direct effect on the titrable acidity of the juice, so that with increasing temperature and time acidity increased with increasing concentrations of coenzyme Q_{10}, the acidity was decreased. The concentration of coenzyme Q_{10} had reverse effect on titrable acidity, since acidity has a reverse relation with pH and according to the discussed reasons about pH changes, the numbers resulted about acidity seem to be normal [20]. The highest titrable acidity was for the treatments stored at 25˚C and stored for three months, and the lowest was for the treatment A1B2C3 (containing 20 mg of coenzyme Q_{10} in 300 ml of juice and storage in 4˚C for 1 month).

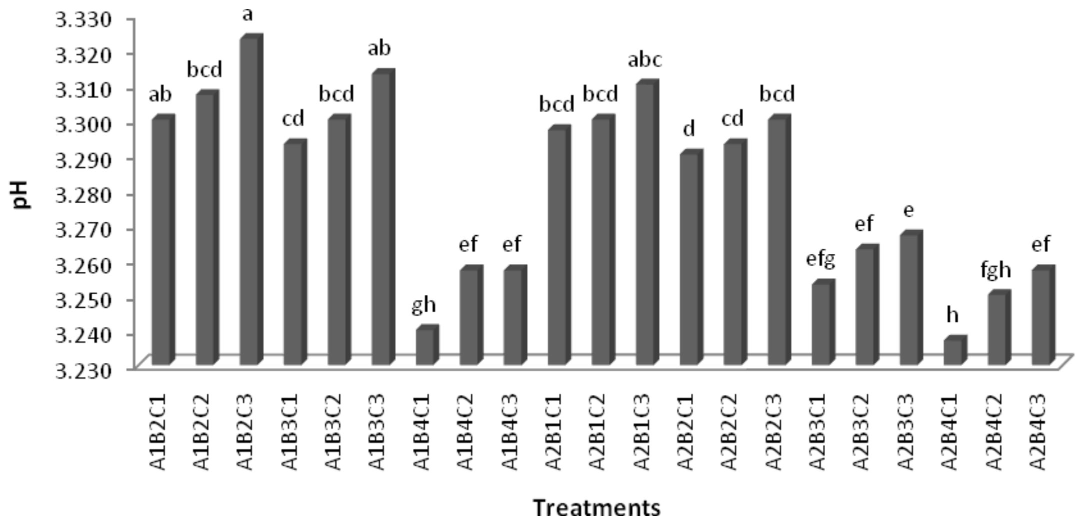

Figure 1. Average pH of pomegranate juice treatments during storage. Values displayed with different letters are significantly different. A = storage temperature (A1 = 4˚C and A2 = 25˚C); B = storage time (B1 = at the start of storage, zero, B2 = month 1, B3 = month 2, B4 = month 3); C = concentration of coenzyme Q_{10} in 300 ml of fruit juice (C1 = 0 mg/300 ml, C2 = 10 mg/300 ml, C3 = 20 mg/300 ml).

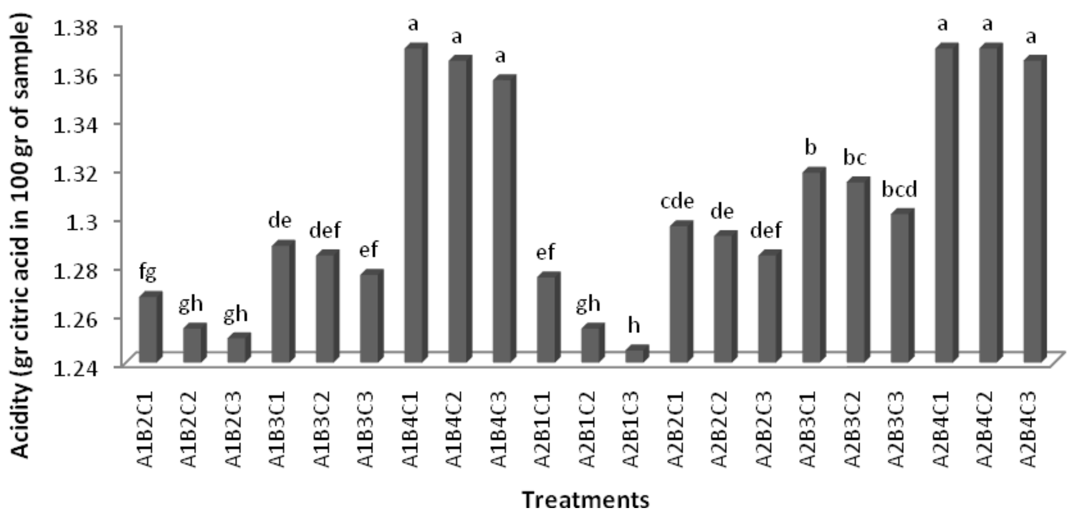

Figure 2. Average acidity of pomegranate juice treatments during storage. Values displayed with different letters are significantly different. A = storage temperature (A1 = 4˚C and A2 = 25˚C); B = storage time (B1 = at the start of storage, zero, B2 = month 1, B3 = month 2, B4 = month 3); C = concentration of coenzyme Q_{10} in 300 ml of fruit juice (C1 = 0 mg/300 ml, C2 = 10 mg/300 ml, C3 = 20 mg/300 ml).

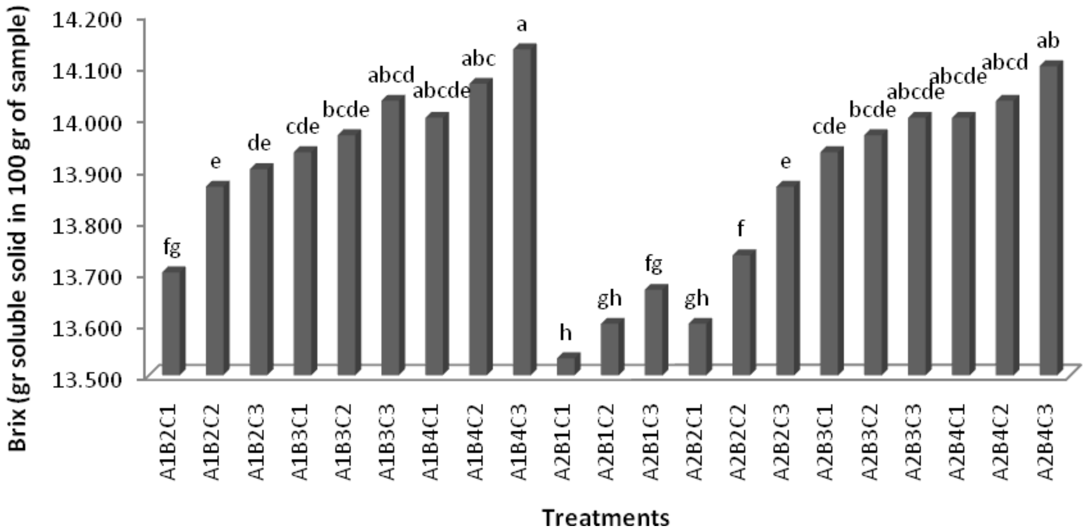

Figure 3. Average Brix of pomegranate juice treatments during storage. Values displayed with different letters are significantly different. A = storage temperature (A1 = 4˚C and A2 = 25˚C); B = storage time (B1 = at the start of storage, zero, B2 = month 1, B3 = month 2, B4 = month 3); C = concentration of coenzyme Q_{10} in 300 ml of fruit juice (C1 = 0 mg/300 ml, C2 = 10 mg/300 ml, C3 = 20 mg/300 ml)

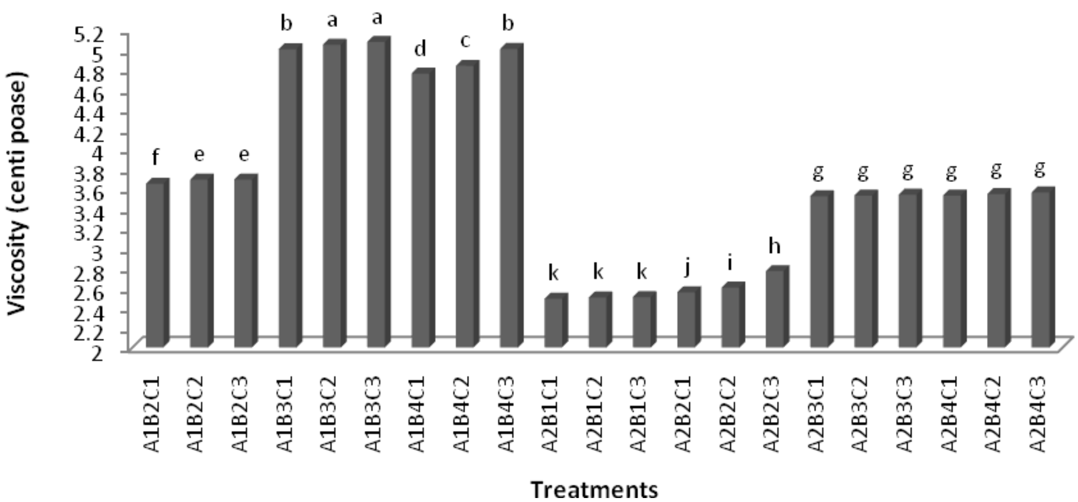

Figure 4. Average viscosity of pomegranate juice treatments during storage. Values displayed with different letters are significantly different. A = storage temperature (A1 = 4˚C and A2 = 25˚C); B = storage time (B1 = at the start of storage, zero, B2 = month 1, B3 = month 2, B4 = month 3); C = concentration of coenzyme Q_{10} in 300 ml of fruit juice (C1 = 0 mg/300 ml, C2 = 10 mg/300 ml, C3 = 20 mg/300 ml)

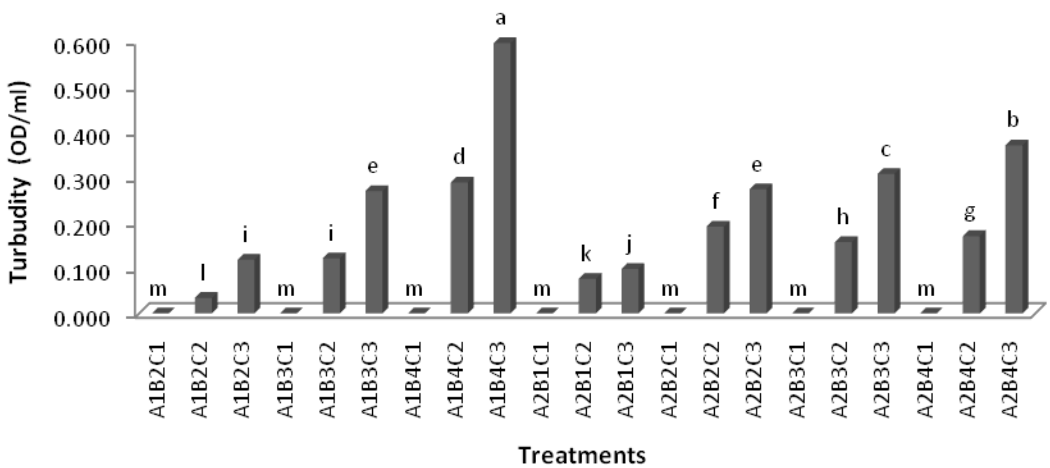

Figure 5. Average turbidity of pomegranate juice treatments during storage. Values displayed with different letters are significantly different. A = storage temperature (A1 = 4˚C and A2 = 25˚C); B = storage time (B1 = at the start of storage, zero, B2 = month 1, B3 = month 2, B4 = month 3); C = concentration of coenzyme Q_{10} in 300 ml of fruit juice (C1 = 0 mg/300 ml, C2 = 10 mg/300 ml, C3 = 20 mg/300 ml).

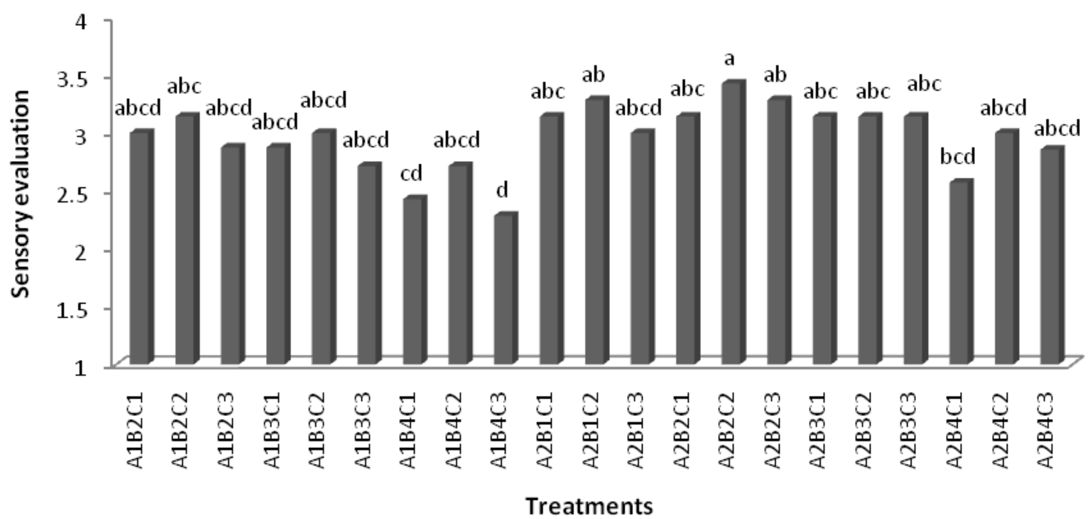

Figure 6. General sensory acceptance of pomegranate juice treatments during storage. Values displayed with different letters are significantly different. A = storage temperature (A1 = 4˚C and A2 = 25˚C); B = storage time (B1 = at the start of storage, zero, B2 = month 1, B3 = month 2, B4 = month 3); C = concentration of coenzyme Q_{10} in 300 ml of fruit juice (C1 = 0 mg/300 ml, C2 = 10 mg/300 ml, C3 = 20 mg/300 ml).

Effect of adding Q_{10} on Brix and viscosity

It was determined that with increase of storing time and concentration of coenzyme Q_{10}, Brix levels was increased due to increased dissolved solids. Only time and concentrations of Q_{10} showed significant effect while temperature had no effect. When storage time and concentration of Q_{10} increased, Brix was increased. The maximum Brix was for treatment A1B4C3 (containing 20 mg of Q_{10} in 300 ml of juice stored 4˚C for 3 months), and the minimum Brix was for treatment A2B1C1 (At the start of storage at 25˚C, with no coenzyme Q_{10}) (Figure 4).

In parallel with increase in storage time and concentration of Q_{10}, juice viscosity was increased (Figure 5). This could be due to the interaction of juice particles with particles of Q_{10}, or creation of small lumps in pomegranate juice over time. Possible crystallization of sucrose and corn starch with coenzyme Q_{10} could also mentioned as a reason [21]. As the storage temperature increased, viscosity of pomegranate juice was reduced because lower temperature (4˚C compared to 25˚C) resulted in a more condensing matrix with an increased density of the juice [21]. Also, at low temperature, the rate of crystallization and creation of small particles of crystals is increased.

Effect of adding Q_{10} on turbidity

Results showed that storage time and concentration of coenzyme Q_{10} had a direct effect on pomegranate juice turbidity. With increase of time and concentration of coenzyme Q_{10}, turbidity was increased (Figure 6). The reason was associated with the orange color of Q_{10}. Results revealed that with increase of temperature, turbidity of pomegranate juice was reduced and the reason could be associated with the lower density of juice particles at higher temperatures [22]. The maximum turbidity was for treatment A1B4C3 (containing 20 mg of Q_{10} in 300 ml of fruit juice stored at 4 ˚C for 3 months), while the minimum turbidity after the control was for treatment A1B2C2 (containing 10 mg of Q_{10} per 300 ml of juice, at the start of storage at 4˚C).

Effect of adding Q_{10} on total sensory acceptance

Most of treatments did not show significant difference in total sensory acceptance (Figure 7). The color of juices kept at lower temperature (4˚C compared those stored at 25˚C) showed higher score. Also, samples with longer storage time had lower score in taste, aroma and overall acceptability. Mentioned facts could be due to lower unwanted interaction of coenzyme Q_{10} and other ingredients in system. The older samples had significantly greater apparent turbidity. The changes in sensory parameters during the storage, although were significant, but fortunately, were not considerable.

CONCLUSION

Addition of coenzyme Q_{10} into food products can improve their functional characteristic due to its healthful effects. On the other hand, pomegranate juice is a good vehicle for enrichment of Q_{10} because of its remarkable antioxidant capacity, anti-microbial and anti-fungal activity and having significant amounts of vitamin C, tannins and estrogen. The results of this study demonstrated that overall, addition of coenzyme Q_{10} in pomegranate juice showed no considerable negative effects on the physicochemical and sensory properties.

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