Original Article

Effects of Blanching, Osmotic and Hydrocolloids Pretreatments on Qualitative and Sensory Characteristics of Processed Barberries

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ABSTRACT

Background and Objectives: This study aimed to assess factors affecting the quality of barberry jam for texture uniformity.

Materials and Methods: Treatments included fresh dried barberry fruits. When processing fresh barberry fruits, pretreatments included blanching, osmosis dehydration and hydrocolloid compounds. Blanching of fresh barberry fruits was carried out in boiled water for 5 and 10 s. Osmosis dehydration of fresh fruits was carried out in 50% sugar solution for 2 and 3 h. Pectin and guar (two hydrocolloid compounds) were added (respectively 0.2 and 0.5%) during jam processing to create high consistency. All pretreatments except osmosis dehydration in sugar solution were used to preparing dried barberry jams. Acidity, soluble solid proportion, pH, ascorbic acid, anthocyanin, two-phasic factor and viscosity were assessed for jam samples. Sensory evaluation of the jams (aroma, taste, color, texture, overall acceptance) was carried out by trained judges in the panel.

Results: Results showed that the lowest two-phasic level in fresh barberry jam was the sample with 0.5% pectin (0.99) and the highest two-phasic level was the control sample (0.52). The lowest two-phasic level in the jam achieved from dried barberry were the samples containing guar hydrocolloid. Dried barberry jam samples with 0.5% guar included the highest viscosity. In sensory evaluation, no significant difference was reported within all the samples.

Conclusions: Jam samples made from fresh and dried barberry containing 0.5% pectin and 0.2% guar included the highest texture uniformity, respectively.

Keywords: Barberry, Blanching, Hydrocolloid, Osmosis, Quality

Highlights

- Barberry (*Barberis vulgaris* L.), belonging to Berberidaceae family, is native to Asian countries, especially Iran.
- Barberry fruits contain vital nutritional components (vitamin C and bioactive compounds) for human health.
- Effective ingredients in barberries such as anthocyanin and phenols include wide uses in food and pharmaceutical industries.
- Barberry processing and production of novel products with high quality and sensory characteristics are valuable.
- The jam uniform texture is important for the consumers.
- Hydrocolloid compounds play a role in creating a homogeneous texture in jams.
- Fresh and dry forms of barberries are used in preparation of barberry jams.

Introduction

Barberries (*Barberis vulgaris*), belonging to Berberidaceae family, are native to Asia, the Middle East and Europe. Barberries include a broad class of spiny evergreen or deciduous shrubs. These shrubs include a height of 1–3 m. Barberry fruits include deep red in color, nearly 10 mm in length and oval in shape. Iran is the largest

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barberry producer in the world. The plant is cultivated in the latitudes of 32.5–34.5° North in Iran (1). South Khorasan Province with 97% of the land under barberry cultivation owns 95% of its production worldwide. Barberries are cultivated in several countries. Importance of barberries is due to their nutritional and medicinal characteristics and their ornamental uses (2). Barberries are consumed as dried fruits and jams, jellies, syrups, marmalades, nectars and food additives (soups, stews and rice dishes) that may be correlated to their unique, palatable and acceptable sour flavor as well as their exciting pleasant color.

Barberry fruits contain vital nutritional components for human health. These include high vitamin C and bioactive compounds. Barberries contain various substances such as carbohydrates, organic acids, vitamins, polyphenolic compounds, pectin, tannin and minerals. The effective ingredients in barberries such as anthocyanin, phenolic and berberine alkaloid compounds include wide uses in food and pharmaceutical industries. Alkaloids of this plant such as berberine include therapeutic characteristics (1). In traditional medicine, this plant with antimicrobial, anti-inflammatory, anti-cancer and anti-microbial characteristics is widely used to strengthen the nerves, help treat cardiovascular diseases (CVD) and decrease blood fats (3, 4).

Fruits and vegetables are important in human nutrition and commerce. However, these foods are seasonal and highly perishable and need to be processed into further stable forms such as jams, jellies and juices to provide their maximum benefits (5). Barberries processing and production of new products are important for farmers and gardeners. The high added values of barberry processed products increase farmers' incomes and develop associated businesses. Jam is a food product that is cooked using meat and/or juice of fruits or vegetables, which are then converted into jelly-like forms. In general, jam is made of only one type of fruits and characteristics of a good jam include soft even texture, favorable color and good taste (6). Jam is an intermediate moisture (semi-solid) food product prepared by cooking of fruits with sugar (with or without added pectin and acid) to increase the total soluble solids (TSS) contents to values greater than 65% (7).

Blanching is thermal process that is carried out before processing (drying and canning) fruits and vegetables, which deactivates enzymes and increases shelf life of the final product. One of the most important goals of fruit blanching is the release of air and gases trapped in the pores of the fruit tissues, which decreases volume and softening of the tissue and decreases intensity of oxidation reactions. Release of air molecules from the fruit pieces increases their weight density (8). In this study, blanching of fresh barberry fruits was carried out as a pretreatment before cooking jams at two times of 5 and 10 s separately with the aim of removing air molecules.

Removing water from the product by osmosis for the subsequent processing of many fruits and vegetables improves quality of the final products. Osmotic dehydration is a method that includes immersion of the product in a high-pressure solution, removal of water from the cell membranes and flowing in intercellular spaces and ultimately into the solution (6). In this study, osmosis of fresh barberry fruits in a sugar solution was carried out as a pretreatment before cooking jams at two times of 2 and 3 h separately with the aim of removing air and water molecules from the barberry fruits and refusing of its floating in the jam. Technically, hydrocolloids are used in many food formulations to improve their quality and shelf-life characteristics. They are majorly used as thickeners and gelling agents. Hydrocolloids are used to increase concentration in preparation of soups, sauces and desserts and as gelling agents in preparation of products such as jams, jellies and marmalades. Pectin is one of the best stabilizers (thickeners) used in jam production. Pectin is a sugar (polysaccharide) compound that gives jams a soft but thick texture (10). Other stabilizers can be used in jam production as well.

Massoud et al., 2018, investigated the effect of xanthan gum and inulin on the rheological characteristics of jams. Results showed that the viscosity of the samples decreased with increases in the replacement levels of xanthan gum and inulin. Xanthan gum up to 25% can be an appropriate substitute for pectin (11). In another study, Nourmohammadi et al. (2021) used pectin in the formulation of sour cherry jams to improve the quality. Results showed that pectin improved the sensory characteristics of the jams, including texture. The optimal quantity of pectin was reported as 0.4% (12). Scientific studies have not been carried out on barberry processing, jam production and methods of improving their quality in Iran. The objective of this study was to produce a novel barberry product that include high sensory characteristics and marketable quality. Therefore, barberry fruits were processed to prepare a novel product to decrease wastes and produce jams with high quality and uniform texture that decrease the quantity of two phasing and improve its sensory characteristics (overall acceptance) to satisfy the consumers.

Materials and Methods

Materials

The chemicals of 0.1 N sodium chloride, 0.01 N iodine solution, potassium iodide, 1% starch reagent, phenol phethalein reagent, potassium chloride buffer (pH = 1) and sodium acetate buffer (pH = 1) were purchased from Sigma, USA. Guar and pectin hydrocolloids of edible commercial brands and bulk packaging were provided by a laboratory material provider, Mashhad, Iran. Sugar was purchased from a local supermarket. Fresh seedless barberry fruits (*Berberis vulgaris*) were picked in full ripeness from an orchard, Qain city, Khorasan Razavi Province, Iran.

Structures

These included desktop refractometer, UV-vis spectrophotometer, pH meter and rotary viscometer.

Methods

First, fresh barberries were cleaned in the Quality Control Laboratory, Razavi Khorasan Agricultural Research Center, Mashhad, Iran, and then stored at 5 °C. Initial assessments such as soluble solids proportion, acidity, pH, ascorbic acid and anthocyanin were carried out for fresh barberries. To solve the problem of barberry floating in jams, three solutions were prepared, which were assessed separately as pretreatments in jam production.

1. Blanching barberries with boiling water. By creating pores on the barberry skin, exit of small air molecules from the barberries was facilitated. For this purpose, barberries were transferred into boiling water for 5 and 10 s.
2. Osmotic dehydration. In this method, barberry fruits were soaked in 50% sugar solution for 2 or 3 h. The ratio of fruits to sucrose solution was 1 to 3. Osmosis caused water and air to leave the barberry fruits, replacing them with sugar.
3. Use of hydrocolloids. Effects of hydrocolloids (pectin and guar) were investigated separately at two concentrations (0.2 and 0.5%) in barberry jam preparation.

Fresh barberry jam preparation

First, sugar syrup with Brix 75 was prepared. Samples 1 or control (90 g of fresh barberries), 2 and 3 (90 g of blanched fresh barberries in boiled water (5 and 10 s)), 4 and 5 (90 g of osmosis of fresh barberries in 50% syrup (2 and 3 h)) were added to 300 g of the boiling syrup separately. In Samples 6, 7, 8 and 9, pectin and guar hydrocolloids (0.2 and 0.5%) were added separately to the control jam during cooking. After mixing and slowly cooking the jam, heat was turned off. After a few hours, jams reached their final texture. Then, these were packed in clean glasses. Moreover, pH, Brix, acidity, ascorbic acid, vitamin C, anthocyanin, two-phase and viscosity assessments were carried out for fresh barberry jam samples. Sensory characteristics of the jams (aroma, taste, color, texture and overall acceptance) were assessed by the judges.

Dried barberry jam preparation

First, syrup with Brix 60 was prepared. Samples 1 or control (30 g of dried barberries), 2 and 3 (30 g of blanched dried barberries in boiling water (5 and 10 s)) were added to 300 g of the boiling syrup separately. In Samples 4, 5, 6 and 7, pectin and guar (0.2 and 0.5%) were separately added to the control jam during cooking. After mixing and slowly cooking the jam, heat was turned off. After a few hours, jams reached the final texture. Then, these were packed in the clean glasses. Acidity, Brix, pH, ascorbic acid, vitamin C, anthocyanin, two phasic and viscosity assessments were carried out for dried barberry jam samples. Sensory characteristics of the jams (aroma, taste, color, texture and overall acceptance) were assessed by the judges.

Physicochemical experiments

1. Soluble solids proportion (Brix)

This was assessed using table refractometer (Carlsels, China).

2. Acidity

Acidity of the barberry jams was calculated using titration method of dominant organic acids in barberry fruits.

3. pH

This was assessed using Metrum-Harissa pH meter model E350B, Switzerland.

4. Ascorbic Acid

Briefly, 5 ml of the jam sample and 20 ml of distilled water (DW) were mixed well. Then, mixture was titrated using iodine solution in potassium iodide in presence of 2 ml of 1% starch reagent until blue color was appeared (13).

5. Anthocyanin

Anthocyanin was assessed using differential pH method of Wrolstad (14).

6. Viscosity

Flow behavior of the barberry jams was assessed using Brookfield rotary viscometer, USA. This test was measured at 25 °C and shear speed was 21 cm/s per second (15).

Sensory characteristics

In this study, ten trained judges were participated. Generally, five attributes (taste, aroma, color, texture and overall acceptance) of barberry jams were investigated in the form of panel test.

Statistical analysis

This study was carried out in a completely random statistical design. Data analysis was carried out using one-way variance test and average results were compared using Duncan's test. Furthermore, SPSS software v.16 (IBM, USA) was used for the analyses.

Results

Assessment of the quality characteristics of fresh barberry jams

Assessment of the quality characteristics of jams: Effects of treatments on the quality characteristics (pH, Brix, acidity, ascorbic acid, anthocyanin, two-phasic factor and viscosity) were included. Effects of treatments on Brix and acidity were significant at 1% level; however, no significant difference was seen in pH (Table 1). Effects of the treatments on two-phase barberry jams were significant at 1% level. Effects of the treatments on quantity of vitamin C in the barberry jam samples were significant at the level of 1%. Based on the available data, anthocyanin values of the jam samples significantly varied at the level of 5% (Table 2). Effects of treatments on the viscosity of fresh barberry jam samples were significant at 1% level (Table 2).

Assessment of the sensory characteristics of jams: Effects of the treatments on the sensory characteristics (taste, color, texture and overall acceptance) of the jams were investigated. Assessment results of the judges showed no significant differences in the sensory characteristics of the fresh barberry jam samples (Table 3).

Table 1. Comparison of the average effects of treatments on brix, acidity and pH of fresh barberry jams

Sample	Soluble Solids	Acidity	pH
1. (control = 300 gr of syrup (brix 75) and 90 gr of fresh barberry)	67.87 a	0.883 a	3 bc
2. (300 gr of syrup (brix 75) and 90 gr blanched fresh barberry in boiled water (5 s))	65.46 cd	0.806 b	3.1 abc
3. (300 gr of syrup (brix 75) and 90 gr blanched fresh barberry in boiled water (10 s))	65.7 cd	0.77 b	3.23 a
4. (300 gr of syrup (brix 75) and 90 gr osmosis fresh barberry in syrup 50% (2 h))	64.38 e	0.773 b	3.2 ab
5. (300 gr of syrup (brix 75) and 90 gr osmosis fresh barberry in syrup 50% (3 h))	65.68 cd	0.649 c	3.1 abc
6. (control+pectin (0.2%))	65.25 d	0.612 c	3.2 ab
7. (control+pectin (0.5%))	65.58 cd	0.878 b	3.1 abc
8. (control+guar (0.2%))	66.75 b	0.652 c	2.9 c
9. (control+guar (0.5%))	66 c	0.599 c	2.93 c

Numbers with different letters in each column have statistically significant differences (P<0.05).

Table 2. Comparison of the average effects of treatments on two-phasic, ascorbic acid, anthocyanin and viscosity of fresh barberry jams

Sample	Two Phase	Ascorbic Acid	Anthocyanin	Viscosity (m pa s)
1	0.522 f	9.68 b	48.92 bc	88.01 f
2	0.597 e	9.78 b	33.55 bc	116.63 d
3	0.671 c	10.56 a	61.03 b	102.65 e
4	0.605 e	7.1 d	25.79 c	100.61 e
5	0.625 d	7.01 d	32.05 bc	120.57 d
6	0.61 de	6.93 d	36.64 bc	387.77 b
7	0.996 a	8.8 c	33.81 bc	896.77 a
8	0.609 de	7.04 d	38.23 bc	152.21 c
9	0.8 b	8.87 c	96.68 a	154.19 c

Numbers with different letters in each column have statistically significant differences (P<0.05).

Table 3. Comparison of the average sensory characteristics of fresh barberry jams

Sample	Taste	Color	Texture	Overall
1	4.125 ab	4.625 ab	3.75 bc	4.125 abc
2	4.625 a	4.75 a	4.625 a	4.375 ab
3	4.125 ab	4.75 a	4.125 abc	4 abc
4	4.625 a	4.375 abc	4.125 abc	4.125 abc
5	4.375 ab	4.75 a	4.375 ab	4.625 a
6	4 ab	4.625 ab	4.25 ab	4.25 ab
7	3.75 b	4 bc	3.375 c	3.5 c
8	4.25 ab	4.125 bc	3.75 bc	4 abc
9	3.75 b	3.75 c	4 abc	3.75 bc

Numbers with different letters in each column have statistically significant differences (P<0.01).

Assessment of the quality characteristics of dried barberry jams

Assessment of the quality characteristics of jams: Results of the effect of treatments on the quality characteristics (pH, Brix, acidity, ascorbic acid, anthocyanin, two-phasic factor and viscosity) of dried barberry jams were analyzed. Effects of treatments on Brix and acidity were significant at 1% level; however, no significant difference was seen in pH (Table 4). Effects of the treatments on the quantity of two-phase, vitamin C and viscosity of barberry jam samples were significant at the level of 1% (Table 5). As the factor of two-phasic Approaches 1, uniformity of the jam increased. In jam Samples 5 and 6, maximum uniformity was seen; hence, all of barberry fruits were spread through the jams with no two-phasic. Since vitamin C is much sensitive and any changes lead to its decrease or destruction; therefore, the highest quantity of vitamin C was detected in the control sample. Results showed that the quantity of anthocyanin in the jam samples included no significant differences. As previously explained, addition of hydrocolloid compounds to the jams led to increases in viscosity or consistency.

Assessment of the sensory characteristics of jams: Effects of the treatments on the sensory characteristics (taste, color, texture and overall acceptance) of the jam samples were investigated. Results of the assessment of the judges showed no significant differences in the sensory characteristics of dried barberry jam samples (Table 6).

Table 4. Comparison of the effects of treatments on brix, acidity and pH of dried barberry jams

Sample	Soluble Solids	Acidity	pH
1. (control = 300 gr of syrup (Brix 60) and 30 gr of dry barberry)	66 cd	0.959 a	3.3 bc
2. (300 gr of syrup (Brix 60) and 30 gr blanched dry barberry in boiled water (5 s))	62.75 e	0.934 b	3.3 abc
3. (300 gr of syrup (Brix 60) and 30 gr blanched dried barberry in boiled water (10 s))	63.71 e	1.053 b	3.36 a
4. (control+pectin (0.2%))	68 ab	1.646 b	3.1 ab
5. (control+pectin (0.5%))	65.5 d	1.566 c	3.3 abc
6. (control+guar (0.2%))	67 bc	1.67 c	3.2 ab
7. (control+guar (0.5%))	68.92 a	1.53 b	3.16 abc

Numbers with different letters in each column have statistically significant differences (P<0.05).

Table 5. Comparison of the effects of treatments on two-phasic, ascorbic acid, anthocyanin and viscosity of dried barberry jams

Sample	Two - Phasic	Ascorbic Acid	Anthocyanin	Viscosity
1	0.4 d	61.6 a	4.63 a	153.81 d
2	0.368 e	35.18 d	0.87 a	76.64 e
3	0.33 f	28.16 e	3.37 a	100.54 e
4	0.7 b	27.27 ef	7.34 a	198.33 c
5	0.5 c	26.39 f	6.09 a	145.71 d
6	1 a	36.94 c	3.5 a	133.98 b
7	1 a	36.96 b	3.5 a	414.88 a

Numbers with different letters in each column have statistically significant differences (P<0.05).

Table 6. Comparison of average sensory properties of dried barberry jam

Sample	Taste	Color	Consistency	Overall Acceptance
1	3.7 a	3.7 a	3.5 a	3.5 a
2	3.7 a	4 a	3.2 a	3.5 a
3	4.1 a	4 a	3.5 a	3.7 a
4	3.3 a	3.7 a	3.7 a	3.4 ab
5	3.6 a	4.2 a	3.8 a	3.6 a
6	4.1 a	3.9 a	3.1 a	3.6 a
7	3.3 a	3.5 a	2.4 a	2.7 b

Numbers with different letters in each column have statistically significant differences (P<0.01).

Discussion

Results of the quality and sensory characteristics of barberry (fresh and dried) jams were shown in this report previously. Studies have been carried out in this field, whose results might verify results of this study. Noormohammadi et al. (2021) investigated the physicochemical, sensory and rheological characteristics of cherry jams based on the use of pectin. Results showed that the investigated factors included no significant effects on the pH of jams. Pectin included a significant effect on color indicators and rheology of the jam texture. Results of this study verified those of the present study (12). Kargorzari et al. (2016) used xanthan in the formulation of a drink prepared with limes. Results showed that although the hydrocolloids improved and stabilized texture of the drink; however, they did not include a significant effect on the acidity and pH of the samples (16). Maleki *et al*. (2017) in a study on ginger jams showed that the use of okra gum decreased pH in ginger jams; in contrast to the current study (17).

Quantity of two-phasic jams was reported as the ratio of the height of the fruit section to total height of the jam. This ratio indicates uniformity in jam texture. Results showed that the barberry jam samples containing 0.5% pectin included the highest texture uniformity and the control jam sample included the lowest uniformity. Maleki et al. (2017) showed that the viscosity of jam increased with okra gum during jam cooking (17). Sharii et al. (2021) used inulin hydrocolloids to improve texture in preparation of jams. Inulin with the ability of water absorption can create a hydrogen bond. It forms a gel network and increases the viscosity of jams (18). Results of this study verified those of the present study. Massoud et al. (2018) investigated the effect of xanthan gum on the rheological characteristics of jams. Results demonstrated that viscosity of the samples decreased when xanthan gum increased in the formulations (11). Hojjati et al. (2018) investigated the effect of edible hydrocolloids on the quality characteristics of fried falafels. Results of sensory evaluation showed that the addition of hydrocolloids improved the appearance, color, crispness and overall acceptance of the samples while included an adverse effect on the taste (19). Sharii et al. (2021) showed that inulin hydrocolloids included a favorable effect on the sensory characteristics of carrot jams; however, taste was not satisfactory (18).

Ochelle et al., 2024, assessed quality of jams produced from fresh and dried Roselle calyces (*Hibiscus sabdariffa*). Jams were produced from fresh and dried Roselle calyces and subjected to physicochemical and sensory analyses using standard methods. Result of the physicochemical characteristics of jams produced from fresh and dried Roselle calyces indicated no significant differences ($P > 0.05$). Results of the sensory attributes of jams produced from fresh and dried Roselle calyces showed no significant differences ($P > 0.05$) in preferences and acceptability. It was concluded that Roselle jams prepared from fresh or dried calyces were acceptable for consumption. The study recommended that fresh or dried Roselle calyces could be used in the production of jams due to their nutritional values (10). Results of this study were similar to those of the present study.

Conclusion

In this study, treatment effects on the quality of the barberry jam samples and their sensory characteristics were investigated. The highest uniformity of texture in fresh barberry jam samples was reported for the samples containing 0.5% pectin and the highest two-phasic level was assessed in control samples. In dried barberry jam samples, the highest uniformity of texture was associated to the samples of jams containing guar. Sample jams of dried barberries containing 0.2% guar were accepted by the judges. According to the judges, all the sensory characteristics of the samples included no significant differences.

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