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Investigating the Physicochemical Properties of Date Syrup Extracted with Ultrasound

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ABSTRACT

Date syrup extracted with ultrasound (for 0, 30, 60 and 90 min, at 25°C, 30 kHz frequency, 1500W and date/water at 1:6 ratio) and assessed for various physicochemical properties, hunter color values, turbidity, total sugar, sucrose, fructose, glucose, total phenolic, total flavonoid and total carotenoid values. Ultrasound had no significant effect ($p>0.05$) on pH, total soluble solids (°Brix) and acidity of date syrup. However, ultrasound significantly ($p<0.05$) increased turbidity, total sugar, sucrose, fructose, glucose, total phenolic, total flavonoid and decrease hunter color values and carotenoid content. Extraction of date syrup using ultrasound could improve properties of date syrup.

Keywords: *Extraction, Ultrasound, Physicochemical property, Date syrup*

INTRODUCTION

Dates (Phoenix dactylifera L.) mostly in the Middle Eastern region grow (Al-Hooti et al. 2000).Dates include proteins (1.9-3%), salt and minerals (1.3%), sugar (70.6-76.3%), fatty acids (0.2-2.8%) and vitamins (Entezari et al., 2004; Homayouni et al., 2015).Dates are rich in potassium and poor in sodium, thus they are an appropriate food for hypertensive persons. Also, dates have high level of dietary fiber content, which can be used for the production of fiber-based foods (Tariq et al., 2000). Dietary fiber displays a protective effect against prostate cancers, coronary heart disease (CHD), hypertension, intestinal, colorectal disorders and are useful for hyperlipidemia, obesity and diabetes (Beikzadeh et al., 2016; 2017).Date, that's seed, sugar and syrup have application in confectionery cream sweetened, jams, Kooshab, marmalades, canned date, ice cream, honey, sponge cake, malt beverage manufacturing. (Haji Aghrari et al., 2017; Homayouni et al., 2015; Homayouni-Rad et al., 2014; 2017).

The most important by product of date is date syrup. It is obtained in either at domestic mode (extraction and boiling down of the juice), or industrial mode (extraction, clarification and concentration of the juice). In both cases, fruit is heated for about 1 hour at 50 °C, which this temperature destroys nutrients and favorite colour (Entezari et al., 2004). Therefore, application of non-thermal methods with retention the original properties and improve nutritional profile is important. Ultrasound as non-thermal, innovative and green techniques is used for processing, pasteurization and extraction.

Ultrasound frequencies are lower than microwaves frequencies and higher than human earring (20 kHz-10 MHz) (Chemat et al., 2011).

Application of ultrasound by the mass transfer increasing between the plant material and solvent improve extraction process. Cavitation make by ultrasonic waves and it consists of three main stages that include the creation, then growth and collapse of bubbles in liquids. Disruption of cell walls due to the collapse of cavitation bubbles, increase penetration of solvent into the plant cells (Toma et al., 2001). In addition, sonication with temperature or alone against pathogens such as Escherichia coli (Salleh-Mack et al., 2007) and Listeria monocytogenes is effective(Baumann et al., 2005).

Ultrasound effects on diverse fruit juices such as kasturi lime (Bhat et al., 2011), orange, strawberry (Tiwari et al., 2008) and guava previously have been studied (Cheng et al., 2007).

Therefore, the main purpose of this work is to investigation of physicochemical properties of syrup dates extracted with ultrasound.

Materials and Methods

Extraction of Date Syrup

Dates used in this study was obtained from local market (East Azarbaijan, Iran). After defrosting and cleaning of date samplesin a meat grinder were gently (Moulinex, type NE 401, France) for date paste production. Then, pastes(200 g) with 1200 ml of water were mixed. For date syrup extraction: Samples mixed with vortex and sonicated for 0 (control), 30, 60 and 90 min. The sonication done at 30 kHz frequency and temperature of 25°C with full power of 1500W (Hielscher Ultrasonics GmbH). Samples in sterilized bags were stored, and kept at 4 °C.

Determination of pH, Total Soluble Solids (◦Brix), Acidity, Turbidity and Color Value

After calibration of pH metre (3510, Bibby, England) with buffer solutions (pH 4.0 and pH 7.0), the pH of date syrup was determined. A refractometer (2WAG ABBE, England) was used for total soluble solids determination. The acidity was titrated date syrups with standardized NaOH (0.1 N) (AOAC 2000). The color contents (L*a*b*) were measured. The a* content changes (green-red), the b* changes (blue-yellow) and L* (lightness) changes (black-white). A spectrophotometer (WKS 3000, England) was used for measurement of turbidity in800 nm against a blank (Al-Hooti. Et al., 1997).

Determination of Total Sugar, Sucrose, Fructose, Glucose

According to AOAC methods, date syrups were analyzed for total sugars and sucrose (AOAC 2000). In addition, byHPLC (plasma method by induction procedure) glucose and fructose were determined (Al-Hooti. Et al., 1997).

Determination of Total Phenolic, Total Flavonoid and Total Carotenoid in Date Syrup Samples

Total polyphenols using Folin–Ciocalteu procedure (mg of gallic acid equivalent)were determined (Al-Farsi et al., 2005).According to Zhishen et al. (1999) procedure with brief variation, total flavonoids were estimated. 0.3 ml of $NaNO_2$ (5%) with water (4 ml) and 1 ml date syrup (0.1 g/ml) mixed (stand for 5 min), then 0.3 ml of $AlCl_3$ (10%) added (stand for 1 min), after that, water (2.4 ml) and 2 ml of NaOH (4%) added. After stirring for 15 min, absorbance was measured at 510 nm. Total carotenoids were extracted and determined by spectrophotometer at 470 nm against a blank (Talcott et al., 1999).

Statistical Analysis

A one-way analysis by the Minitab Analysis System used for determination of significant differences ($P< 0.05$) between data.

Results and Discussion

Effect of Sonication on pH, Total Soluble Solids (◦Brix), Acidity, Turbidity and Color Value

Extraction of syrup using ultrasound on pH, acidity, °Brix, colour and turbidity were shown in Table (1).Samples were sonicated and control had no significant differences in terms of pH, Brix. Similar results in fruit (tomato and orange) juices were indicated (Adekunte et al., 2010).

Colour content in consumer satisfaction had an important character in judge the quality of date syrup. The results showed that date syrup samples extracted with ultrasound had significant differences ($p<0.05$)in comparison with control. The syrup extracted for 90 min showed the highest b* and the lowest L* and a* and vice versa for control sample. Aadil et al (2013) reported that the syrup extracted for 90 min showed the lowest colour values for(a*), (b*) and (L*), although the highest values for L*and a*in the control indicated while the highest b*determined in sample extracted for 60 min. Similar result was reported for guava juice (Cheng et al., 2007).

All the sonicated date syrups had significant increase ($p<0.05$) in turbidity content when compared to control. Samples sonicated for 90 min had the highest turbidity content. During extraction with ultrasound, the bigger particles break into the smaller particles due to homogenise and high pressure ramp by cavitation. Therefore, suspended molecular quantities increased and the space between elements decreased (Chemat et al., 2011).

Table1. *Effect of Sonication on Brix, pH, acidity, colour and turbidity in date syrup*

Sample	pH	Acidity	Brix	Turbidity	Color attributes		
					L^*	a^*	b^*
Control	4.682±0.01[a]	0.385±0.01[a]	79.016±0.21[a]	211±0.73[d]	9.14±0.01[a]	0.98±0.02[a]	2.03±0.04[d]
Ultrasound 30 min	4.643±0.02[a]	0.381±0.02[a]	78.994±0.35[a]	220±0.82[c]	8.88±0.02[b]	0.92±0.03[b]	3.66±0.02[c]
Ultrasound 60 min	4.681±0.02[a]	0.396±0.03[a]	78.845±0.19[a]	248±1.11[b]	8.52±0.01[c]	0.85±0.01[c]	4.11±0.01[b]
Ultrasound 90 min	4.655±0.03[a]	0.384±0.01[a]	78.693±0.42[a]	260±1.29[a]	8.43±0.04[d]	0.80±0.01[d]	4.89±0.02[a]

Contents including various letters (a-d) were significantly different ($P < 0.05$) in the same column.

Effect of Sonication on Total Sugar, Glucose, Fructose and Sucrose in Date Syrup

Total sugar of date syrup ranged from 56.242 g/100 g to 68.471 g/100 g (Table 2). The total level of total sugar was higher in syrups extracted for 90 min and lower in control sample. Glucose ranged from 37.583 g/100 g to 48.661 g/100 g. Fructose ranged from 18.554 g/100 g to 27.973 g/100 g. Sucrose ranged from 0.706 g/100 g to 0.915 g/100 g. In general, in these measurements there was significant increase in extracted date syrups by ultrasound in comparison with control. Breakdown of cell wall and cavitation increased production of sugar in sonicated syrups.

Table2. *Effect of sonication on total sugar, glucose, fructose and sucrose in date syrup*

Sample	Total sugar	Glucose	Fructose	Sucrose
Control	56.242±6.12^{c}	37.583±3.01^{c}	18.554±2.12^{b}	0.706±0.11^{b}
Ultrasound 30 min	61.587±5.01^{bc}	40.211±3.56^{bc}	24.671±3.02^{ab}	0.753±0.10^{b}
Ultrasound 60 min	66.232±6.33^{ab}	44.779±2.87^{ab}	25.346±2.69^{ab}	0.884±0.22^{a}
Ultrasound 90 min	68.471±4.41^{a}	48.661±3.42^{a}	27.973±1.97^{a}	0.915±0.19^{a}

Contents including various letters (a-d) were significantly different (P < 0.05) in the same column.

Effect of Sonication on Total Phenolic, Total Flavonoid and Total Carotenoid in Date Syrup

Total phenolic content of date syrup ranged from 402.552 mg/100 g to 510.562 mg/100 g (Table 3). The total quantities of phenolic compounds were higher in sonicated syrup for 90 min and lower in control syrup. Also, there was significant increase in total phenolic insonicated syrups as in comparison with control. Total flavonoid content of syrups ranged from 91.684 mg/100 g to 102.774 mg/100 g.

The lowest and highest content indicated in control syrup and sonicated syrup for90 min respectively. The results showed significant increase in sonicated syrups in comparison with controlin terms of total flavonoids. During extraction using ultrasound, cell wall by the cavitation pressure break and release of bound form of phenolic and flavonoid contents. Also, the hydroxyl group produced and added to the aromatic ring of phenolic compounds (Bhat et al., 2011).Total carotenoid content of date syrup ranged from 0.012 mg/100 g to 0.121 mg/100 g. The highest and lowest content obtained in control syrup and sonicated syrup for 90 min respectively. Liberation of carotenoids in the chloroplasts and in cell fluids and hydrolysis of pectin and cellulose increased carotenoids contents. Similar result attained in orange juice sonicated with high pressure (Chemat et al., 2011).

Table3. *Effect of sonication on total phenolic, total flavonoid and total carotenoid in date syrup*

Sample	Total phenolic	Total flavonoid	Total carotenoid
Control	402.552±8.22^{d}	91.684±5.87^{d}	0.121±0.01^{a}
Ultrasound 30 min	445.890±7.51^{c}	95.523±4.65^{c}	0.100±0.03^{b}
Ultrasound 60 min	487.337±5.43^{b}	99.903±6.91^{b}	0.017±0.01^{c}
Ultrasound 90 min	510.562±9.05^{a}	102.774±6.79^{a}	0.012±0.01^{c}

Contents including various letters (a-d) were significantly different (P < 0.05) in the same column.

CONCLUSION

Effect of ultrasound on physicochemical properties of date syrup investigated. No significant differences in pH, acidity and °Brix, but significant increases in turbidity, colour, total sugar, glucose, fructose, sucrose, total phenolic and total flavonoid contents and significant decrease in total carotenoid sonicated sample were observed after ultrasound. This research indicated that ultrasound as a non-thermal and economical technique could be used to increase extraction yield and nutritional quality of date syrup.

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