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Effect of Wheat Germ Addition on Physicochemical and Antioxidant Properties of Date Syrup

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ABSTRACT

Wheat germ was utilized for improvement in quality and nutritive value of date syrup in the present study. Some physicochemical (total soluble solids, water activity, pH, consistency, color) and antioxidant properties of different date syrup/wheat germ blends (0, 2, 4, 6, 8 and 10% wheat germ) were investigated. Total soluble solids and pH of date syrup were slightly affected by addition of wheat germ. The consistency values of blends were increased by increasing wheat germ addition, while, water activity values were gradually decreased (0.677-0.655). Significant differences ($p<0.05$) in the CIE L* a* b* color values for date syrup/wheat germ blends were noticed. The phenolic content of blends was slightly affected by wheat germ addition. Non significant differences ($p<0.05$) were observed in the antioxidant activity (192-200 TEAC μmol/100 g sample) among the date syrup/wheat germ blends. Results showed that blends containing 2, 4 and 6% wheat germ presented a higher overall acceptability. The obtained results suggest that wheat germ could be used for improvement in quality and nutritive value of date syrup.

Key words: Date syrup, wheat germ, DPPH, antioxidant activity, consistency values

INTRODUCTION

Dates (*Phoenix dactylifera* L.) are important crop in many Arabian countries. Date fruit is an important component of meals in the Arabian Gulf countries. Dates processing plants are producing various products including the production of date syrup (El-Sharawy *et al*., 1989; Ahmed and Robinson, 1999), salami-like rolls and fruit cakes and the production of sugar, alcohol and vinegar (Shinwari, 1992), the production of chutney and glaces (Sawaya *et al*., 1989), ice cream making (Hamad *et al*., 1983), the production of high caramel colour (Mikki *et al*., 1983), the preparation of dehydrated sheets (Tamaruddin) of dates (El-Nakhal *et al*., 1989) and date paste (Ahmed *et al*., 2005).

Date syrup is thick-dark brown syrup extracted from dates. The east side of Saudi Arabia produced about 1200 ton of date syrup in 2008 (Algazail, 2008).

Date syrup, the main byproduct of date, is utilized as an ingredient in many foods like jams, marmalades, beverages, chocolates, ice cream and confectioneries (Entezari *et al*., 2004), citric acid production (Roukas and Kotzekidou, 1997; Al-Shehri and Mostafa, 2006), functional yogurt (Gad *et al*., 2010) and manufacturing a yellowish colour with excellent flavor granules and tablets (Alanazi, 2010). The processing of date syrup, the fruits are mixed with water and heated for around 1 h at 50°C, when the main components, sugars, are extracted (Entezari *et al*., 2004). Date syrup is rich in nutrients (Razavi *et al*., 2007), the main component in date syrup is sugars (about 88%) such as glucose and fructose (Al-Hooti *et al*., 2002), important elements i.e., K, Mg and Ca (Al-Khateeb, 2008).

The embryo of the wheat grains is known as the wheat germ and produced during wheat milling as a by-product. Wheat germ is rich in important nutrients such as proteins, oils, sugars, vitamins (i.e., tocopherols, pantothenic acid, thiamine) and minerals (i.e., magnesium, zinc, phosphorous). The germ provides three times as much protein, seven times as much fat, fifteen times as mush sugars and six times as much mineral content than does wheat flour (Rao *et al*., 1980).

Wheat germ possesses antioxidant activity mainly due to its content of tocopherols (Ford-Martin, 2005). However, there is no information on the use of wheat germ in date syrup. In this study, the author attempted to assess the suitability of wheat germ utilization for improvement in quality and nutritive value of date syrup.

MATERIALS AND METHODS

Studies of some physicochemical and antioxidant properties of date syrup as affected by wheat germ addition were conducted on October, 2010 till December 2011 at Food Science and Human Nutrition Department, Agriculture and Veterinary Medicine College, Qassim University, Qassim, Saudi Arabia.

Materials: Date syrup (DS) was obtained from El-Watania company, Qassim, Saudi Arabia. Wheat germ (WG) was obtained from Grains Silos and Flour Mills Association, Qassim branch, Qassim, Saudi Arabia, while, 1,1-Diphenyl -2- Picrylhydrazyl (DPPH) was purchased from Fluka Chemika (Buchs, Switzerland). All solvents and chemicals were of analytical grades and obtained from local markets.

Date syrup/WG blends preparation: Date syrup and WG samples were separately weighed then WG was added to date syrup. The different blends (0, 2, 4, 6, 8 and 10% WG) well mixed and refrigerated till use.

Proximate composition: Proximate composition (moisture, protein, fat, carbohydrates, fibers and ash) of wheat germ and date syrup (fresh weight bases) was carried out according to AOAC (2000), while the Abbe Refractometer (at 20°C) was utilized to measure the total soluble solids (brix) of the DS/WG blends (0, 2, 4, 6, 8 and 10% WG). The pH of the blends were measured using pH meter (Hanna, Romania).

Bostwick consistency: The consistency (flow time, sec) of the DS/WG blends (0, 2, 4, 6, 8 and 10% WG) was measured using Bostwick consistometer. The reported values are the distance in centimeters the product flowed in a Bostwick consistometer when both blends and consistometer were adjusted to 20°C (Marsh *et al*., 1980).

Water activity: Water activity of the DS/WG blends was measured using water activity meter (Aqualab Model Series 3, Decagon, Devices, Inc, USA).

Determination of phenolic compounds: The Total Phenolic compounds (TP) of DS/WG blends (0, 2, 4, 6, 8 and 10% WG) were determined according to the Folin-Ciocalteu method (Singleton *et al*., 1999) using gallic acid as standard.

Determination of antioxidant activity: The 1, 1-Diphenyl -2- Picrylhydrazyl (DPPH) assay (Lee *et al*., 2003) was utilized with some modifications. The stock reagent solution was prepared by

dissolving 24 mg of DPPH in 100 mL methanol and stored at -20°C until used. The working solution was obtained by mixing 10 mL of the stock solution with 45 mL methanol to obtain an absorbance value of 1.1±0.02 at 515 nm using a spectrophotometer (Jenway, USA). One gram of each DS/WG blend was extracted by 50 mL methanol 80% with shaking for 5 min. Date syrup and wheat germ blends extracts (0.75 mL each) were allowed to react with 1.5 mL of the DPPH solution, then the absorbance was measured at 515 nm at the 5th min. A control sample with no added extract was also carried out. Standard curve was carried out using Trolox and the results were expressed as Trolox Equivalent Antioxidant Capacity (TEAC).

CIE L* a* b* colour measurement of date syrup: The CIE L* a* b* colour values for DS/WG blends (0, 2, 4, 6, 8 and 10% WG) were measured with a Hunter Lab colour measurement system (HunterLab, Colorflex, Hunter Associates laboratory, USA).

Sensory evaluation: Fresh samples of DS/WG blends (0, 2, 4, 6, 8, 10% WG) were given digit codes and organoleptically evaluated by 20 staff members in Food Science and Human Nutrition Department, Agriculture and Veterinary Medicine College, Qassim University. All samples were evaluated for color, texture, taste, odor, appearance and overall acceptability on ten-point hedonic scale, on which a score of 10 represented attributes most liked; 5 represented attributes at an unacceptable margin and 1 represented attributes most disliked.

Statistical analyses: All analyses were carried out in triplicate. The CIE L* a* b* color values and antioxidant activity data were statistically ($p<0.05$) analyzed using one-way analyses of variance, ANOVA (Rao and Blane, 1985).

RESULTS AND DISCUSSION

Proximate composition of the used wheat germ and date syrup: Table 1 presents the average compositions (fresh weight bases) of the used wheat germ. It could be noticed that wheat germ contained moisture 5.26, carbohydrate 46.70, ash 5.00, fat 9.90, fiber 4.96 and protein 26.80%. It also contained total phenols 0.77%. The obtained results are in agreement with those of Hassan *et al.* (2010) and Kumar *et al.* (2011). This indicates that these by-products resulted during wheat milling could be used as a source of carbohydrate, protein and phenolic compounds.

Also, data in Table 1 show that proximate composition (fresh weight bases) of the used date syrup. The date syrup contained moisture, carbohydrate, ash, fat and protein as follows: 20.50, 73.00, 1.50, 2.80 and 0.92%, respectively. It also contained 0.28% phenolic compounds. These results are in agreement with those of Al-Farsi *et al.* (2007).

Total soluble solids and pH values: Table 2 showed that the Total Soluble Solids (TSS) in date syrup (control) were slightly affected by addition of WG. The TSS in date syrup was 75.6 brix and increased to 76.6 brix in date syrup blended with 10% WG. Likewise, pH values of date syrup were slightly increased by increasing the addition of WG. The pH of date syrup (control) was 4.60 and increased to 4.87 in date syrup containing 10% WG.

Water activity: Water activity (aw) of the date syrup/WG blends (0, 2, 4, 6, 8 and 10% WG) was determined as shown in Table 2. Water activity values in the date syrup/WG blends were gradually decreased by increasing WG addition. Water activity of date syrup was 0.677 and decreased to

Table 1: Proximate composition of the used wheat germ and date syrup (fresh weight bases)

	Percentage	
Constituents	Wheat germ	Date syrup
Protein	26.80	0.92
Fat	9.90	2.80
Ash	5.00	1.50
Fiber	4.96	-
Moisture	5.26	20.50
Phenolic content	0.774	0.281
Water activity	0.56	0.67
[a]Carbohydrate	46.70	73.00

[a]Carbohydrate obtained by difference

Table 2: Total soluble solids, pH, water activity, consistency values, total phenolic content and antioxidant activity of date syrup as affected by wheat germ addition

Sample	TSS (brix)	pH	aw	Consistency (flow time, sec.)	Total phenolic content (%)	Antioxidant activity Trolox µmol /100 g sample
Control (DS)	75.6	4.60	0.677	18	0.281	192.8±3.39[a]
DS+2%WG	76.0	4.66	0.672	21	0.345	197.6±3.39[a]
DS+4%WG	76.1	4.69	0.663	37	0.368	192.0±4.52[a]
DS+6%WG	76.1	4.73	0.662	40	0.381	197.6±3.39[a]
DS+8%WG	76.3	4.74	0.656	80	0.386	200.0±4.52[a]
DS+10%WG	76.6	4.87	0.655	120	0.390	200.0±4.52[a]

DS: Date syrup, WG: Wheat germ, TSS: Total soluble solids, aw: Water activity, Means followed by different superscripts within columns are significantly different at the 5 % level

0.655 in date syrup containing 10% WG. Most bacteria cannot grow at aw below 0.9, yeasts below 0.85 and moulds below 0.7 (Bender, 1982). Therefore, the blends could be considered microbiologically shelf stable as long as no moisture is gained during storage.

Bostwick consistency: Although consistency may be considered a textural quality attribute, in many instances we can see consistency and so it also is another factor in food appearance (Potter and Hotchkiss, 1995). The simplest method to determine consistency is to measure the time it takes for more viscous foods to flow down an inclined plane using the Bostwick consistometer. The consistency (flow time, sec) of the DS/WG blends (0, 2, 4, 6, 8 and 10% WG) was shown in Table 2. The viscosity of date syrup/WG blends was increased by increasing WG addition. The flow time of date syrup (control) was 18 sec and increased to 120 sec, in date syrup containing 10% WG.

Total phenolic content: Table 2 shows the total extracted phenolic compounds from WG using the water. Results generally, revealed that the total phenolic content was slightly increased in date syrup by increasing the WG addition. Total phenolic content was 0.281% in date syrup (control) and increased to 0.390% in date syrup containing 10% WG. This is due to the high content of total phenols (0.774%) in WG (Table 1). The obtained results are in agreement with those of Al-Farsi *et al.* (2007), who found that date syrup contained total phenolics 96-162 mg gallic acid/100 g sample.

Antioxidant activity: The DPPH radical is commonly used for the assessment of antioxidant potency in vitro and it is foreign to biological systems (Zhou and Yu, 2004). DPPH is a very stable organic free radical with deep violet colour, which gives absorption maxima within the 515-528 nm range. Upon receiving a proton from any hydrogen donor, mainly from phenolics, it loses it chromophore and becomes yellow. By increasing the concentration of phenolic compounds or degree of hydroxylation of the phenolic compounds, their DPPH radical scavenging activity also increases and can be defined as an antioxidant (Sanchez-Moreno *et al*., 1999). Because these radicals are very sensitive to the presence of hydrogen donors, the whole system operates at a very low concentration; a large number of samples can be tested in a short time (Iqbal *et al*., 2006; Zhou and Yu, 2004).

Data in Table 2 show the antioxidant activities (TEAC) of the methanolic extracts of DS/WG blends (0, 2, 4, 6, 8 and 10% WG). Non Significant differences ($p<0.05$) between the methanolic extracts of DS/WG blends were observed at the 5th min of the reaction (192-200 TEAC µmol/100 g sample). Al-Farsi *et al*. (2007) found that date syrups contained 84-174 TEAC µmol/g sample. Results clearly indicate that all methanolic extracts exhibited a slight increase in antioxidant activity by increasing the addition of WG. There is a correlation between the total phenols and antioxidant activity as shown in Table 2. Several studies showed good correlation between the total phenols and antioxidant activity (Huang *et al*., 2005; Javanmardi *et al*., 2003; Silva *et al*., 2007).

CIE L* a* b* colour measurement of date syrup: Colour is important sensory quality attribute of date syrup because it is usually the first characteristic the customer observes. The CIE L* a* b* colour values for DS/WG blends (0, 2, 4, 6, 8 and 10% WG) showed that by increasing wheat germ addition the lightness, redness and yellowness colours of the blends increased (Table 3). Significant differences ($p<0.05$) in L* a* b* colour values among DS/WG blends were noticed. L* passes from 6.05 (control) to 15.28 (date syrup containing 10% WG), a* ranged from -0.04 (control) to 8.21 (date syrup containing 10% WG) and b* ranged between 2.22 (control) and 9.21 (date syrup containing 10% WG).This is indicating that date syrup containing more WG became relatively lighter (high lightness value) and more attractive. This could be due, the yellowish white colour of the wheat germ. As shown in Table 3, the use of this material (WG) could affect the colour of the final product and become more lighter and attractive.

Sensory evaluation: Data presented in Table 4 indicate the sensory evaluation of different DS/WG blends. The data showed that colour improvement was found in the samples replaced with 2, 4, 6, 8 and 10% WG compared with the control sample, whereas more addition of WG at 6, 8 and

Table 3: CIE L* a* b* colour values of date syrup as affected by wheat germ addition

Sample	L*	a*	b*
Control (DS)	6.05 ± 0.1^{f}	-0.04 ± 0.01^{f}	2.22 ± 0.1^{f}
DS+2%WG	10.56 ± 0.2^{d}	5.96 ± 0.20^{d}	6.21 ± 0.1^{d}
DS+4%WG	10.33 ± 0.1^{e}	5.48 ± 0.10^{e}	5.77 ± 0.1^{e}
DS+6%WG	13.21 ± 0.1^{b}	7.93 ± 0.20^{b}	8.04 ± 0.1^{b}
DS+8%WG	12.88 ± 0.2^{c}	7.42 ± 0.10^{c}	7.43 ± 0.1^{c}
DS+10%WG	15.28 ± 0.2^{a}	8.21 ± 0.20^{a}	9.21 ± 0.2^{a}

DS: Date Syrup, WG: Wheat germ. Means followed by different superscripts within columns are significantly different at the 5 % level L* value is a measure of lightness ranging from 0(black) to 100(white), the a* value ranges from -100(greenness) to +100(redness) and the b* value ranges from -100 (blueness) to +100 (yellowness)

Table 4: Sensory evaluation of date syrup as affected by wheat germ addition

Sample	Colour	Texture	Taste	Odour	Overall acceptability
Control (DS)	9.0±0.1	9.0±0.1	8.0±0.2	9.0±0.2	9.0±0.1
DS+2%WG	9.0±0.1	9.0±0.2	8.0±0.1	8.0±0.1	8.5±0.2
DS+4%WG	9.0±0.2	8.0±0.2	8.0±0.1	8.0±0.1	8.0±0.3
DS+6%WG	9.0±0.1	7.0±0.1	8.0±0.2	8.0±0.2	8.0±0.3
DS+8%WG	9.0±0.1	6.0±0.2	7.0±0.2	7.0±0.3	6.5±0.2
DS+10%WG	10.0±0.3	6.0±0.1	6.0±0.3	6.0±0.2	6.0±0.3

DS: Date syrup, WG: Wheat germ, Mean±Standard deviation

10% decreased texture, taste, odour and overall acceptability scores. Concerning syrup colour, gradual increase in scores was noticed in the samples replaced with 2, 4, 6, 8 and 10% WG compared with the control sample and colour of samples became relatively lighter and more attractive as mentioned in Table 3. On the other hand, WG negatively affected texture because the substituted samples became more viscous and look like jam. As for taste and odour gradual decrease was noticed between tested samples and control till a 10% replacement with WG. In general date syrup substituted with 8 and 10% WG got the lowest acceptability scores due to unacceptable texture, taste and odour. Overall acceptability data indicated that the date syrup samples substituted with 2, 4 and 6% WG were in the acceptable limit compared with the control sample.

CONCLUSION

The results presented here suggest that wheat germ, wheat by-products, led to quality improvement of date syrup, in particular aw, colour, total phenolics and antioxidant activity. Therefore, wheat germ serve as inexpensive source of important nutrients, total phenolics and natural antioxidant activity could be used as a functional food or functional food ingredient.

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