International Food Research Journal 23(6): 2419-2425 (December 2016)
Journal homepage: http://www.ifrj.upm.edu.my

Date seed as a new source of dietary fiber: physicochemical and baking properties

[1]Shokrollahi, F. and [2*]Taghizadeh, M.

[1]*Department of Food Science and Technology, Ferdowsi University of Mashhad (FUM), Mashhad 9177948974, Iran*
[2]*Department of Food Science and Technology, Ferdowsi University of Mashhad (FUM), Mashhad 9177948974, Iran*

Article history

Received: 23 December 2014
Received in revised form: 28 March 2016
Accepted: 13 April 2016

Keywords

Date seed
Dietary fiber
Physicochemical properties
Baking properties

Abstract

Dietary fiber possesses positive effects on health as well as appropriate functional properties which make it suitable to be used in different food products. In this research, date seed dietary fiber (DSDF) which is the defatted powder of date seed was examined as a new source of dietary fiber. Chemical, physical and baking properties were evaluated and compared with a commercial fiber, called Fibrex which is obtained from sugar beet after sugar extraction. DSDF high content of dietary fiber (78.6 %) indicated that it is richer and purer than Fibrex (65.74 %). Analysis of L^*, a^* and b^* showed light red and yellow color for DSDF and Fibrex, respectively. Oil holding capacity of DSDF (1.33 g/g) was similar to Fibrex (1.32 g/g) but water retention capacity of DSDF (2.75 g/g) was lower than Fibrex (5.26 g/g). Substitution of wheat flour with 2.5% and 5% of Fibrex or DSDF showed that only firmness of bread containing 2.5% DSDF was not different with the control bread (0% fiber). Sensory analysis revealed that all samples except samples containing 5% Fibrex obtained overall acceptability, thus these samples would be advisable for bread making. These results confirm that DSDF is a rich source of dietary fiber with appropriate physical and baking properties which could be successfully used in bakery products.

Introduction

Dietary fiber is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances. Dietary fibers promote beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation (AACC, 2001). In addition to health effects, dietary fiber has positive technological effects such as increasing viscosity, modifying texture, prohibiting of crystallization, increasing retained oil and water, stabilizing emulsions etc. For these reasons, dietary fiber has widespread applications in food industry. It can be used in bread, baked products, pasta, noodles, juices, soups, confectioneries, dairy, meat and fishery products (Tosh and Yada, 2010; Elleuch *et al.*, 2011; Aziah and Komathi, 2009).

Phoenix dactylifera L. also known as the date palm is cultivated in the hot desert regions of Southwest Asia and North Africa. Date fruit is composed of 2 parts: seed and fleshy pericarp. Date flesh is rich in sugars (43.4 g/100 g) and is a good source of rapid energy (Al-Farsi and Lee, 2008). This could be one of the explanations of why Muslims use date fruit to break their fast during holy month of Ramadan, and also might be the reason Saint Mary was told to eat ripe and fresh date following giving birth to Jesus to compensate her physical weakness (The holy book of Quran, C.19, V.25). Date seed which constitutes 10 - 15% of the fruit weight (Hussein *et al.*, 1998) is an excellent source of dietary fiber (73.1 g/100 g) comparing to the date flesh (7.5 g/100 g). Date seed possesses health benefits due to its high amount of dietary fiber. Moreover, the high phenolic compounds content makes date seed to be considered as a functional food ingredient (Al-Farsi and Lee, 2008). Bauza (2002) reported that date kernel is rich in phytohormones that have anti-aging properties. Consequently, date kernel significantly reduces skin wrinkles.

Iran, with annual date production of 1,066 million tons, is in the second rank of date producers in the world (FAO, 2012). At the processing units, when several operations including pitting, chopping and syrup extraction were performed on date fruit, date seed is either being collected for animal feeding

*Corresponding author.
Email: mtaghizadeh@um.ac.ir
Tel: 0098-51-38805755

or discarded without any use. Considering the large amount of date seed which is currently being discarded as a waste stream and its high dietary fiber content, characterization of date seed dietary fiber would introduce a new great and inexpensive source of dietary fiber to food industry.

Some research works have been carried out in order to investigate chemical composition of date seeds (Hamada *et al*., 2002; Ali-Mohamed and Khamis, 2004; Al-Farsi *et al*., 2007; Habib and Ibrahim, 2009; Shams Ardekani *et al*., 2010; Habib *et al*., 2013). Some other researchers have used date seed for the production of different substances such as citric acid (Abou-zeid *et al*., 1983), baker's yeast biomass (Nancib *et al*., 1997), Streptococcus thermophilus (Nancib *et al*., 1999) or for other applications such as jam production (Mirghani *et al*., 2012) as well as bread making (Almana and Mahmoud, 1994). Although several works have been done on date seed, characterization of date seed's dietary fiber has not yet been reported. The aim of this study was: (1) to characterize the physicochemical and baking properties of date seed dietary fiber, (2) to compare date seed dietary fiber with Fibrex (commercial fiber from sugar beet).

Materials and Methods

Materials

Date from kaluteh variety at "tamr stage" (full ripeness) was obtained from Jiroft city, Iran. Fibrex was purchased from Nordic sugar (Copenhagen, Denmark), enzymes from megazyme (Wicklow, Ireland), chemical reagents from Merck Inc (Darmstadt, Germany). Wheat flour was obtained from acce ard (Mashhad, Iran). Salt (sodium chloride), sugar (sucrose) and active dry yeast were purchased from local market (Mashhad, Iran).

Preparing DSDF

Date seeds were removed, cleaned with water, dried at 50°C for 48 hours, crushed with a hammer mill and finally were passed through a 420 micron sieve. The resulted powder was defatted with n-hexane for 2 hours and then was dried at 60 °C for 4 hours. The final defatted powder was tagged as "date seed dietary fiber (DSDF)" and was refrigerated at 5 °C prior to further analysis.

Chemical composition

Moisture, ash, protein and fat contents were determined according to the corresponding AOAC methods (2000). Dietary fiber was determined according to the enzymatic-gravimetric method of Prosky *et al.* (1988). Digestible carbohydrate was calculated by difference.

Particle size

Retsch test sieves (Vibro GmbH and Co., Retsch, Haan, West-Germany) was applied to shake 50 grams of samples. The sieves were 60, 70, 80, 120, 140, 200 mesh. Sigma plot (version 11.0) was used calculate the geometric mean diameter.

Color

To determine the color characteristics, Images of DSDF and fibrex were acquired by Genius scanner (color page-HR6X Slim) and were saved in JPEG format. ImageJ software v. 1.4 g (National Institute of Health, USA) was used to extract L^*, a^* and b^* values.

Bulk and packed density

The method proposed by Prakongpan *et al.* (2002) was used to measure bulk and packed density.

Hydration properties

Swelling and water retention capacity (WRC) were determined following the procedures proposed by Robertson *et al*. (2000).

Oil holding capacity

The method proposed by Dalgetty and Baik (2003) with slight modification was used to determine oil holding capacity (OHC). Five hundred mg of sample was mixed with 10 cm^3 sunflower oil in a 50 cm^3 centrifuge tube. Every 5 minutes, the tube was shaken for 30 seconds in a 30–minute time period and then was centrifuged at 1600 g for 25 minutes. The supernatant was discarded and the volume was recorded.

Emulsifying capacity

A suspension of 2% fiber was prepared and emulsifying capacity was determined according to the method of Betancur Ancona *et al.* (2004)

Baking procedure

Bread was made using wheat flour (100%), sugar (1%), sodium chloride (1.5%), oil (1%), dry activated yeast (1%) and water (60%). Baking tests were carried out by substitution of flour with 5 and 10% of dietary fiber. The dough was fermented for 10 minutes. Then dough was divided into 250 g pieces. After 60 minutes fermentation at 37°C and 87% moisture, bread was baked 30 minutes at 180°C. After baking, the loaves were removed from the oven and were cooled for 1 hour at room temperature. Finally bread loaves were packed in polyethylene bags and were kept at room temperature until further determination.

Specific volume of bread

Sesame seed displacement method (Approved Method 10-05, AACC, 2000) was used to determine the volume for 1 hour-cooled bread loaves. Weight of each loaf was recorded and specific volume was calculated in cubic centimeter per gram of sample.

Color of bread

Three slices were randomly selected from the middle of loaves. Each slice was 4 × 4 and was scanned by the scanner at 600 dpi. Images were saved in RGB format and $L^*a^*b^*$ values were obtained using ImageJ software.

Bread texture

Texture profile analysis (TPA) was performed using a texture analyzer (Model QTS Brookfield, UK). A 36 mm diameter cylindrical probe with a crosshead speed of 100 mm/min was used to compress the sample until 40% strain (Approved Method 74-09, AACC, 2000).

Sensory evaluation

Nine-point hedonic scale was conducted, where 9 was representing extremely liked and 1 was representing extremely disliked. Thirty semi-trained panelists evaluated 1-old day bread for 5 attributes including color, aroma, taste, texture, and overall acceptability.

Statistical analysis

All data were analyzed with Minitab 16.2 using one way analysis of variance (ANOVA) and the least significant difference (LSD) test. Significant differences were considered at $P < 0.05$. Data were expressed as mean ± standard deviation.

Results and Discussion

Physicochemical properties

Chemical analysis of date seed, date seed dietary fiber (defatted date seed) and Fibrex is shown in Table 1. The values obtained for date seed components are in agreement with results reported by others (Hamada *et al*., 2002; Al-Farsi *et al*., 2007; Habib and Ibrahim, 2009) who analysed 24 variations of date seeds (Table 2). The results showed that total dietary fiber (TDF) content of Kaluteh variety, in this study, is similar to the average value of other 24 variations. It indicates that Kaluteh is an appropriate variety to supply dietary fiber.

Date seed is a rich source of dietary fiber compared to some other agricultural by-products. Cereal bran including oat bran (Manãs, 1992; Grigelmo-Miguel and Martín-Belloso, 1997), rice bran (Abdul-Hamid and Luan, 2000), barley bagasse (Mollá *et al*., 1994) and wheat bran (Grigelmo-Miguel and Martín-Belloso, 1997; Prosky *et al*., 1988) have a TDF ranged from 10.24 to 44.46%. Several fruit residues including wine grape pomace skins, grapefruit, orange, apple and lemon contain 17.28 to 89.8% (Figuerola *et al*., 2005; Deng *et al*., 2011).

Little amount of ash in date seed could be a reason for the low amount of phytic acid. Habib and Ibrahim (2009) have reported low amount of ash (0.82-1.14 g/100 g) and phosphorus (128.3 mg/100 g) for 18 variations of date seed. As a result, date seed is an excellent source of dietary fiber compared to cereal bran because of its higher dietary fiber and lower phytic acid.

All components in DSDF and Fibrex are significantly different ($P < 0.05$). Fibrex contains significantly higher amount of soluble dietary fiber (SDF) comparing to that of DSDF. This could positively affect hydration properties of Fibrex. IDF and TDF of DSDF were higher than Fibrex. The other components (impurities such as fat, protein, ash and digestible carbohydrate) in DSDF were lower than Fibrex. Thus, DSDF can be considered as a rich and pure source of dietary fiber in comparison with Fibrex.

Particle size

DSDF has a significant larger geometric mean diameter (170.32 micron) compared to Fibrex (77.62 micron). This may be due to the different milling process of date seed and Fibrex. The larger particle size of DSDF might have positive effect on health. Brodribb and Groves (1978) reported that larger particle of bran increases stool weight. An increase in stool weight leads to decrease in transit time and diverticular disease outbreak.

Color

Table 3 represents the color parameters of DSDF and Fibrex. Similar results were obtained for lightness (L^*) while a^* and b^* values were found to be significantly ($P < 0.05$) different in DSDF and Fibrex. The positive value of a^* shows that DSDF is reddish and the higher values of yellowness ($+b^*$) in Fibrex shows that Fibrex is yellowish.

All L^*, a^* and b^* values obtained in this study are similar to the values reported by Rosell *et al*. (2009) for 11 commercial dietary fibers. This suggests the high competitive potential of DSDF as source of

Table 1. Chemical analysis of date seed, date seed dietary fiber and Fibrex (g/ 100g)

	Date seed	DSDF	Fibrex
Moisture	6.78 ±0 .42 ab	6.35 ± 0.26 ^{b}	6.94 ± 0.07 ^{a}
Protein	5.81 ± 0.02 c	6.29 ± 0.06 ^{b}	10.04 ± 0.04 ^{a}
Fat	8.89 ± 0.05 a	3.45 ± 0.32 b	2.56 ± 0.39 c
Ash	0.91 ± 0.03 b	0.99 ± 0.02 b	3.71 ± 0.08 a
IDF	69.18 ± 0.37 b	73.98 ± 0.63 a	44.40 ± 1.02 c
SDF	4.29 ± 1 b	4.62 ± .70 b	21.34 ± 1.8 a
TDF	73.47 ± 1.17 b	78.60 ± 0.67 a	65.74 ± 1.79 c
Digestible carbohydrate	4.14 ± 0.80 b	4.32 ± 0.81 b	11.01 ± 1.14 a

Note: Means that do not share a letter within a row are significantly different (P < 0.05, n = 3).

Table 2. Chemical analysis of different variations of date seed (g/ 100g)

Number of varieties	Moisture	Protein	Fat	Ash	Fiber	Indigestible Carbohydrate	Reference
18 varieties	10.47	5.59	7.07	0.97	71.32	4.58	Habib, H. M., & Ibrahim, W. H. (2009)
3 varieties	4.24	3.87	5.34	1.03	79.25	6.27	Al-Farsi *et al.*, (2007)
3 varieties	9.10	5.63	11.2	1.4	67.03	5.64	Hamada *et al.*, (2002)
Average	9.52	5.38	7.37	1.03	72.47	4.19	

dietary fiber in case of color characteristics.

Bulk and packed density

Bulk densities of DSDF and Fibrex were found to be 0.48 and 0.54 g/cm^3, respectively. Additionally, packed density values were 0.75 and 0.67 g/cm^3 for DSDF and Fibrex, respectively.

Hydration properties

Hydration properties of both DSDF and Fibrex are also presented in Table 3. Both swelling and water retention capacity of DSDF were significantly (P < 0.05) lower than those of Fibrex. Grigelmo-Miguel and Martín-Belloso (1999), Betancur-Ancona *et al.* (2004), Fuentes-Alventosa *et al.* (2009) and Gómez-Ordóñez *et al.* (2011) stated that higher SDF leads to higher hydration properties. But Robertson *et al.* (2000) indicated that WRC measures water retained by the insoluble matrix. Thebaudin *et al.* (1997) also indicated that water holding capacity (WHC) and water binding capacity (WBC) are not relevant for SDF. So there are two possibilities for the higher hydration properties of Fibrex: first is the higher SDF content of Fibrex and the second is a difference in chemical and physical properties of IDF of Fibrex and DSDF. Maybe Fibrex which is a commercial fiber have been treated. Sangnark and Noomhorm (2003 and 2004) indicated that alkaline hydrogen peroxide affects on chemical and physical properties of dietary fiber. They indicated that alkaline hydrogen peroxide decreased lignin which is the most insoluble component. Moreover, the hydrogen bonding pattern between cellulose chains was disrupted, free hydroxyl group become available for binding molecule of water, thereby enhancing the WHC of cellulose.

Abdul-Hamid and Luan (2000) reported similar value of 4.56 g/g for Fibrex. WRC of DSDF is higher than cellulose (Lecumberri *et al.*, 2007), rice bran (Chen *et al.*, 1984), grape, lemon, apple, orange, (Figuerola *et al.*, 2005). It is similar to the values obtained for pea, wheat (Thebaudin *et al.*, 1997), and wheat bran (Chen *et al.*, 1984).

Oil holding capacity

No significant difference (P < 0.05) in OHC was found between DSDF and Fibrex (Table 3). Abdul-Hamid and Luan (2000) reported similar OHC value for Fibrex (1.29 ml/g). Also, OHC of DSDF was found to be similar to pulses fiber (Wang and Toews, 2011), grape, lemon, apple (Figuerola *et al.*, 2005), wheat, pea, carrot and apple (Thebaudin *et al.*, 1997).

Emulsifying Capacity

Emulsifying capacity of DSDF was found to be significantly (P < 0.05) higher than Fibrex but both had a low value (2.66% and 1.43% respectively). Prakongpan *et al.* (2002) stated that emulsifying capacity of dietary fiber and cellulose obtained from pineapple core are in the range of 4.27% to 23.02%. Moreover, Betancur-Ancona *et al.* (2004) reported values of 8.6% and 49.3% for two kinds of bean fibrous residues and conclude that this could be due to high amount of their protein content.

Table 3. Functional properties of date seed dietary fiber and Fibrex

Property	DSDF	Fibrex
Bulk density (g/cm³)	0.43 ± 0.001 b	0.49 ± 0.01 a
Packed density (g/cm³)	0.75 ± 0.01 a	0.67 ± 0.02 b
Swelling (cm³/g)	5.28 ± 0.06 b	7.40 ± 0.13 a
WRC (g/g)	2.75 ± 0.04 b	5.26 ± 0.06 a
OHC (g/g)	1.33 ± 0.02 a	1.32 ± 0.01 a
Emulsifying capacity (%)	2.67 ± 0.07 a	1.43 ± 0.09 b
L*	83.50 ± 0.42 a	83.74 ± 0.25 a
a*	2.73 ± 0.05 a	-0.18 ± 0.08 b
b*	11.76 ± 0.35 b	17.84 ± 0.92 a

Notes: Means that do not share a letter within a row are significantly different (P < 0.05, n = 3).

Table 4. Effect of fiber addition on bread properties

Level of fiber	Firmness (N)	Specific volume (ml/g)	L*	a*	b*
0 (control)	2.35 ± 0.10 c	3.39 ±0 .04 a	87.66 ± 1.31 a	-2.40 ± 0.50 d	24.1 ± 1.2 b
2.5% DSDF	2.88 ± 0.22 c	3.12 ± 0.04 b	66.76 ± 1.44 d	-0.15 ± 0.23 b	20.13 ± 1.01 c
5% DSDF	4.12 ± 0.54 b	2.46 ± 0.03 d	55.31 ± 1.70 e	0.96 ± 0.22 a	24.04 ± 1.0 b
2.5% Fibrex	3.87 ± 0.48 b	2.75 ± 0.04 c	85.30 ± 0.72 b	-0.67 ± 0.17 c	25.15 ± 0 .33 b
5% Fibrex	6.45 ± 0.78 a	2.32 ± 0.03 e	80.45 ± 1.29 c	-0.13 ± 0.08 b	26.92 ± 1.20 a

Notes: Means that do not share a letter within a column are significantly different (P < 0.05, n = 4).

Specific volume of bread

Addition of DSDF and Fibrex caused a significant (P < 0.05) reduction in specific volume of bread samples (Table 4). Other researchers obtained similar results indicating that addition of fiber would reduce volume and specific volume of the final bread (Wang *et al*., 2002; Filipovic *et al*., 2007; Hu *et al.*, 2009). Volume reduction is attributed to gluten dilution and changing crumb structures which leads to a decrease in carbon dioxide retention and consequently reduction in volume (Pomeranz *et al.*, 1997).

Color of bread

Increasing fiber level caused significant changes (P < 0.05) in L^*, a^* and b^* values (Table 4). Low L^* value shows that addition of DSDF results in producing darker bread samples comparing to addition of Fibrex. Sangnark and Noomhorm (2004) treated rice straw with alkaline hydrogen peroxide and obtained 22% increase in L^*.

Texture of bread

As presented in table 4, generally addition of fiber to bread leads to an increase in firmness. Firmness of samples containing 2.5% DSDF was not significantly (P < 0.05) different from that of control sample. Comparing obtained values for firmness in samples with 5% DSDF and samples with 2.5% Fibrex no significant (P < 0.05) difference was found while both of these samples showed significant difference in firmness values compared to control. Based on the obtained results, the highest firmness was observed in sample with 5% Fibrex. Thus, breads containing DSDF were found to be softer than those containing Fibrex. These findings are in agreement with the results obtained by Filipovic *et al*. (2007) and Hu *et al.* (2009) who reported an increase of firmness for the fiber supplemented bread. However, few exceptions can be found in literature. For instance, Wang *et al.* (2002) reported that breads with 3% carob fiber and breads with 3% pea fiber had a lower firmness than control.

Sensory evaluation

Table 5 presents sensory scores for the supplemented fiber bread. Sensory attributes were scored from 1 to 9 and samples which receive a score equal to or more than 5 (neither like nor dislike) were considered as acceptable. Color of DSDF bread was not acceptable. As mentioned earlier, treatments such as alkaline hydrogen peroxide would resolve this problem. In case of taste and aroma, DSDF breads were not significantly different from control bread but Fibrex breads were significantly different (P < 0.05). In the case of texture, 2.5% DSDF and 2.5% Fibrex breads reached to acceptable level. For overall acceptance of samples, all samples except 5% Fibrex bread received appropriate score. This shows the sufficient acceptability of DSDF breads in comparison with Fibrex ones.

Conclusion

Results obtained in this study prove that DSDF is a rich source of dietary fiber compared to Fibrex and some other agricultural by-products. Date seed

Table 5. Sensory scores of fiber supplemented bread

Level of fiber	Color	Aroma	Taste	Texture	Overall acceptability
0 (control)	7.89 ± 0.78 a	7.11 ± 1.54 a	6.44 ± 1.50 a	7.33 ± 0.70 a	7.44 ± 0.88 a
2.5% DSDF	4.89 ± 1.27 c	6.11 ± 1.90 ab	6.11 ± 1.16 ab	6.44 ± .1.01 b	6 ± 1 b
5% DSDF	3.67 ± .1.12 d	5.67 ± 1.80 abc	5.11 ± 1.61 ab	4.78 ± 0.83 c	5.11 ± 1.12 bc
2.5% Fibrex	6.55 ± 1.13 b	5.56 ± 1.13 bc	5.89 ± 1.27 ab	5.78 ± 0.97 b	5.67 ± 1 b
5% Fibrex	5.55 ± 0.88 bc	4.44 ± 1.13 c	4.89 ± 1.76 b	4.55 ± 0.88 c	4.44 ± 1.23 c

Notes: Means that do not share a letter within a column are significantly different ($P < 0.05$, $n = 30$).

high content of dietary fiber would introduce it as an excellent replace for Fibrex or other fiber sources. DSDF's reddish color and appropriate OHC represent its potential to be used in meat industry. Although DSDF has lower water retention capacity than Fibrex, but baking properties of DSDF was found to be better. Moreover, sensory evaluation of different samples indicated higher acceptability of DSDF breads in comparison with Fibrex breads. Treating with alkaline hydrogen peroxide is suggested since it may positively affect on color and hydration properties of DSDF and lead to a better quality bread. Future research could be focused on investigation of potential application of DSDF in other food products.

Acknowledgement

This research was funded by Vice president for research and technology, Ferdowsi University of Mashhad, Iran.

References

Abdul-Hamid, A. and Luan, Y. S. 2000. Functional properties of dietary fibre prepared from defatted rice bran. Food Chemistry 68: 15-19.

Abou-Zeid, A. A., Baghlaf, A. O., Khan, J. A. and Makhashin, S. S. 1983. Utilization of date seed and cheese whey in production of citric acid by candida lipolytica. Agricultural wastes 8: 131-142.

Al-Farsi, M., Alasalvar, C., Al-Abid, M., Al-Shoaily, K., Al-Amry M. and Al-Rawahy, F. 2007. Compositional and functional characteristics of dates, syrups, and their by-products. Food Chemistry 104: 943-947.

Al-Farsi, M. A. and Lee, C. Y. 2008. Nutritional and functional properties of dates: a review. Critical Reviews in Food Science and Nutrition 48: 877-887.

Almana, H. A. and Mahmoud, R. M. 1994. Palm date seeds as an alternative source of dietary fibre in Saudi bread. Ecology of Food and Nutrition 32: 261-270.

Ali Mohamed, A. Y. and Khamis, A. S. 2004. Mineral ion content of the seeds of six cultivars of Bahraini date palm *(Phoenix dactylifera)*. Journal of Agricultural and Food Chemistry 52: 6522-6525.

American Association of Cereal Chemist. 2000. Approved Methods of the AACC (10th ed). The Association, S. Paul, MN.

American Association of Cereal Chemists. 2001. The definition of dietary fiber. (Report of the Dietary Fiber Definition Committee to the Board of Directors of the AACC). Cereal Foods World 46(3): 112-126.

AOAC. 2000. Official methods of analyses. Washington, DC: Association of Official Analytical Chemists.

Aziah, N. and Komathi, C. A. 2009. Acceptability attributes of crackers made from different types of composite flour. International Food Research Journal 16: 479-482.

Bauza, E. 2002. Date palm kernel extract exhibits antiaging properties and significantly reduces skin wrinkles. International Journal of Tissue Reactions 24: 131-136.

Betancur-Ancona, D., Peraza-Mercado, G., Moguel-Ordoñez, Y. and Fuertes-Blanco, S. 2004. Physicochemical characterization of Lima bean and Jack bean fibrous residues. Food Chemistry 84(2): 287-295.

Brodribb A. J. M. and Groves, C. 1978. Effect of bran particle size on stool weight. Gut., 19: 60-63.

Collar, J. Y., Piva, M. and Labuza, T. P. 1984. Evaluation of water binding capacity (WBC) of food fibre sources. Journal of Food Science 49(1): 59-63.

Dalgetty, D. D. and Baik, B. K. 2003. Isolation and Characterization of Cotyledon Fibers from Peas, Lentils, and Chickpeas. Cereal Chemistry 80(3): 310-315.

Deng, Q., Penner, M. H. and Zhao, Y. 2011. Chemical composition of dietary fiber and polyphenols of five different varieties of wine grape pomace skins. Food Research International 44: 2712-2720.

Elleuch, M., Bedigian, D., Roiseux, O., Besbes, S., Blecker, C. and Attia., H. 2011. Dietary fibre and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications: A review. Food Chemistry 124: 411-421.

Figuerola, F., Hurtado, M. L., Estévez, A. M., Chiffelle, I. and Asenjo, F. 2005. Fibre concentrates from apple pomace and citrus peel as potential fibre sources for food enrichment. Food Chemistry 91: 395-401.

Filipovic, N., Djuric, M. and Gyura, J. 2007. The effect of the type and quantity of sugar-beet fibers on bread characteristics. Journal of Food Engineering 78: 1047-1053.

Fuentes-Alventosa, J. M., Rodríguez-Gutiérrez, G., Jaramillo-Carmona, S., Espejo-Calvo, J. A., Rodríguez-Arcos, R., Fernandez-Bolaños, J., Guillén-

Bejarano, R. and Jiménez-Araujo, A. 2009. Effect of extraction method on chemical composition and functional characteristics of high dietary fibre powders obtained from asparagus by-products. Food Chemistry 113: 665-671.

Grigelmo-Miguel, N. and Martín-Belloso, O. 1997. A dietary fiber supplement from fruit and vegetable processing waste. 1997 Conference of Food Engineering (CoFE '97). American Institute of Chemical Engineers. Los Angeles, CA.

Grigelmo-Miguel, N. and Martín-Belloso, O. 1999. Characterization of dietary fiber from orange juice extraction. Food Research International 31(5): 355-361.

Habib, H. M. and Ibrahim, W. H. 2009. Nutritional quality evaluation of eighteen date pit varieties. International Journal of Food Sciences and Nutrition 60: 99-111.

Habib, H., Kamal, H., Ibrahim, W. S. and Dhaheri, A. S. A. 2013. Carote¬noids, fat soluble vitamins and fatty acid profiles of 18 vari¬eties of date seed oil. Industrial Crops and Products 42: 567-572.

Hamada, J. S., Hashim, I. B. and Sharif, A. F. 2002. Preliminary analysis and potential uses of date pits in foods. Food Chemistry 76: 135-137.

Internet: Food and Agriculture Organization 2012. Downloaded from *http://faostat.fao.org/site/339/default.aspx*

Hu, G., Huang, S., Cao, S. and Maa, Z. 2009. Effect of enrichment with hemicellulose from rice bran on chemical and functional properties of bread. Food Chemistry 115: 839-842.

Hussein, A. S., Alhadrami, G. A. and Khalil, Y. H. 1998. The use of dates and date pits in broiler starter and finisher diets. Bioresource Technology 66: 219-223.

Lecumberri, E., Mateos, R., Izquierdo-Pulido, M., Rupérez, P., Goya, L. and Bravo, L. 2007. Dietary fibre composition, antioxidant capacity and physico-chemical properties of a fibre-rich product from cocoa (*Theobroma cacao* L.). Food Chemistry 104: 948-954.

Manãs, E. 1992. Análisis de fibra alimentaria. Fuentes de error en los métodos actuales y propuesta de nueva metodología. Madrid, Spain: University of Alcal á de Henares, Ph.D. thesis.

Mirghani, M. E. S., Al-Mamun, A., Daoud, J. I. and Mustafa, S. M. 2012. Processing of Date Palm Kernel (Dpk) For Production of Edible Jam. Australian Journal of Basic and Applied Sciences 6(1): 22-29.

Mollá, E., Esteban, R. M., Valiente, C. and López-Andreu, F.J. 1994. Dietary fiber content in byproducts coming from manufacture of beer and citric's juice industry. Alimentaria 251: 61-64.

Nancib, N., Nancib, A. and Boudrant, J. 1997. Use of waste date products in the fermentative formation of bakers yeast biomass by *Saccharomyces cerevisiae.* Bioresource Technology 60: 67-71.

Nancib, N., Ghoul, M., Larous, L., Nancib, A., Admin, L. Z., Remmal, M. and Boudrant, J. 1999. Use of date products in production of thermophilic dairy starter strain Streptococcus thermophilus. Bioresource Technology 67: 291-295.

Navarro-González, I., García-Valverde, V., García-Alonso, G. and Periago, M. J. 2010. Chemical profile, functional and antioxidant properties of tomato peel fiber. Food Research International 44: 1528-1535.

Pomeranz, Y., Shogren, N. M., Finney, K. F. and Bechtel, D. B. 1977. Fibre in breadmaking: Effects on functional properties. Cereal Chemistry 54: 25-41.

Prakongpan, T., Nitithamyong, A. and Luangpituksa., P. 2002. Extraction and Application of Dietary Fiber and Cellulose from Pineapple Cores. Food Chemistry and Toxicology 67(4): 1308-1313.

Prosky, L., Asp, N. G., Scheweizer, T. F., DeVries, J. W. and Furda, I. 1988. Determination of insoluble, soluble, and total dietary fibre in foods and food products: Interlaboratory study. Journal of the Association of Official Analytical Chemists 71: 1017-1023.

Robertson, J. A., de Monredon, F. D., Dysseler, P., Guillon, F., Amado, R. and Thibault, J. F. 2000. Hydration properties of dietary fibre and resistant starch: a European collaborative study. LWT-Food Science and Technology 33: 72-79.

Rosell, C. M. Santos, E. and collar, C. 2009. Physico-chemical properties of commercial fibres from different sources: A comparative approach. Food Research International 42: 176-184.

Sangnark, A. and Noomhorm, A. 2004. Chemical, physical and baking properties of dietary fiber prepared from rice straw. Food Research International 37: 66–74.

Shams Ardekani, M. R., Khanavi, M., Hajimahmoodi, M., Jahangiri, M. and Hadjiakhoondi, A. 2010. Comparison of Antioxidant Activity and Total Phenol Contents of some Date Seed Varieties from Iran. Iranian Journal of Pharmaceutical Research 9(2): 141-146.

Thebaudin, J. Y., Lefebvre, A. C., Harrington, M. and Bourgeois, C. M. 1997. Dietary fibres: nutritional and technological interest. Trends in Food Science and Technology 8: 41-48.

The Holy book of Quran, Chapter 19, Versus 25.

Tosh, S. M. and Yada, S. 2010. Dietary fibres in pulse seeds and fractions: Characterization, functional attributes, and applications. Food Research International 43: 450-460.

Wang, J., Rosella, C. M. and de Barbera, C. B. 2002. Effect of the addition of different fibres on wheat dough performance and bread quality. Food Chemistry 79: 221-226.

Wang, N. and Toews, R. 2011. Certain physicochemical and functional properties of fibre fractions from pulses. Food Research International 44: 2515-2523.