Advance Journal of Food Science and Technology 8(1): 8-13, 2015
DOI:10.19026/ajfst.8.1455
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: July 24, 2014 Accepted: September 13, 2014 Published: May 05, 2015

Research Article

Substitution of Sugar with Dates Powder and Dates Syrup in Cookies Making

[1]W.A. Alsenaien, [3]R.A. Alamer, [1]Zhen-Xing Tang, [1]S.A. Albahrani,
[3]M.A. Al-Ghannam and [1, 2]S.M. Aleid
[1]Date Palm Research Center of Excellence,
[2]Department of Food and Nutrition Sciences, King Faisal University,
[3]National Date Palm Research Center, Ministry of Agriculture, Alahsa, Saudi Arabia

Abstract: In this study, the effects of dates powder and dates syrup as a sugar substitution, on the physical properties and sensory attributes of cookies were studied. An increase in firmness and moisture content of cookies supplemented with dates was obtained. The diameter and spread ratio of cookies showed a decrease with increasing levels of date powder or date syrup. Partial replacement of sugar with date powder or date syrup produced cookies with more dark and red color. Sensory evaluation results indicated that cookies with acceptable preference could be supplemented up to 50% with dates powder and up to 75% with dates syrup. Date-based cookies using dates powder or dates syrup could be produced at a commercial scale.

Keywords: Cookies quality, dates powder, dates syrup, physical characteristics, sensory properties

INTRODUCTION

The use of dates in bread formula has long been practiced in traditional small bakeries in Saudi Arabia. Such bakeries are disappearing gradually with the new automated bakeries being introduced all over the country (Mustafa *et al*., 1986). Some date varieties in Rutab stage with high moisture content of 28-32% suffer from a periodic pre-harvest loss because they tend to drop before reaching Tamr stage. They are perishable and delicate which deterioration will take place within days. Fooladi and Golshan (2007) dehydrated Rutab at 50-55°C, 10-15% relative humidity up to 24 h. During drying process, the acidity content was gradually increased due to microorganisms' activity, but sensory properties were decreased especially after 12 h of drying time. El-Sharnouby *et al*. (2007) studied the effect of four different drying methods (oven, microwave oven, solar energy and oven under vacuum) on the quality of dates powder. Results of chemical analysis indicated that there were differences in total sugars, crude protein, fiber, ash and vitamin C among powders produced by different drying methods. Results of sensory evaluation indicated that date powder samples dried by microwave oven were more acceptable than other powders produced by other methods (El-Sharnouby *et al*., 2007). Kulkarni *et al*. (2008) evaluated the processing and dehydration conditions for preparation of dehydrated fruits from immature date fruits (Khalal stage). The results indicated that blanching in water at 96±1°C and subsequently dehydration at 60±2°C for 18-20 h, resulted in good quality dehydrated dates as compared to the dates dried without heat treatment.

Consumption of date syrup is very popular in Saudi Arabia. It is used as a sweetener for a variety of traditional food dishes. Low quality dates can be used as raw material for production of date syrup, which is a good source of glucose and fructose (Aleid *et al*., 2012). Another sugar present in significant quantities is sucrose. The color of date syrup is light or dark brown. Date syrup can be converted to white sugar by applying various decolorization processes (Wolf *et al*., 1976). Date syrups show low sodium to potassium ratio (Tang *et al*., 2013). Rygg (1977) reported that low sodium to potassium ratio in date, might be of dietetic importance especially for those who have a restriction on sodium intake. Sanders (1991) reported that the higher potassium to sodium content favored its use in products designed for individuals who wanted to manage their elevated blood pressure. Date syrup also has antioxidant activity related to total phenolic content. Mikki *et al*. (1983) reported experimental use of dates in various products, such as bakery products. Replacement of sucrose by date paste in breads and cookies improved their nutritional value by increasing levels of both minerals and vitamins. Most date sugars are invert sugars, which increase the softness of bread and cookies. Aleid (2009) investigated incorporation of date paste (Khalas variety) into an Arabic bread recipe as a sugar source at 10, 20 and 30% of the flour weight, respectively. The results of the Arabic bread baking

Corresponding Author: M.A. Al-Ghannam, National Date Palm Research Center, Ministry of Agriculture, Alahsa, Saudi Arabia

tests showed a positive relationship between total bread quality and the addition of date paste.

Cookies are one of the most popular bakery item consumed nearly by all population. This is mainly due to its ready-to-eat nature, good nutritional quality and availability in different varieties and affordable cost (Sudha *et al*., 2007; Guo *et al*., 2014). The effect of sucrose replacement in cookies has been studied by many authors. Sai Manohar and Haridas Rao (1997) employed reducing sugars as sucrose replacers in cookies and studied their rheological characteristics. They concluded that liquid glucose and invert syrup produced greater changes in adhesiveness and stickiness, while high fructose corn syrup had a greater effect on the color of the cookies. Gallagher *et al*. (2003) used an oligosaccharide to replace 20-30% sugar in the cookies. They obtained softer eating cookies and different surface color attributes. Recently, Pareyt *et al*. (2011) used arabinoxylan oligosaccharides as potential sucrose replacers in sugar-snap cookies to replace up to 30% sucrose. They obtained cookies with a diameter and height comparable to their control sample; however, the color of the cookies was darker in comparison with control.

Date can be added to cookies formula to increase its nutritional value as well as its taste and keeping the quality. Several studies on the effect of dates on the quality of white pan and Arabic bread have been reported (Aleid, 1998; Al-Saidy *et al*., 1979; Al-Zubaydi *et al*., 1983; Mustafa *et al*., 1986; Yousif *et al*., 1995). Nevertheless, no similar studies are made on cookies. The objective of this study is to evaluate the response of dates powder and dates syrup as a sugar substitution on physical quality and sensory properties of cookies.

MATERIALS AND METHODS

Preparation of date powder and date syrup: Fresh dates at Bisr stage (*Phoenix dactylifera* L.) (Khalas variety, production season 2012) were obtained from the experimental farm of National Research Center for Date Palm, Alahsa, Saudi Arabia. Fruits were de-pitted, cut into small pieces and dried in a vacuum drying oven (OV-11, Jeio Tech Co., Ltd. South Korea) at 75±1°C for 24 h and crushed in grinder (M-20, IKA-Werke, GMBH & CO. KG, Staufen, Germany) for 2 min. The obtained date powder was sifted in a steel mesh sifter (0.85 mm openings) to obtain fine homogenized particles. The obtained powder was stored in a close container at 4-5°C. A micro-filtered date syrup (75 Brix) was obtained from Alahsa National Food Processing Plant (Alahsa, Saudi Arabia), then stored at room temperature until it was used.

Cookies preparation: Typical all purpose flour (Kuwait Flour Mills and Bakeries, Safat, Kuwait) was used in the experiment. Flour analytical data is shown in Table 1. Falling number test was performed according to AACC method 56-81.03 (AACC, 2000). Cookies were made according to AACC method No. 10-52 (AACC, 1995) using a formula showed in Table 2. Cookies dough was cut in 0.6 mm thickness and 6.5 mm diameter and baked under 205°C.

Table 1: Characteristics of experimental flour

Protein[1] (%)	12.12
Ash[1] (%)	0.51
Falling number (s)	565

[1]: Based on 14% moisture basis

Table 2: Experimental cookies formula

Ingredients	(g)
Flour	100
Sugar	60
NFDY	3
Shortening	30
Water[1]	6.75
Ammonium chloride	0.50
Sodium bicarbonate	0.80
Sodium chloride	0.45

[1]: Based on 14% moisture basis of flour

Sugar (sucrose) was substituted with date powder or date syrups at four replacement levels (25, 50, 75 and 100%, respectively) in the cookies formula. One treatment with 100% sucrose was used as a control. The experimental design was a randomized complete block design. All treatments ware repeated three times.

Physicochemical analysis: Water activity (aw) was determined according to AOAC (1995) method number 978.18 using an AquaLab apparatus (Decagon Devices, Inc. Pullman, Washington). Color measurements were done using a Hunterlab Color Quest-45/0 LAV color difference meter (Hunter Associates Laboratory, Inc., U.S.A.) standardized with black and green tiles. Measured parameters were the degree of Lightness (L) with an L value of 100 representing white, L value of zero representing black, positive 'a' values representing redness and negative 'b' values representing yellowness. Measurements were conducted on five individual cookies per replicate according to Aleid *et al*. (2012). Cookies thickness and diameter were measured using absolute digimatic digital electronic vernier caliper (Model CD-15CW, Mitutoyo Corporation, Japan). A penetration test for the measurement of cookies firmness was performed on single cookies using a penetrometer (Stanhope-Seta Setamatic Penetrometer, Surrey, UK) with a cone weight of 102.3 g and a 45° cone angle (Aleid *et al*., 2012). The distance travelled was measured in mm at room temperature. Measurements were conducted on five individual cookies per replicate.

Sensory evaluation: Panelists for sensory evaluation were 16 untrained volunteers, 12 nonsmokers and 4 smokers, aged 25-50 years old. They were selected from graduate students, laboratory technicians, senior researchers and the staff of Date Palm Research Center of Excellence, King Faisal University. The panelists were not trained, but prior to cookies evaluation, they

received instruction regarding the evaluation procedures in both written and verbal formats. The panelists tasted cookies at self-determined pace with no time limit for completing the session. Although, the cookies evaluation sessions tended to last 15-30 min and to minimize adaptation, panelists were instructed to take breaks as they desired for 2-3 min and the evaluation was associated with the control treatment. The panelists evaluated the cookies two weeks after baking.

Statistical analysis: Results were analyzed statistically using the analysis of variance and the Least Significant Difference (LSD) as described by Richard and Gouri (1987).

RESULTS AND DISCUSSION

Physical properties:

Thickness: Physical parameters of cookies prepared by substituting sugar with date powder or date syrup ware showed in Table 3. In our present study, the thickness of cookies prepared from date powder and date syrup, was ranged from 9.49 to 9.46 mm and 9.98 to 10.19 mm, respectively (Table 3). The significant effect of different levels of date powder or date syrup on the thickness of cookies was not observed. This was in line with the findings of Pareyt *et al*. (2009). In their studies, increasing molasses content did not significantly affect the thickness in any of tested biscuit variants. Recently, Kulthe *et al*. (2014) studied physical parameters of cookies prepared by substituting Maida with 0-25% defatted soy flour. Even though the thickness of cookies in their study was increased from 7.0 to 7.6 mm, no significant effect was found. In general, Gluten development contributes to an expansion in thickness of backed products, but cookies don't increase dramatically in thickness, because sugar preferentially attracts water over gluten proteins. Therefore, the amount and type of sugar in the formula can affect the thickness of cookies (Handa *et al*., 2012).

Diameter: Cookie spread occurs as sugars dissolve during baking. Sucrose is not completely dissolved prior to baking, so the non dissolved sugars will dissolve during baking, which allows greater spread to occur. The diameter of cookies prepared from date powder was significantly decreased from 69.16 to 55.89 mm. Similarly, the diameter of cookies prepared from date syrup was significantly reduced to 64.21 mm at 25% date syrup compared to that of control cookies 77.12 mm (Table 3). This result might be explained by date powder or date syrup being less soluble and maintaining its un-dissolved nature longer during baking, which would restrict the flow of the dough. Our results agreed with many other studies (Taylor *et al*., 2008; Ajila *et al*., 2008; Kulthe *et al*., 2014).

Spread ratio: Cookie spread represents a ratio of diameter to thickness. Thus, sugar's effects on the diameter (sugar dissolution) and thickness (inhibiting gluten development) are combined into a single parameter. Cookies having higher spread ratio are considered most desirable (Handa *et al*., 2012). Also, larger cookie diameter and higher spread ratio are considered as the desirable quality attributes (Yamamoto *et al*., 1996; Handa *et al*., 2012). Spread ratio of control cookies was 23.7 in this study. However, spread ratio of cookies prepared by date powder or date syrup was significantly decreased (Table 3). Reduced spread ratios of cookies were due to the fact that date powder or date syrup increased the numbers of hydrophilic sites available for competing for the limited free water in cookie dough (Hooda and Jood, 2005). Rapid partitioning of free water of these hydrophilic sites occurred during dough mixing and increased dough viscosity, thereby limiting cookie spread and top grain formation during baking. Many other researchers also reported the reduction of spread ratio during cookies baking (Hooda and Jood, 2005; Chen *et al*., 1998; Sharma and Chauhan, 2002; Singh *et al*., 1996).

Firmness: A penetration test for the measurement of cookies firmness was performed on single fruits using a penetrometer (Table 3). Firmness is a significant physical quality attribute of cookies. The penetrant sinks more deeply into soft samples than hard samples. Therefore, higher penetration numbers are associated with softer samples. Lower penetration values indicate

Table 3: Effect of different levels of date powder and date syrup on physical parameters of cookies

Treatment	Thickness (mm)	Diameter (mm)	Spread ratio (%)	Penetration (mm)	Water activity	Moisture (%)
Control	9.48^{a}	77.12^{a}	23.70^{a}	0.49^{d}	0.469^{g}	6.7^{g}
25% powder	9.49^{a}	69.16^{abc}	11.00^{b}	0.71^{d}	0.522^{f}	8.1^{e}
50% powder	7.58^{b}	66.97^{bc}	7.40^{bc}	2.29^{b}	0.451^{h}	7.3^{f}
75% powder	9.64^{a}	62.13^{cd}	-0.32^{d}	2.62^{ab}	0.532^{e}	9.6^{d}
100% powder	9.46^{a}	55.89^{d}	-10.30^{e}	0.52^{d}	0.560^{c}	9.7^{d}
25% syrup	9.98^{a}	64.21^{bc}	3.020^{d}	1.39^{c}	0.452^{h}	9.5^{d}
50% syrup	8.95^{ab}	67.76^{bc}	8.71^{bc}	2.37^{b}	0.568^{b}	10.7^{c}
75% syrup	7.76^{b}	71.62^{ab}	14.90^{b}	2.93^{a}	0.541^{d}	11.9^{b}
100% syrup	10.19^{a}	69.54^{abc}	11.60^{b}	2.63^{ab}	0.573^{a}	13.3^{a}
LSD at 5%	1.51	7.55	5.43	0.36	0.002	0.3

Within each column, different letters indicate significant differences at $p<0.05$

Table 4: Color measurements of cookies containing varying levels of date powder and date syrup

Treatment	L	a	b	Results
Control	88.86[a]	4.51[f]	35.98[b]	95.59[a]
25% powder	82.34[b]	3.52[f]	26.47[d]	86.59[b]
50% powder	63.53[d]	15.18[bc]	41.65[a]	77.49[d]
75% powder	72.88[c]	9.52[e]	32.59[c]	80.58[c]
100% powder	54.78[e]	16.18[ab]	36.89[b]	69.11[e]
25% syrup	64.20[d]	10.98[d]	37.81[b]	75.40[d]
50% syrup	53.30[e]	14.72[bc]	37.85[b]	67.08[e]
75% syrup	45.65[f]	16.81[a]	36.51[b]	60.90[f]
100% syrup	45.98[f]	14.54[c]	32.62[c]	58.36[f]
LSD at 5%	1.81	1.40	2.25	2.70

Within each column, different letters indicate significant differences at $p<0.05$

greater hardness of cookies structure. Firmness is one of the major indexes in the assessment of cookies' quality. High firmness leads to a decline in chewiness and an increase in brittleness of cookies. However, with low firmness, the vibration resistance will decrease and the packaging and transportation of cookies will be affected. In general, cookie firmness is related to the development of gluten and the interaction with flour ingredients in the formula (Khouryieh and Aramouni, 2012). As shown in Table 3, the significant increase in cookies penetration values was associated with the increase of the concentrations of date powder or date syrup in the formula. The penetration values of cookies prepared from date powder increased from 0.71 mm at 25% date powder to 2.52 mm at 100% date powder. Similarly, the penetration values of cookies prepared from date syrup increased from 1.39 mm at 25% date syrup to 2.39 mm at 100% date syrup. The possible reason for this result was due to date powder or date syrup by virtue of having more sugar content diluting the gluten, affecting the interaction of gluten and other ingredients. Many other researchers also showed similar results (Drisya *et al*., 2013; Collar *et al*., 2007; Nandeesh *et al*., 2011; Ajila *et al*., 2008; Sudha *et al*., 2007).

Water activity: The physicochemical and microbiological stability of food depends greatly on the water content and its interaction with food ingredients. Water activity is a measure of the availability of water molecules to enter into microbial, enzymatic or chemical reactions. The water activity concept has been used as a reliable assessment of the microbial growth and chemical stability of foods following manufacture. Bacteria do not grow at water activity of 0.80 or below, while the limit for mold and yeast growth is 0.6. There is no microbial proliferation below water activity of 0.6. Water activity has been used to control lipid oxidation in susceptible food products. Lipid oxidation is accelerated at both very high and very low water activities. Auto-oxidation of lipids is diminished in the water activity range of 0.3-0.5, while below or above this range the auto-oxidation of lipids increases rapidly (Rahman and Labuza, 1999). In this study, all measured water activity levels were in the range of 0.3 to 0.6 so the cookies would not be susceptible to any microbial or chemical activities (Table 3).

Color: Cookies color plays a major role in consumers' perception and acceptability. The L, a and b color values of tested cookies ware showed in Table 4. L values are indicative of the lightness of samples. Lower L values indicate a darker surface color. The a values indicate the degree of redness or greenness, with positive values signifying redness and negative values indicating greenness. The b values indicate yellowness or blueness: positive values represent yellow, while negative values represent blue.

Increase in date powder or date syrup level led to a significant increase in the darkness of cookies. Cookies with date powder or date syrup were significantly darker than the control as indicated by lower L values. The difference in redness was also statistically significant. Increase in redness was observed as date powder or date syrup level was increased. Cookies with date powder or date syrup were redder in color than control (Table 4). The lower L value and higher a value observed for date fortified cookies were possibly related to maillard browning reactions in the baking process, causing darker color for the cookies. Similar results were also found by many researchers (Singh and Mohamed, 2007; McWatters *et al*., 2003; Yamsaengsung *et al*., 2012; Khouryieh and Aramouni, 2012).

The b values for the cookies prepared with date powder and date syrup were 41.65 at 50% date powder and 37.85 at 50% date syrup, respectively. At substitution levels more than 50%, the b values of the cookies prepared with date powder and date syrup, were reduced progressively (Table 4). Date powder and date syrup are rich in polyphenols and may contain some polyphenol oxidase and peroxidase with low activities. Therefore, due to enzymatic browning reaction, the b values might be deceased. This phenomenon was also reported in the study of Ajila *et al*. (2008).

Sensory evaluation: The effect of date powder and date syrup supplement on sensory characteristics of the cookies is presented in Table 5. The results indicated that no significant differences in the cookies having date powder (below 50%) and date syrup (below 75%) for all sensory attributes. However, replacement of sugar with 100% date powder significantly impaired all sensory characteristics of cookies, which decreased significantly from 6.8 to 2.0 (taste), 7.0 to 3.6 (aroma), 6.8 to 3.2 (texture), 7.0 to 4.0 (appearance), 7.6 to 2.8 (color), 5.2 to 2.2 (over acceptability). Similarly, the results occurred to the cookies prepared with 100% date syrup which decreased significantly from 7.3 to 2.4 (taste), 5.9-2.4 (aroma), 5.6 to 3.4 (texture), 5.3 to 2.7 (appearance), 5.1 to 2.4 (color) and 6.3 to 2.9 (over acceptability), respectively. Therefore, compared to control cookies, the cookies obtained from 100% date powder and 100% date syrup had the lowest sensory acceptance. From the above evaluation, it could be

Table 5: Mean sensory ratings for consumer acceptance of cookies containing different levels of date powder and date syrup

Treatment	Taste (10)	Aroma (10)	Texture (10)	Appearance (10)	Color (10)	Overall acceptability (10)	Total (60)
Control	7.0^{a}	6.8^{a}	6.4^{a}	6.0^{ab}	7.2^{ab}	7.1^{a}	40.5^{a}
25% powder	6.8^{a}	7.0^{a}	6.8^{a}	7.0^{a}	7.6^{a}	5.2^{ab}	40.4^{a}
50% powder	6.8^{a}	6.8^{a}	6.8^{a}	6.2^{ab}	6.8^{abc}	6.8^{a}	40.2^{a}
75% powder	3.8^{bc}	4.2^{b}	4.6^{bc}	5.6^{ab}	5.6^{bc}	6.0^{ab}	29.8^{b}
100% powder	2.0^{d}	3.6^{bc}	3.2^{c}	4.0^{cd}	2.8^{d}	2.2^{d}	17.8^{c}
25% syrup	4.3^{b}	5.9^{a}	5.6^{ab}	5.3^{bc}	5.1^{c}	4.3^{bc}	35.5^{ab}
50% syrup	7.4^{a}	6.1^{a}	5.7^{ab}	5.6^{ab}	5.3^{bc}	6.9^{a}	37.0^{ab}
75% syrup	6.3^{a}	6.7^{a}	5.9^{ab}	6.3^{ab}	6.9^{abc}	6.9^{a}	39.0^{a}
100% syrup	2.4^{cd}	2.4^{c}	3.4^{c}	2.7^{d}	2.4^{d}	2.9^{cd}	16.2^{c}
LSD at 5%	1.6	1.5	1.5	1.4	1.7	1.7	4.8

Within each column, different letters indicate significant differences at $p<0.05$

concluded that date powder or date syrup could be incorporated up to 50% for date powder and 75% for date syrup in the formulation of cookies without affecting their sensory quality.

CONCLUSION

This study revealed that the cookies could be successfully formulated using date powder or date syrup as a partial replacer for sugar. The physical properties of the cookies prepared using date powder or date syrup were affected by demonstrating a decrease in diameter, a lower spread ratio, a lower firmness, a higher moisture content and a reasonable water activity. Substitution of sugar with date powder or date syrup could gave cookies with a darker and redder color. Sensory evaluation indicated that date powder and date syrup could replace up to 50 and 75% of the sugar without affecting the quality of cookies, respectively. Hence, the results obtained in this study showed the possibility of utilizing date powder or date syrup to develop date-based cookies.

ACKNOWLEDGMENT

The authors would like to thank Date Palm Research Center of Excellence, King Faisal University, Alahsa, Saudi Arabia and the Ministry of Agriculture, Saudi Arabia for financial support to carry out this study.

REFERENCES

AACC, 1995. Approved Methods of the American Association of Cereal Chemists. 9th Edn., St. Paul, Minnesota, USA.

AACC, 2000. Approved Methods of the American Association of Cereal Chemists. 10th Edn., St. Paul, MN.

Ajila, C.M., K. Leelavathi and U.J.S. Prasada Rao, 2008. Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. J. Cereal Sci., 48: 319-326.

Aleid, S.M., 1998. Substitution of sugar with date syrup in bread making. Egypt. J. Appl. Sci., 13(11): 271-285.

Aleid, S.M., 2009. Utilization of date paste in double layered Arabic bread. Final Techenical Report, Research Project # 6009, Department of Scientific Research, King Faisal University, Alahsa 31092, Saudi Arabia.

Aleid, S.M., A.R. Barber, M. Rettke, N. Leo, W.A. Alsenaien and A.A. Sallam, 2012. Utilization of modified atmosphere packaging to extend the shelf life of Khalas fresh dates. Int. J. Food Sci. Tech., 47: 1518-1525.

Al-Saidy, M.A., K.A.K. Al-Dujaili and A.M. Majeed, 1979. Evaluation of date syrup (dibs) as a substitute for table sugar in bread making. Technical Bulletin No. 5/79. Palm and Dates Research Centre, Baghdad, Iraq.

Al-Zubaydi, A.A., A.A. Al-Kaissi, K.A. Shaker and S.M. Hamel, 1983. Use of date syrups in breadmaking. Cereal Chem., 60(1): 56-58.

AOAC, 1995. Association of Official Analytical Chemists: Official Methods of Analysis. 15th Edn., AOAC, Washington, DC.

Chen, H., G.K. Tubenthaler, H.K. Leung and J.D. Baranowski, 1998. Chemical, physical and baking properties of apple fibre compared with oat and wheat bran. Cereal Chem., 65: 244-250.

Collar, C., E. Santos and C.M. Rossel, 2007. Assessment of rheological profile and fibre-enriched bread doughs by response surface methodology. J. Food Eng., 78: 820-826.

Drisya, C.R., B.G. Swetha, V. Velu, D. Indrani and R.P. Singh, 2013. Effect of dried *Murraya koenigii* leaves on nutritional, textural and organoleptic characteristics of cookies. Journal of Food Science and Technology, 52(1): 500-506.

El-Sharnouby, G.A., M.S. Al-Wesali and A.A. Al-Shathri, 2007. Effect of some drying methods on quality of palm date fruits powder. Proceeding of the 4th Symposium on Date Palm. Date Palm Research Center, King Faisal University, Al-Hassa, Saudi Arabia.

Fooladi, M.H. and T.A. Golshan, 2007. Artificial ripening of mazafati rutab to tamr by dehyderation process. Proceeding of the 4th Symposium on Date Palm. Date Palm Research Center, King Faisal University, Al-Hassa, Saudi Arabia.

Gallagher, E., C.M. O'Brien, A.G.M. Scannell and E.K. Arendt, 2003. Evaluation of sugar replacers in short dough cookie production. J. Food Eng., 56: 261-263.

Guo, M.M., J.H. Du, Z.A. Zhang, K.L. Zhang and Y.H. Jin, 2014. Optimization of brewer's spent grain-enriched biscuits processing formula. J. Food Process Eng., 37: 122-130.

Handa, C., S. Goomer and A. Siddhu, 2012. Physicochemical properties and sensory evaluation of fructoligosaccharide enriched cookies. J. Food Sci. Tech., 49: 192-199.

Hooda, S. and S. Jood, 2005. Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. Food Chem., 90: 427-435.

Khouryieh, H. and F. Aramouni, 2012. Physical and sensory characteristics of cookies prepared with flaxseed flour. J. Sci. Food Agr., 92: 2366-2372.

Kulkarni, S.G., P. Vijayanand, M. Aksha, P. Reena and K.V.R. Ramana, 2008. Effect of dehydration on the quality and storage stability of immature dates (*Pheonix dactylifera*). Food Sci. Technol., 41: 278-283.

Kulthe, A.A., V.D. Pawar, P.M. Kotecha, U.D. Chavan and V.V. Bansode, 2014. Development of high protein and low calorie cookies. J. Food Sci. Tech., 51: 153-157.

McWatters, K.H., J.B. Ouedraogo, A.V. Resurreccion, Y.C. Hung and R.D. Phillips, 2003. Physical and sensory characteristics of sugar cookies containing mixtures of wheat, fonio (*Digitaria exilis*) and cowpea (*Vigna unguiculata*) flours. Int. J. Food Sci. Tech., 38: 403-410.

Mikki, M.S., W.F. Al-Tai and Z.S. Hamodi, 1983. Industri-alization of dates and development of new products. Proceeding of the 1st International Symposium on Date Palm. King Faisal University, Saudi Arabia, March 23-25.

Mustafa, A.I., A.K. Yousif and A.N. Wahdan, 1986. Utilization of date paste in bakery products. Proceeding of the 2nd Symposium of the Date Palm in Saudi Arabia. Date Palm Research Center, King Faisal University, 2: 207-217.

Nandeesh, K., R. Jyotsna and G. Venkateswara Rao, 2011. Effect of differently treated wheat bran on rheology, microstructure and quality characteristics of soft dough biscuits. J. Food Process. Pres., 35: 179-200.

Pareyt, B., M. Goovaerts, W.F. Broekaert and J.A. Delcour, 2011. Arabinoxylan oligosaccharides (AXOS) as a potential sucrose replacer in sugar-snap cookies. LWT-Food Sci. Technol., 44: 725-728.

Pareyt, B., F. Talhaoui, G. Kerckhofs, K. Brijs, H. Goesaert, M. Wevers and J.A. Delcour, 2009. The role of sugar and fat in sugar-snap cookies: structural and textural properties. J. Food Eng., 90: 400-408.

Rahman, M.S.M. and T.P. Labuza, 1999. Water Activity and Food Preservation. In: Rahman, M.S. (Ed.), Handbook of Food Preservation. Marcel Dekker, New York, pp: 339-382.

Richard, J. and B. Gouri, 1987. Statistics, Principles and Methods. John Wiles and Sons, New York, pp: 403-427.

Rygg, G.L., 1977. Date Development, Handling and Packing in the United States. Agriculture Research Service, Agric. Handbook No. 482. USDA, Washington, DC.

Sai Manohar, R. and P. Haridas Rao, 1997. Effect of sugar on the rheological characteristics of cookie dough and quality of cookies. J. Sci. Food Agr., 75: 383-390.

Sanders, S.W., 1991. Using prune juice concentrate in whole wheat bread and other bakery products. Cereal Food. World, 36: 280-283.

Sharma, H.R. and G.S. Chauhan, 2002. Effects of stabilized rice bran-fenugreek blends on the quality of breads and cookies. J. Food Sci. Tech., 39: 225-233.

Singh, M. and A. Mohamed, 2007. Influence of gluten-soy protein blends on the quality of reduced carbohydrates cookies. LWT-Food Sci. Technol., 40: 353-360.

Singh, R., G. Singh and G.S. Chauhan, 1996. Effect of incorporation of defatted soy flour on the quality of biscuits. J. Food Sci. Tech., 33: 355-357.

Sudha, M.H., R. Vetrimani and K. Leelavathi, 2007. Influence of fibre from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. Food Chem., 100: 1365-1370.

Tang, Z.X., L.E. Shi and S.M. Aleid, 2013. Date fruit: Chemical composition, nutritional and medicinal values, products. J. Sci. Food Agr., 93: 2351-2361.

Taylor, T.P., O. Fasina and L.N. Bell, 2008. Physical properties and consumer liking of cookies prepared by replacing sucrose with tagatose. J. Food Sci., 73: S145-S151.

Wolf, F., S. Lindus and K.M. Jamil, 1976. Flocculation and decolorization of Iraqi date juice solutions. Nahrung, 20(8/9): 84-846.

Yamamoto, H., S.T. Worthington, G. Hou and P.K.W. Ng, 1996. Reeological properties and baking qualities of selected soft wheats in the United States. Cereal Chem., 73: 215-221.

Yamsaengsung, R., E. Berghofer and R. Schoenlechner, 2012. Physical properties and sensory acceptability of cookies made from chickpea addition to white wheat or whole wheat flour compared to gluten-free amaranth or buckwheat flour. Int. J. Food Sci. Tech., 47: 2221-2227.

Yousif, A.K., I.D. Morton and A.I. Mustafa, 1995. Light and scanning electron microscopy of wheat-paste dough and bread. Arab. Gulf J. Sci. Res., 13(2): 275-292.