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Research Article

Effect of Substituting Table Sugar with Date Fruit Powder on the Nutritional and Sensorial Properties of Cake

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Abstract: Despite the World Health Organization's advice to limit sugar consumption, consumers unwillingly rely on table, refined, or added sugars owing to a lack of suitable alternatives. Date powder (DP) is a potential nutraceutical reservoir that can be an excellent natural sugar or table sugar (TS) replacer. Since *Dhaki* is one premium date fruit variety, it was utilized in its *Tamer* stage for developing DP owing to its higher sugar content, shelf-life stability, and low moisture. The date fruit was cleaned, depitted, thermally dehydrated (50±1°C for 2 days), powdered, and utilized as a TS replacer in cakes. A total of four formulations of cake sweeteners were set (i.e., T_0 = control/ cake without DP, T_1 = 10% DP + 90% TS, T_2 = 20% DP + 80% TS, T_3 = 30% DP + 70% TS). DP and cake formulations were subjected to assessment as per standard analytical methods. Findings showed that DP had 3.45% moisture, 5.22% protein, 0.78% fat, 6.84% fiber, 5.23% ash, 21.34% carbohydrate, 68.18% reducing sugar, 3.33% non-reducing sugar and 71.51% total sugar with pH value 5.4. The nutritional and sensorial properties of all cake samples (T_0-T_3) remained statistically different ($p < 0.05$). Among all samples T_3 had significantly higher ($p < 0.05$) average values for fat (19.03%), protein (15.44%), ash (5.77%), carbohydrate (61.36%), fiber (3.51%), non-reducing sugar (6.85%), energy value (478.47 kcal/100g), color (8.33), texture (8.33), taste (9.0), aroma (8.33), and overall acceptability (8.50) followed by T_2, T_1, and T_0. Findings conclude that increasing DP proportion in cakes not merely improved sweetness but also enhanced their nutritional value (fiber content, energy value, etc.), and sensorial attributes. DP is therefore recommended to be used as one suitable TS replacer in a variety of food products.

Keywords: Date Fruit Powder, Table Sugar Replacer, Baked Goods, Nutritional Assessment, Sensorial Properties.

1. INTRODUCTION

Date (*Phoenix dactylifera* L.) being a significant crop of the *Arecaceae* family has been cultivated for over 4,000 years in many arid regions of the Middle East and Northern Africa for date fruit [1, 2]. Pakistan ranks fifth in the world among date fruit-producing countries while date fruit is the country's fourth most popular fruit [3]. This fruit is versatile since having immense nutritional, medicinal, nutraceutical, etc. attributes [4]. It contains high quantities of sugars (fructose and glucose), dietary fibers, micronutrients, etc., [5]. Date fruit sugars have a low glycemic index and can be absorbed more promptly in blood and tissues than refined sugars [6]. An excessive intake of refined or table sugar (TS) has been recognized as a crucial risk factor for type 2 diabetes, obesity, cancer, cardiovascular diseases, etc. [7]. Despite this fact, the consumption rate of table sugar is quite high in most Asian countries. Researchers are therefore exploring appropriate interventions to substitute TS with fruit-based natural sugar for acquiring a sweet taste in foods to limit consumers' health risks. A substantial review of scientific literature suggests the adequacy of using date fruit as a TS replacer [8-11]. In Pakistan, the provinces of Baluchistan and Sindh are major contributors to date fruit production

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with leading varieties, i.e., *Mozawati, Aseel, Dhaki, Zahidi, Fasli,* etc., [1, 12]. The date fruit has four maturity stages, it achieves firm texture, dark brown color, and maximum sweetness in *the Tamer* stage (last stage of maturation) hence is the ultimate fruit stage to be utilized for developing date powder (DP). Date fruit in various forms may serve as a suitable TS replacer (i.e., date syrup, paste, and powder). Since, among various baked foods, cakes acquire a premium place due to their sweetness and richness of taste. In the present study, DP was developed from var. *Dhaki* and utilized against table sugar as a TS replacer in cakes. However, the nutritional and sensory quality characteristics of the cake samples were also determined to assess their suitability.

2. MATERIALS AND METHODS

2.1. Collection of Raw Materials

Date fruit (var. *Dhaki*) was purchased from the National Super Mart near Hala Naka, Hyderabad City, Pakistan. Raw materials for preparing cake samples (i.e., fine wheat flour, butter, table sugar, baking powder, fresh eggs, etc. were procured from a grocery store in Hyderabad City, Pakistan.

2.2. Preparation of Raw Materials

2.2.1. Drying of date fruit/ development of date powder

Date powder was prepared as per the method described by Manickavasagan *et al.* [13] with slight modifications. The date fruits were cleaned/sorted manually to remove any bruised or unhealthy fruit from the entire lot. The selected date fruits were properly washed with running tap water to remove dust and debris, air dried at room temperature, de-pitted manually using a stainless-steel knife, sliced (0.5 cm thickness), and subsequently set on to the perforated trays of cabinet dehydrator at 50 ± 1°C for 2 days. After drying, dried date fruit slices were milled in an electric mill to obtain date powder. Finally, the date powder was sieved through 80 mesh sieve and kept in an air-tight glass jar till further use.

2.2.2. Development of cake samples

The method described by Ghasemi *et al.* [14] was followed for developing date powder-enriched cake samples with some minor modifications. The batter of cake was prepared using ingredients such as fine wheat flour, butter, table sugar/icing sugar, date fruit powder, baking powder, milk powder, eggs, etc., (the detailed ingredients used for making cake samples are given in Table 1). The fine wheat flour and icing sugar were sifted, eggs were beaten, and other ingredients to be used were weighed. Later, all ingredients were taken in a bowl mixed properly using an electric beater, poured into the mold, and baked in an electric oven for about 25 minutes at 180 ºC. After baking, the cake samples were removed from the oven and cooled at room temperature. The cakes were sliced (1.5 cm), packed into the box, properly labeled, and used for sensory evaluation from panelists and chemical analysis.

Table 1. List of ingredients used for making cake samples.

Ingredients	Treatments of cakes			
	Control/T_0	T_1	T_2	T_3
Fine wheat flour (g)	100	100	100	100
Date powder (g)	-	8	16	24
Table sugar (g)	80	72	64	56
Egg whole	1	1	1	1
Milk powder (g)	10	10	10	10
Baking powder (g)	1	1	1	1
Butter (g)	20	20	20	20
Fat (g)	20	20	20	20
Salt (g)	1	1	1	1
Vanilla essence (drops)	2	2	2	2

2.3. Sample Analysis

2.3.1. Nutritional assessment

The pH value of date powder and cake samples was determined by using a digital pH meter (Model HI, Hanna Instruments, Italy) according to the method of AOAC [15]. By following the standard methods of AOAC [16], i.e., moisture (%), fat (%), protein (%), ash (%), carbohydrate (%), and fiber (%) were analyzed. The energy value (kcal/100g) of date powder and cake samples was calculated as per the method by Paul and Southgate [17]. The method described by Awan [18] was used to examine the reducing sugar (%) and total sugar (%) of date powder and cake samples. Non-reducing sugar (%) was determined as per the difference method by using the formula given below:

$$\text{Non} - \text{reducing sugar (\%)} = \text{Total sugar} - \text{Reducing sugar}$$

2.3.2. Determination of sensorial attributes

For descriptive sensory evaluation, a group of 10 trained panelists with 50:50 (male: female) gender ratio, aged 22-56 years was requested to participate in the study by taking formal consent for sensory evaluation of cake samples. The sensorial attributes, i.e., color, texture, taste, aroma, and overall acceptability of cake samples were determined as per the method described by Iwe [19] using nine-point hedonic scale (i.e., 9 = like extremely to 1 = dislike extremely).

2.4. Statistical Analysis

A total of three replications were studied during the studies for all tests (nutritional and sensorial properties). The data obtained from the present study was tabulated in Excel and analyzed using Statistical Package for the Social Sciences-20 for one-way ANOVA. The mean values range (maximum and minimum) at p-value < 0.05 were evaluated.

3. RESULTS

During the study, freshly developed date fruit powder was evaluated for nutritional analysis. The results regarding the nutritional and sensorial properties of all cake treatments are presented in this section.

3.1. Nutritional Analysis of Date Fruit Powder

The results regarding the nutritional analysis of date fruit powder are presented in Table 2. The result revealed that date fruit powder showed to have 3.45% moisture, 5.22% protein, 0.78% fat, 6.84% fiber, 5.23% ash, 21.34% carbohydrate, 68.18% reducing sugar, 3.33% non-reducing sugar, and 71.51% total sugar while pH value remained 5.4.

3.2. Nutritional Attributes of Cake Samples with Different Levels of Table Sugar and Date Fruit Powder

The results regarding the average nutritional attributes of cake samples prepared with different levels of sugar and date powder are presented in Tables 3 and 4. The observed results revealed that all treatments showed statistically different ($p<0.05$) mean values.

The moisture content in cake samples varied from 17.61% to 23.12%, with T_0 showing the highest moisture content (23.12%), followed by T_1 (20.34%), T_2 (19.03%), and T_3 (17.61%). The pH values ranged from 5.67 to 6.94, with T_3 having the highest pH (6.94) followed by T_2 (6.33), T_1 (5.81), and T_0 (5.67). Fat content ranged from 17.23% to 19.03%, with T_3 showing the highest fat content (19.03%), followed by T_2 (18.88%), T_1 (18.07%), and T_0 (17.23%). Protein content ranged from 12.03% to 15.44%, with T_3 having the highest protein content (15.44%), followed by T_2 (14.54%), T_1 (13.92%), and T_0 (12.03%). Ash content varied from 1.89% to 5.77%, with T_3 showing the highest

Table 2. Nutritional attributes of date fruit powder.

Nutritional attributes	Average values
Moisture (%)	3.45
Protein (%)	5.22
Fat (%)	0.78
Fiber (%)	6.84
Ash (%)	5.23
Carbohydrate (%)	21.34
Reducing sugar (%)	68.18
Non-reducing sugar (%)	3.33
Total sugar (%)	71.51
pH value	5.4

Table 3. Nutritional attributes of cake samples with different levels of sugar and date powder.

Treatments	Moisture %	pH Value	Fat %	Protein %	Ash %	Carbohydrate %
T_0	23.12 a	5.67 d	17.23 d	12.03 d	1.89 d	56.18 c
T_1	20.34 b	5.81 c	18.07 c	13.92 c	3.89 c	58.49 b
T_2	19.03 bc	6.33 b	18.88 b	14.54 b	4.56 b	59.98 ab
T_3	17.61 c	6.94 a	19.03 a	15.44 a	5.77 a	61.36 a
SE ±	0.8186	0.0312	0.0216	0.0286	0.0252	0.7049
LSD (0.05)	1.8877	0.0719	0.0498	0.0659	0.0580	1.6255
SD	2.1898	0.4995	0.7191	1.2504	1.4062	2.0451

T_0 = control/ cake without DP; T_1 = 10% DP + 90% added sugar; T_2 = 20% DP + 80% added sugar; T_3 = 30% DP + 70% added sugar; SE = Standard Error; LSD = Least Significant Difference; SD = Standard Deviation; Mean values with different letters across rows are significantly different at ($p < 0.05$).

Table 4. Nutritional attributes of cake samples with different levels of sugar and date powder.

Treatments	Fiber %	Reducing sugar %	Non-reducing sugar %	Total sugar %	Energy value (kcal/100 g)
T_0	1.91 d	23.45 a	3.33 d	26.78 a	427.88 d
T_1	2.27 c	21.11 b	4.52 c	25.63 ab	452.27 c
T_2	2.97 b	19.03 c	5.12 b	24.15 b	468.00 b
T_3	3.51 a	17.23 c	6.85 a	24.08 b	478.47 a
SE ±	0.0216	0.8084	0.0242	0.8085	1.0724
LSD (0.05)	0.0498	1.8642	0.0557	1.8643	2.4730
SD	0.0498	2.4593	1.2698	1.3826	19.0816

T_0 = control/ cake without DP; T_1 = 10% DP + 90% added sugar; T_2 = 20% DP + 80% added sugar; T_3 = 30% DP + 70% added sugar; SE = Standard Error; LSD = Least Significant Difference; SD = Standard Deviation; Mean values with different letters across rows are significantly different at ($p < 0.05$).

ash content (5.77%), followed by T_2 (4.56%), T_1 (3.89%) and T_0 (1.89%). Carbohydrate content in cake samples ranged from 56.18% to 61.36%, with T_3 having the highest carbohydrate content (61.36%), followed by T_2 (59.98%), T_1 (58.49%) and T_0 (56.18%). Fiber content ranged from 1.91% to 3.51%, with T_3 showing the highest fiber content (3.51%), followed by T_2 (2.97%), T_1 (2.27%) and T_0 (1.91%). Reducing sugar content varied from 17.23% to 23.45%, with T_0 showing the highest reducing sugar content (23.45%), followed by T_1 (21.11%), T_2 (19.03%) and T_3 (17.23%). Non-reducing sugar content ranged from 3.33% to 6.85%, with T_3 having the highest non-reducing sugar content (6.85%), followed by T_2 (5.12%), T_1 (4.52%) and T_0 (3.33%). Total sugar content varied from 24.08% to 26.78% with T_0 showing the highest total sugar content (26.78%), followed by T_1 (25.63%), T_2 (24.15%), and T_3 (24.08%). The energy value ranged between 427.88 to 478.47 kcal/100g, with T_3 having the highest energy value (6.94 kcal/100g), followed by T_2 (468 kcal/100g), T_1 (452.27 kcal/100g) and T_0 (5.67 kcal/100g).

3.3. Sensorial Attributes of Cake Samples with Different Levels of Table Sugar and Date Fruit Powder

The results regarding average sensorial attributes of cake samples prepared with different levels of sugar and date powders are presented in Figure 1. The observed results revealed that all treatments showed statistically different ($p < 0.05$) mean values for sensory attributes. The color scores across treatments ranged from 6.33 to 8.33, with T_3 significantly outperforming other treatments at

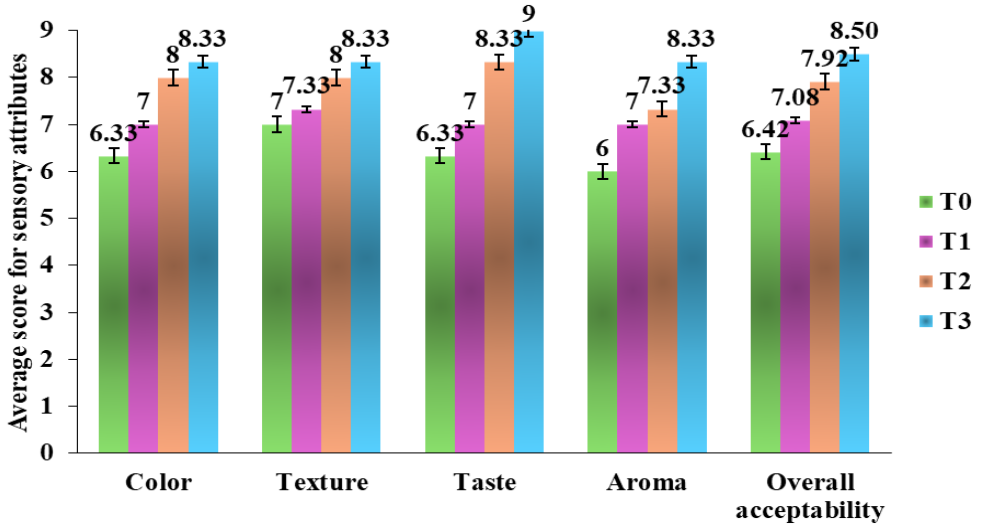

Fig. 1. Cake samples with different levels of table sugar and date powder.

8.33, followed by T_2 (8) and T_1 (7), while T_0 had the lowest score at 6.33. Scores for texture varied between 7 and 8.33, with T_3 having the highest score (8.33), followed by T_2 (8) and T_1 (7.33), while T_0 scored significantly lower at 7. For taste, scores ranged from 6.33 to 9, with T_3 leading at 9, followed by T_2 (8.33) and T_1 (7), while T_0 had the lowest score at 6.33. Scores for aroma ranged from 6 to 8.33, with T_3 scoring significantly higher at 8.33, followed by T_2 (7.33) and T_1 (7), while T_0 had the lowest score at 6. The scores for overall acceptability ranged from 6.42 to 8.50, with T_3 having significantly higher acceptability at 8.50, followed by T_2 (7.92) and T_1 (7.08), while T_0 had the lowest score at 6.42.

4. DISCUSSION

DP not merely supplies energy, promotes digestive health due to its immense fiber content, exerts antioxidant activity [20] but also adds pleasant sweetness in foods therefore can be effectively used as a healthier replacer of TS. DP offers huge health benefits instead to refined TS due to its nutrient richness, low glycemic index, etc., [21]. It was noticeable that DP of var. *Dhaki* showed to have a substantial proportion of energy, carbohydrate, and total sugars. Moreover, reducing sugars were extremely higher than non-reducing sugars. The chief carbohydrate in DP is sugar, i.e., monosaccharides (mainly glucose and fructose) as reducing sugars and disaccharides (sucrose) as non-reducing sugar [22]. The fiber content in DP found higher due to moisture removal during drying. In our findings, *Dhaki* DP contained substantial protein, which may be considered a reasonable quantity. Date fruit drying removes moisture resulting in a higher concentration of other components such as fiber, ash, protein, fats, etc., [23]. However, fat is one limiting component in date fruits [24]. The pH of DP was slightly acidic due to having different organic acids, i.e., malic, citric, and oxalic acid [5].

Cake is a popular food loaded with refined TS that links it to several health-related issues [25]. Present findings suggest that cake samples performed differently for nutritional characteristics and sensorial attributes due to having varying proportions of DP and TS. Among all cake samples, T_0 exhibited lower average values for fat, protein, ash, carbohydrate, and fiber content while energy value was also minimal, whereas moisture content and total sugars were found higher in T_0. The cake formulations in which TS was replaced with DP showed to have adequate levels of essential components such as fat, protein, ash, carbohydrate, and fiber content whereas the energy value was also higher. Among DP-added cake samples, T_3 performed appropriately for both nutritional and sensorial attributes. Fat serves as a shortening agent in cakes that elevates taste and calorific value. T_3 showed a higher percentage of fat indicating greater energy value than the counterpart samples. Studies by Mrabet *et al.* [26] show higher fat in cakes with date fruit. However, DP exhibited a low-fat content suggesting it is a poor source of fat. Majzoobi *et al.* [27] observed higher ash in date fruit press cake. Mrabet *et al.* [26] reported ash content in date-

enriched muffins ranging from 0.96 to 1.07 g/100g. However, in the current study higher ash was noted in T_3 and DP. Dried date fruit contains fiber ranging from 8.09 to 20.25 g/100g [28], therefore, fiber remained higher in T_3. In this study, the cake samples were subjected to sensorial evaluation and the result showed that T_3 perceived a maximum average score for color, texture, taste, aroma, and overall acceptability. This proves that replacing TS with DP imparted richness in the sensorial attributes of the cake samples. It can be therefore interpreted that replacing TS with DP enhanced the overall nutritional and sensorial attributes of cake samples. DP can be a promising substitute for refined TS in cakes since it is concentrated with essential health-promoting components [23].

5. CONCLUSIONS

It is concluded from the present study that all cake samples attributed suitable nutritional properties and sensorial attributes. Among all treatments, T_3 (with the highest DP content, i.e., 30%) exhibited superior outcomes for most nutritional attributes followed by T_2 and T_1. Moreover, T_3 showed to have significantly higher average values for all sensorial attributes followed by T_1 and T_2. These findings suggest that DP can be a vital TS replacer in various foods for potentially enhancing their nutritional value without compromising sensory enjoyment.

6. RECOMMENDATIONS

Keeping in mind, the facts obtained from the present study that cake samples replaced with date powder against added sugar are nutritious and palatable therefore these can be commercialized to a market level so that consumers may get access.

7. CONFLICT OF INTEREST

The authors declare no conflict of interest.

8. ETHICAL STATEMENT

The present study did not involve any ethical issues concerning to human or animal subjects. All materials utilized were plants-sourced and no harmful procedures were performed. The study focused on the formulation and assessment of a food product (cake) with a natural sugar substitute (date fruit powder).

9. REFERENCES

1. A.H. Soomro, A. Marri, and N. Shaikh. Date palm (*Phoenix dactylifera*): A review of economic potential, industrial valorization, nutritional and health significance. In: Neglected Plant Foods of South Asia: Exploring and valorizing nature to feed hunger. T. Ismail, S. Akhtar, and C.F. Lazarte (Eds.). *Springer, Switzerland* pp. 319-350 (2023).
2. K.D. Alotaibi, H.A. Alharbi, M.W. Yaish, I. Ahmed, S.A. Alharbi, F. Alotaibi, and Y. Kuzyakov. Date palm cultivation: A review of soil and environmental conditions and future challenges. *Land Degradation & Development* 34(9): 2431-2444 (2023).
3. N. Solangi, M.A. Jatoi, N. Tunio, A.A. Mirani, A.A. Abul-Soad, and G.S. Markhand. Fruit Morphological and Biochemical Characterization of Three Saudi Arabian Date Palm (*Phoenix dactylifera* L.) Cultivars Grown in District Khairpur, Pakistan. *Proceedings of the Pakistan Academy of Sciences: B Life and Environmental Sciences* 61(1): 11-20 (2024).
4. A.S. Ibrahim, R. Sukor, F. Anwar, S. Murugesu, J. Selamat, and R. Siva. Nutritional, nutraceutical attributes, microbiological and chemical safety of different varieties of dates—A review. *Future Foods* 10: 100421 (2024).
5. M. Derouich, R. Meziani, B. Bourkhis, Y. Filali-Zegzouti, and C. Alem. Nutritional, mineral, and organic acid composition of syrups produced from six Moroccan date fruit (*Phoenix dactylifera* L.) varieties. *Journal of Food Composition and Analysis* 93: 103591 (2020).
6. R.S. Almuziree and R.M. Alhomaid. The effect of sugar replacement with different proportions of Khalas date powder and molasses on the nutritional and sensory properties of Kleicha. *Processes* 11(11): 3077 (2023).
7. C. Debras, E. Chazelas, B. Srour, E. Kesse-Guyot, C. Julia, L. Zelek, C. Agaësse, N. Druesne-Pecollo, P. Galan, S. Hercberg, and P. Latino-Martel. Total and added sugar intakes, sugar types, and cancer risk: results from the prospective NutriNet-Santé cohort. *The American Journal of Clinical Nutrition* 112(5): 1267-1279 (2020).
8. K. Djaoud, L. Boulekbache-Makhlouf, M. Yahia, H. Mansouri, N. Mansouri, K. Madani, and A. Romero. Dairy dessert processing: Effect of sugar substitution by date syrup and powder on its quality characteristics. *Journal of Food Processing and Preservation* 44(5): e14414 (2020).
9. F. Hasan, A. Nazir, B. Sobti, H. Tariq, R. Karim, A.H.

Al-Marzouqi, and A. Kamal-Eldin. Dehydration of date fruit (*Pheonix dactylifera* L.) for the production of natural sweet powder. *NFS Journal* 27: 13-20 (2022).
10. N. Muñoz-Tebar, M. Viuda-Martos, J.M. Lorenzo, J. Fernandez-Lopez, and J.A. Perez-Alvarez. Strategies for the valorization of date fruit and its co-products: A new ingredient in the development of value-added foods. *Foods* 12(7): 1456 (2023).
11. H. Dana and A. Sonia. Substituting sugar in pastry and bakery products with functional ingredients. *Applied Sciences* 14(18): 8563 (2024).
12. Y. Bano, A. Rakha, M.I. Khan, and M. Asgher. Chemical composition and antioxidant activity of date (*Phoenix dactylifera* L.) varieties at various maturity stages. *Food Science and Technology* 42: e29022 (2022).
13. A. Manickavasagan, K. Thangavel, S.R. Dev, D.A. Delfiya, E. Nambi, V. Orsat, and G.S.V. Raghavan. Physico-chemical characteristics of date powder produced in a pilot-scale spray dryer. *Drying Technology* 33(9): 1114-1123 (2015).
14. E. Ghasemi, S. Loghmanifar, and S. Salar. The effect of adding date kernel powder on the qualitative and sensory properties of spongy cake. *Journal of Novel Applied Sciences* 9(3): 47-53 (2020).
15. AOAC. Official Methods of Analysis of Association of Official Analytical Chemists (18th ed.). *Washington, DC* (2010).
16. AOAC. Official Methods of Analysis of AOAC International (20th ed.). Association of the Official Analytical Chemists. *Benjamin Franklin Station, Washington DC* (2016).
17. A.A. Paul and D.A.T. Southgate (Eds.). Mccane and Widdowsen's: The Composition of Foods. *London : Her Majesty's Stationary Office* (1988).
18. J.A. Awan. Food Analysis Manual. *Unitech Communications* (2003).
19. M.O. Iwe. Handbook of Sensory Methods and Analysis. *PROJOINT Communication Services Ltd, Uwani-Enugu* pp. 70-72 (2002).
20. P.K. Vayalil. Date fruits (*Phoenix dactylifera* L.): An emerging medicinal food. *Critical Reviews in Food Science and Nutrition* 52(3): 249-271 (2012).
21. A.E. Butler, J. Obaid, P. Wasif, J.V. Varghese, R. Abdulrahman, D. Alromaihi, S.L. Atkin, and N. Alamuddin. Effect of date fruit consumption on the glycemic control of patients with type 2 diabetes: A randomized clinical trial. *Nutrients* 14(17): 3491 (2022).
22. K. Rambabu, G. Bharath, A. Hai, F. Banat, S.W. Hasan, H. Taher, and H.F. Mohd Zaid. Nutritional quality and physico-chemical characteristics of selected date fruit varieties of the United Arab Emirates. *Processes* 8(3): 256 (2020).
23. A.S. Shah, S.V. Bhat, K. Muzaffar, S.A. Ibrahim, and B.N. Dar. Processing technology, chemical composition, microbial quality, and health benefits of dried fruits. *Current Research in Nutrition and Food Science* 10(1): 71 (2022).
24. A.E.H.A. Ibraheem. Food processing of date palm fruits in Sinai. In: Management and Development of Agricultural and Natural Resources in Egypt's Desert. A.A. Elkhouly and A. Negm (eds.). *Springer Water, Springer, Cham* pp. 491-515 (2021).
25. N. Makarem, E.V. Bandera, J.M. Nicholson, and N. Parekh. Consumption of sugars, sugary foods, and sugary beverages in relation to cancer risk: a systematic review of longitudinal studies. *Annual Review of Nutrition* 38: 17-39 (2018).
26. A. Mrabet, G. Rodríguez-Gutiérrez, R. Rodríguez-Arcos, R. Guillén-Bejarano, A. Ferchichi, M. Sindic, and A. Jiménez-Araujo. Quality characteristics and antioxidant properties of muffins enriched with date fruit (*Phoenix dactylifera* L.) fiber concentrates. *Journal of Food Quality* 39(4): 237-244 (2016).
27. M. Majzoobi, G. Karambakhsh, M.T. Golmakani, G. Mesbahi, and A. Farahnaky. Effects of level and particle size of date fruit press cake on batter rheological properties and physical and nutritional properties of cake. *Journal of Agricultural Science and Technology* 22(1): 121-133 (2020).
28. C. Borchani, S. Besbes, C. Blecker, M. Masmoudi, R. Baati, and H. Attia. Chemical properties of 11 date cultivars and their corresponding fiber extracts. *African Journal of Biotechnology* 9(26): 4096-4105 (2010).