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Fortification of Date Bars with Different Protein Sources and their Nutritional Profiling

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Abstract. Date bar is an energy-dense snack food with a high content of carbohydrates and bioactive compounds and deficits protein. The date bar can be fortified with different protein sources and may be used as a functional food product to overcome protein related malnutrition. The present study was conducted to develop protein fortified date bars using skim milk, soybean and almond powders as protein sources and to examine their physico-chemical and sensory characteristics. Four different treatments for protein fortified date bar samples were prepared with different formulations and coded as A (control, 100% date fruit), B (80% date fruit + 20% skim milk powder), C (80% date fruit + 20% soybean powder) and D (80% date fruit + 20% almond powder). Among the treatments, D and C were found to have significantly higher ($P<0.05$) mean values for most of the physico-chemical properties in comparison to A and B. The average moisture content (18.50%) and carbohydrates (74.02%) remained significantly higher ($P<0.05$) in A, pH value (6.63) and TSS (28.26 °Brix) in B, ash (2.81%), protein content (12.52%) and vitamin C (11.54 mg/100g) in C and titratable acidity (0.33%), fat content (4.16%) and fibre content (5.15%) in D. The average score for sensory attributes i.e. colour, flavour, texture, aroma and overall acceptability remained significantly higher ($P<0.05$) in B, while significantly higher ($P<0.05$) score for taste was recorded in D. It was concluded from the present study that fortification of date bars with different protein sources improved the physico-chemical properties, sensorial attributes particularly protein content of the date bars in comparison to A (control), thus protein-fortified date bars are ideal for human nutrition.

Keywords: date bars, fortification, functional foods, protein

Introduction

Date palm is a fruit-bearing tree and it is widely grown in arid or semi-arid areas (Maqsood *et al*., 2020). The fruit from date palm i.e. date fruit is an exceptional source of carbohydrates, dietary fibre, vitamins, minerals, and phenolic compounds. Scientific literature also reveals its multiple therapeutic effects on human health (Nadeem *et al*., 2018). The date fruit is highly nutritious and is an exceptional source of energy (Vayalil, 2012).

For centuries, the essential constituents from fruits and vegetables are being used for developing new food products (Ranjha *et al*., 2020). The consumption of functional foods is associated with health related benefits therefore, food researchers are mainly focusing on the development of food products with functional ingredients (Carvalho Barros *et al*., 2020; Nikmaram *et al*., 2017). Functional foods are edible products fortified with excellent ingredients with additional health and safety benefits (Granato *et al*., 2020; Granato *et al*., 2017). Among different fruit-based confections, the fruit bar is one of the concentrated confections with excellent nutritional quality and energy values. Moreover, fruit bars also possess an extended shelf-life and are wholesome food for all age groups. Currently, attempts are being made to produce highly nutritious and fortified fruit bars by using date fruit as a key ingredient (Munir *et al*., 2015; Parn *et al*., 2015; Nadeem *et al*., 2012).

The date is nutritious and energy-rich but it lacks a substantial quantity of protein. According to (Sirisena *et al*., 2015), date fruit contains merely 1.5% protein. Therefore, this insufficiency may be fulfilled by fortifying date bars with suitable protein sources. Concerning the same issue, Parimita and Arora (2015) also developed whey protein fortified date bars. Protein fortified date bars may also overcome the challenge of protein energy malnutrition among the deprived societies of developing countries.

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Keeping this aim in view, in the present study, the protein sources i.e. skim milk powder (SMP), defatted soy powder (DSP), and almond powder (AP) were used to develop protein fortified date bars. Skim milk powder is among the most commonly used raw materials of different food products because of less weight, low moisture helping in easy transportation and excellent preservation. The defatted soy powder is a cheaper and richest source of protein. While the almond is a high protein (up to 25%) nut and contains all the important amino acids (except methionine). In the present study, the protein fortified date bars were developed and analyzed for their physic-ochemical and sensorial attributes.

Materials and Methods

Sample collection. Date fruits (Begum Jhangi variety of Turbat, Balochistan) were purchased from the local market of TurbatKech, Balochistan. Other ingredients such as skim milk powder, defatted soybean powder, and almond powder were purchased from the supermarket of Hyderabad, Sindh.

Preparation of date bars. Date bars were developed according to the method described by Nadeem *et al*. (2012). The formulation of date bars is shown in Table 1. Date fruits were washed, air-dried, pitted, steamed, and minced using a mincing machine to obtain fine and consistent date paste. The date paste was separately mixed with different protein sources (skim milk powder, defatted soybean powder and almond powder) and the mixture was transferred into a cutting table and protein fortified date bars of approximately 50 ± 2 g of desired shape and size (2.5 cm in width, 6.5 cm in length and 1.5 cm in height) were developed, packed in glass jars and analyzed for physico-chemical and sensory attributes.

Table 1. Treatment plan of date bars

Treatments	Date fruit (%)	SMP (%)	DSP (%)	AP (%)
A(Control)	100%	_	_	_
B	80%	20%	_	_
C	80%	_	20%	_
D	80%	_	_	20%

* SMP: skim milk powder; DSP= defatted soy powder; AP= almond powder; A= control; B= date bar with skim milk powder; C= date bar with soybean powder; D= date bar with almond powder.

Sample analysis of date bars. ***Physico-chemical characteristics.*** The pH value of protein fortified date bars was analyzed through a digital pH meter (Model HI, Hanna Instruments, Italy) according to the method of AOAC (2010). By following the standard methods of AOAC (2016), titratable acidity (%), ash (%), TSS (°Brix), moisture (%), protein (%), fat (%), total carbohydrate (%) and fibre (%) were determined, while vitamin C (mg/100g) was evaluated by the method of Mazumdar and Majumder (2003).

Sensory attributes. The sensory evaluation of protein fortified date bars was carried out by the panel of twenty judges to measure the degree of preference among the different treatments for various attributes i.e. colour, flavour, texture, taste, aroma, and overall acceptability by using a nine-point hedonic scale as described by Iwe (2002) shown in (Fig. 1).

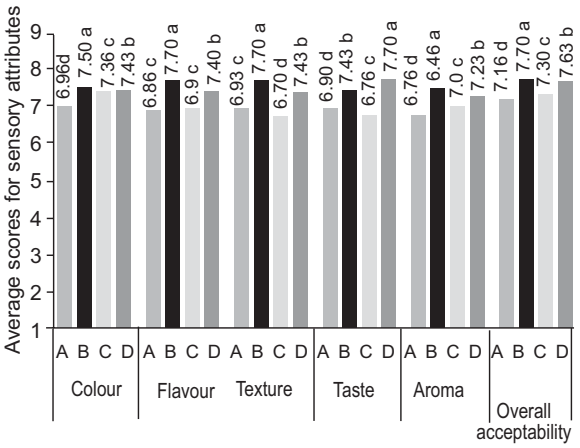

Fig. 1. Sensory evalution of protein fortified date bars.

Statistical analysis. The data recovered from the present findings were statistically analyzed to one-way analysis of variance (ANOVA) to assess the effect of protein fortification on physico-chemical and sensory characteristics of date bars as described by Steel *et al*. (1997).

Result and Discussion

Physico-chemical composition of date bars. The average physico-chemical properties were statistically different ($P<0.05$) among all the treatments. The mean values for the physico-chemical composition of date bars are presented in Table 2.

Table 2. Physico-chemical characteristics of date bars fortified with different protein sources

Treatments	Physico-chemical characteristics									
	pH Value	Titratable Acidity (%)	TSS (°Brix)	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Total carbohydrate (%)	Vitamin C (mg/100g)	Fibre (%)
A	6.25 c	0.23 d	26.71 b	18.50 a	1.61 c	2.71 d	0.70 b	74.02 a	10.67 b	2.46 c
B	6.63 a	0.29 b	28.26 a	17.26 c	1.43 d	6.56 c	0.61 c	72.22 b	7.67 d	1.91 d
C	6.41 b	0.26 c	22.21 d	18.03 b	2.81 a	12.52 a	0.56 d	63.53 d	11.54 a	2.54 b
D	5.84 d	0.33 a	24.17 c	16.85 d	2.02 b	7.64 b	4.16 a	64.18 c	9.23 c	5.15 a
SE	0.0156	0.0009	0.2883	0.3497	0.0139	0.0137	0.0135	0.3475	0.4206	0.0009
LSD (0.05)	0.0383	0.0228	0.7054	0.8557	0.0341	0.0335	0.0331	0.8504	1.0292	0.0221
SD	0.3025	0.0950	2.373	0.761	0.554	3.66	1.602	4.91	2.094	1.312

* A= control; B= date bar with skim milk powder; C= date bar with soybean powder; D= date bar with almond powder; SE= standard error; LSD= least significant difference; SD= standard deviation.

pH. The mean values for pH varied significantly and ranged from 5.84 to 6.63. The maximum pH value was observed in sample B (6.63) followed by C (6.41), A (6.25) and D (5.84). The recorded pH range categorized all protein fortified date bars as low acid foods. This variation in pH value possibly occurred owing to variable protein sources that were incorporated in date bars. The date bar sample fortified with skimmed milk showed a slightly neutral pH value since milk itself is a neutral food (Tsioulpas *et al*., 2007) whereas, the sample fortified with almond powder had a minimum pH value might be because of the slightly lower pH value of almond nut powder i.e. 5.51 as recorded by Olatidoye *et al*. (2011). Interestingly, present findings for pH value of date bars are in conformity with the work of Akhtar *et al*. (2014) who also observed pH values ranging from 4.30 to 5.28 in apple-date pulp incorporated fruit bars.

Titratable acidity. The average titratable acidity of date bars ranged from 0.23 to 0.33%. The highest titratable acidity was observed in sample D followed by B (0.29), C (0.26) and A (0.23). It may be seen that due to the acidic nature of almond powder in comparison to soybean and skimmed milk powder, the almond powder fortified date bars were recorded to have higher titratable acidity. Present results are in agreement with the findings of Munir *et al*. (2018) who also observed an increased titratable acidity in oat-based date bars (i.e. 0.3 to 0.4%). Similar findings were also recorded by Patel and Kulkarni (2017) that the average titratable acidity (%) of banana-cactus pear mixed fruit bars were between 0.26 to 0.34%.

Total soluble solids. In the present findings, total soluble solids in date bars were ranged from 22.21 to 28.26 °Brix. Sample B showed the maximum total soluble solids (28.26 °Brix) followed by A (26.71 °Brix), D (24.17 °Brix) and C (22.21 °Brix). An inconstant °Brix among the sample indicates that different protein sources functioned differently in date bars for altering °Brix meanwhile, the main contributor for having sufficient °Brix value in date bars is date fruit itself since sucrose content is higher in it (Ashraf and Hamidi-Esfahani, 2011). However, some related results were also obtained by Munir *et al*. (2018), which show that total soluble solids increased (from 48.0 to 64.2 °Brix) with an increase of oat to date bars.

Moisture. The average values belonging to moisture (%) were ranged from 16.85 to 18.50%. Date bar sample A showed higher moisture (18.50 %) followed by C (18.03 %), B (17.26 %) and D (16.85 %). Moisture being the most crucial feature of food commodities specifies food's storability. Date bars are semisolid confections with no added water in them (Akhtar *et al*., 2014) are not susceptible to prompt spoilage. In a similar study, Muhammed *et al*. (2015) incorporated flaxseeds in date bars and it was noticed that average moisture percent decreased in bars with an increase in flaxseeds i.e. from 10.54% to 14.61%.

Ash. The average ash (%) was ranged from 1.43 to 2.81 in date bar samples. A higher content was recorded in sample C (2.81 %) followed by D (2.02 %), A (1.61 %) and B (1.43 %). The date fruit has sufficient total mineral or ash content ranging from 1 to 2.5 % (Ashraf and Hamidi-Esfahani, 2011) moreover, different protein sources added in date bars also have enough ash content. It seems that date fruit and protein sources synergistically worked in date bars for enhancing ash content. The recorded results are in agreement with the findings of

Shaheen *et al*. (2013) who also observed ash content ranging from 1.90 to 3.93% in fortified date bars.

Protein. Average protein content (%) was ranged from 2.71 to 12.52 % in the samples of date bars. Sample C had higher protein content (12.52 %) followed by D (7.64 %), B (6.56 5%) and A (2.71 %). Results revealed a sufficient increase in protein content of fortified date bars in comparison to sample A (control). It can be broadly stated that different protein sources functioned differently for enhancing protein content in the date bars. Date fruit under maturation stage is self sufficient in protein content (i.e. 1 to 7 %) but during ripening fruit loses its protein owing to non-enzymatic browning/ Maillard's reaction (Ashraf and Hamidi-Esfahani, 2011). The recorded results correlate with the findings of Munir *et al*. (2015), according to their observations an increased protein contents (11.87 to 15.28%) was noticed with the addition of different protein sources to the date bars.

Fat. The data regarding average fat (%) varied from 0.56 to 4.16%. A higher fat content was reported in sample D i.e. 4.16 % followed by A (0.70 %), B (0.61), and C (0.56 %). The control sample (A) proved to have low fat since date fruit contains little fat, while sample D exhibited more fat content which is an ultimate function of almond nut powder. The observed results coordinated with the findings of Munir *et al*. (2015), who also recorded fat content in a range of between 2.45% to 5.13% in protein fortified date bars as different protein sources affected the fat percentage in these bars.

Carbohydrate. Average carbohydrates content (%) ranged from 63.53 to 74.02% in date bars. Maximum carbohydrate was seen in A sample (i.e. 74.02 %) followed by B (72.22 %), D (64.18 %) and C (63.53 %). The protein sources used to fortify date bars are not so rich in carbohydrate content in comparison to date fruit therefore, control sample (A) exhibited more carbohydrate content than fortified date bars. Carbohydrates being the major nutritional constitute of date provide a great number of different sugars (i.e. sucrose, arabinose, xylose, glucose and galactose etc.). These results correlate with the findings of Muhammed *et al*. (2015) who also observed an increase in carbohydrate content (50.00 to 57.64%) with the incorporation of flaxseed flour in date bars.

Vitamin C. The average vitamin C (mg/100g) ranged from 7.67 to 11.54 mg in date bars. The maximum value was observed in sample C (11.54 mg/100g) followed by A (10.67 mg/100g), D (9.23 mg/100g), and B (7.67 mg/100g). Date bar sample fortified with soybean powder exhibited more vitamin C content. According to Mrabet *et al*. (2008), in date fruit ascorbic acid content remain higher in the early stages of maturity and decreases during maturation. The results of this study are similar to the findings of Sharma *et al*. (2013) who also observed vitamin C (mg/100g) in the range of between 8.43 to 9.52 mg/100g in apricot-based fruit bars.

Fibre. The average fibre contents (%) ranged from 1.91 to 5.15 %.The mean values for crude fibre indicate that sample D showed the highest fibre content (5.15 %) followed by C (2.54 %), A (2.46 %) and B (1.91 %). Fortified and control date bar showed a significant portion of fibre which makes them an ideal fibre containing confection. The results regarding fibre content are in close agreement with the findings of Munir *et al*. (2018) who also observed fibre contents (%) in date fruit-based snack bars in the range of between 2.9 to 6.8%.

Sensory attributes of date bars. The average scores for sensory attributes of all date bars are presented in Fig. 1. The scores of all sensory attributes i.e. colour, flavor, texture, test aroma, and overall acceptability remained significantly higher ($P<0.05$) in protein fortified date bars samples (B, C, and D) in comparison to the control sample (A) except taste which secured least average score for sample C. The findings showed significant differences in sensory attributes among different treatments due to different protein sources in date bars but surprisingly, all samples gained acceptable sensory scores but among them, sample B showed significantly higher ($P<0.05$) results for colour, flavour, texture, aroma and overall acceptability. However, among A, C and D significantly higher ($P<0.05$) scores for colour, flavour, texture, aroma and overall acceptability were perceived by D in comparison to A and C, while for taste the significantly higher ($P<0.05$) score was recorded in D followed by B, A and C, respectively. The consequences of the present study coordinated with the findings of Munir *et al*. (2018) who also observed better sensory attributes in fortified date bar samples as compared to controlled samples. According to a study conducted by Shaheen *et al*. (2013), the sensory attributes of date bars can be improved by the addition of different nutrient sources.

Conclusion

Date fruits can be incorporated with different protein sources to increase their protein content. Therefore, it can be concluded from the present study that all the

treatments of date bars fortified with different protein sources were found to be nutritionally superior in protein content in comparison to control date bar samples. It is further concluded that fortification of date bars with different protein sources was found to be improved in sensory attributes and overall quality in comparison to control date bar samples.

Conflict of Interest. The authors declare no conflict of interest.

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