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Addition of Oat Enhanced the Physico-Chemical, Nutritional and Sensory Qualities of Date Fruit Based Snack Bars

Masooma Munir[1,2,*], Muhammad Nadeem[1], Tahir Mahmood Qureshi[1], Aqsa Qayyum[2], Muhammad Suhaib[4], Falak Zeb[5], Ijaz-ul-Haq[5], Aneela Qureshi[1], Muthupandian Ashokkumar[3]

[1]Institute of Food Science and Nutrition, University of Sargodha, Sargodha- Pakistan
[2]Food Science Research Institute, National Agricultural Research Centre, Islamabad-Pakistan
[3]School of Chemistry, University of Melbourne, VIC 3010-Australia
[4]Land Resources Research Institute, National Agricultural Research Centre, Islamabad- Pakistan
[5]Department of Nutrition and Food Hygiene, Nanjing Medical University Jiangsu- China
*Corresponding author: masho@unimelb.edu.au

Abstract Fruit based products are major part of healthy diet ever since human life began on earth. In the present study, four treatments (T_0 to T_4) of date based snack bar of approximately 36±2g with high nutritional value were prepared on the basis of oats supplementation. Electronic hygropalm meter was used to determined water activity. After sensory evaluation, proximate composition, pH and free fatty acids, the mineral contents were measured by using atomic absorption spectrophotometry. The hardness increased and water activity decreased significantly ($p < 0.05$) among the treatments. Moisture content in all treatments was low as compared to that of date paste. Maximum fat content was found in T_3 (6.9%) and the minimum in T_0 (2.5%). The maximum protein content was found in T_3 (~14%) than all other three treatments. Significant difference ($p < 0.05$) was found in mineral contents of all treatments. Total sugars ranged from 50.7% to 45.9% were recorded with significant variation among treatments. Reducing sugars were high than non-reducing sugars, while acidity and free fatty acid contents were varied non-significantly among treatments. The highest score (7.1 score) of sensory evaluation recorded for T_2, followed by T_1 and T_3 and lowest for T_0. It has been concluded that the addition of oats have positive effect on acceptability and nutritional value of bars. Because of high nutritive value these bars would be healthy for consumers and motivate the food manufacturers and farmers for cottage as well as international industry.

Keywords: *treatments, water activity, proximate composition, nutritional value, sensory evaluation*

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1. Introduction

Fruits and fruit based products are major part of healthy diet ever since human life began on earth. It has been well-established that fresh fruits are more nutritious than processed fruit products. Epidemiological studies also suggest that regular consumption of fruits may reduce the risk of chronic diseases [1,2]. Consumer preference is tremendously increasing for convenient, natural and nutritious food products with minimal processing [3]. Fruit bar is a convenient and concentrated food product that has high nutritive value with longer shelf life as compared to fresh fruits. In addition, fruit bars can deliver high dietary fiber, proteins, carbohydrates, micronutrients and many other bioactive compounds to human body which are necessary to meet daily requirements of body. Fruit bars are equally nutritious for all age group [3]. The reason is that currently, food manufacturers are in search of various methods to make ready to eat healthy food products especially from fruits.

Fruit based cereal bars are more popular among consumers due to their balanced nutritional content and convenience. Oat (*Avena sativa*) is distinct among the cereals due to its multifunctional characteristics, nutritional profile and high dietary fiber content. Recent advancement in food and nutrition has revealed the importance of its various components. It is a good source of dietary fiber especially beta-glucan, minerals and other nutrients [4]. Oat and oat by-products have been proven to be helpful in the treatment of diabetes and cardiovascular disorders. Oat bran in particular, is good source of B complex vitamins, protein, fat, minerals in addition to heart healthy cereals. The incorporation of oat grains and oat bran in food products improves not only the nutrients level but also act as a preventive therapy against various maladies [5].

We have recently reported in the preparation and characterization of fruit bars [6] that the addition of skim

milk powder in fruit bars resulted in significantly higher sensory attributes.

In addition, dates are highly nutritious and considered as good source of energy mainly due to the presence of high amount of readily digestible carbohydrates [7]. Date fruit is also a good source of important phytochemicals, strong antioxidants and minerals [8-11]. Attempts are being made since few years to develop nutritious and fortified snack bars with dates as key ingredient [6,12,13]. Hence, date fruit bars are a good alternative to freshly fruits specially in off season and also could be marketed to any country where this fruit is not grown. Parimita and Arora developed date bars fortified with whey proteins in order to develop a product with a balanced diet [14]. Parn have used two different date varieties to prepare date bars in the absence of any artificial additives [13]. The product showed excellent textural and nutritional properties. HO et al., (2016) developed date bars using Malaysian ingredients and highlighted the importance of characterizing date bars made of local ingredients [15].

As Pakistan is among top ten date producing countries, a new manufacturing process involving local production with functional ingredients will be a good opportunity. The utilization of locally produced dates would generate health as well as economic benefits for the region as well as in the global market. By considering this scenario, the main aim of this study was to produce novel date based confectionary bars for consumers, especially children, by utilizing date paste and oats with improved nutritional (fat, proteins, fiber and mineral contents), textural and sensory properties. The results reported in this study will not only benefit food industries but also in tackling the growing nutritional abnormalities in population.

2. Materials and Methods

2.1. Procurement and Preparation Date Paste and Raw Materials

Dates, white oat (oatmeal), skim milk, roasted gram, almonds, pistachio, cardamom powder and CMC (carboxy methyl cellulose) were purchased from local market in Islamabad- Pakistan. Firstly, dates were washed, dried and then pitted. After pitting steam was given to dates for 20-25 minutes until they become soft. In order to obtain a paste, mincing of these dates was done in a mincing machine. White oats were roasted for 5 minutes until it gave cooked flavor. Roasted gram and cardamoms were ground to make powder. Nuts (almonds, pistachio) were crushed into pieces.

2.2. Procedure for Development of Snack Bars

After preparing the raw materials, all the ingredients were mixed with date paste homogeneously and transferred to a cutting table. After this, sheeting was performed with the help of a stainless steel roller and the sheet was cut into bars of 3 cm width, 7 cm length and 1.5 cm height. Each bar of approximately 36±2g was packed and sealed in air tight aluminum packs. All the ingredients in each treatment were in same quantity, only the quantity of white oat was different in all treatments with a control without white oat. The formulation and treatment plan are provided in Table 1 and Table 2 respectively.

Table 1. Formulation of Date Bars Enriched with White Oat

Ingredients	Quantity (g)
Dates	100
Gram flour	5
Skim milk powder	5
Cardamom powder	0.5
Almonds	5
Pistachio	5
Carboxy Methyl Cellulose (CMC)	0.5

Table 2. Treatment Plan for Snack Bars Formation

Treatments	Oat quantity
T_o	Without white oat
T_1	15 g
T_2	25 g
T_3	35 g

T_o = Snack bars without white oat, T_1= Snack bars with 15g white oat, T_2= Snack bars with 25g white oat, T_3= Snack bars with 35g white oat.

2.3. Analysis of Physical Properties

2.3.1. Water Activity (a_w)

Electronic hygropalm water activity meter (Model Aw-Win, Rotronic, equipped with a Karl-Fast probe, Rotronic, Hong Kong, China) was used to determined water activity [16].

2.3.2. Instrumental Texture Analysis

Texture analyses of snack bars were analyzed by texture analyzer with 5 kg load cell (Model TA.XT plus, Stable Microsystems, Surrey, UK) [12].

2.4. Proximate Analysis

Proximate composition such as moisture, ash, crude fat, crude protein and crude fiber of snack bars was determined and expressed on dry matter basis according to the procedures given in AOAC [17].

2.5. Sugar Determination

Total sugars, reducing sugars and non-reducing sugars were determined according to Lane and Eynon method No.935.64 given in AOAC [17].

2.6. ºBrix, Titrateable Acidity and Free Fatty Acids

The pH was determined by a digital pH meter, while ºBrix was measured by Abbe refractometer. Titratable acidity and free fatty acids of the sample were determined according to the standard method of AOAC [17].

2.7. Calorific Value of Date Bars

The gross energy of fruit bars was calculated using standard factors of 3.75 for protein, 9.0 for fat and 3.75 kcal/g for carbohydrates [18].

2.8. Mineral Analysis

Sample was ashed at 550°C in furnace. Then digestion of dry ash was carried out by adding 6m HCL and 0.1 $MHNO_3$ at equal ratio. After dilution, mineral contents were measured by using atomic absorption spectrophotometric method according to AOAC [17].

2.9. Microbiological Analysis

Total plate count (TPC) and yeast and mold count (Y and M) were determined according to method no. 42-11 and no. 42-50 of AACC [19].

2.10. Sensory Evaluation of Date Bars

Date bars was evaluated for sensory characteristics such as color, flavor, taste, mouth feel and overall acceptability by expert panel of 20 judges which includes 12 females (5 master level students and 7 professionals) and 8 males (3 teenagers, and 5 professionals) from National Agricultural Research Centre (NARC). The evaluation was done in sensory evaluation laboratory by a panel with normal lights on 9-points Hedonic Scale.

2.11. Statistical Analysis

Results were statistically analyzed by using analysis of variance technique (ANOVA). The difference in means was evaluated by the Least Significant Design, by using statistics 9.0 software (Analytical software, Tallahassee, FL).

3. Results

Figure 1 shows the hardness of date bars with different treatments because texture is a key parameter to estimate the consumer acceptability. It is evident from the data that hardness increased significantly *($p< 0.05$)* with supplementation of oat in date bars. Minimum hardness was recorded for T_0 (611.8±5.1 g), while maximum was recorded for T_3 (1008.9±8.6 g). The reason for an increase in hardness is discussed below in relation to water activity. In contrast, the water activity decreased significantly *($p< 0.05$)* from 0.613±0.005 (T_0) to 0.559±0.005 (T_3) as shown in Figure 2.

Table 3 represents the proximate composition of date based snack bars. In our study, the moisture content of fruit bars decreased significantly by adding white oats in dates. The highest moisture was observed in T_0 (18.7±0.3%) while lowest moisture content was in T_3 (14.4±0.1%). Moisture contents in all treatments were low as compared to that of date paste. Foods with higher water content will have a higher water activity than dry foods. Hence, it can be stated that our new date snack product contained moisture levels within acceptable range found in products previously reported in other studies, confirming its suitability for consumer market. Fat contents of date bars increased with an increase in white oats. Maximum fat percentage was observed in T_3 (6.9%) and the minimum in T_0 (2.5%). In addition, the protein and fiber contents also increased, providing health benefits. The protein content in raw date samples and snack bars showed significant ($p <0.05$) differences. The maximum protein content was found in T_3 (~14%) then in descending order in T_2, T_1 and T_0. Ash contents in date bars ranged from ~2-4%, gradually increased with addition of white oat. In case of fiber contents, a similar increase was observed. The value of nitrogen free extract (NFE) decreased from T_0 to T_3 significantly. A decrease in NFE means that carbohydrate contents decreased which is indication of increased fiber (dietary fiber β-glucan), protein and ash (minerals) contents in date bars.

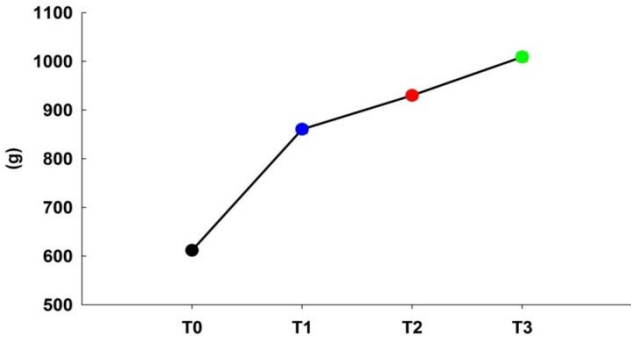
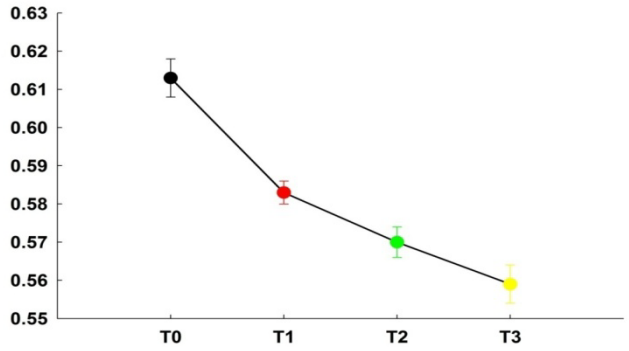


Figure 1. Hardness of snack bars



T_o = Snack bars without white oat, T_1= Snack bars with 15 g white oat, T_2= Snack bars with 25g white oat, T_3= Snack bars with 35g white oat

Figure 2. Water activity of snack bars

Table 3. Proximate Composition of Date Based Snack Bars

Samples	Moisture%	Fat%	Protein%	Ash%	Fiber%	NFE
Date Paste	28.1±0.3	0.5±0.1	2.38±0.22	1.4±0.03	2.9±0.1	92.7±0.2
White Oat	8.3±0.2	8.6±0.35	9.9±0.10	2.05±0.01	3.3±0.1	76.1±0.2
T_0	18.7±0.3^a	2.5±0.27^d	9.7±0.23^d	2.1±0.08^d	3.5±0.08^d	82.2±0.3^a
T_1	16.7±0.03^b	5.4±0.07^c	12.1±0.10^c	3.7±0.23^c	5.7±0.04^c	72.98±0.3^b
T_2	15.5±0.03^c	6.1±0.04^b	13.2±0.19^b	4.1±0.42^b	6.1±0.06^b	70.5±0.5^c
T_3	14.4±0.10^d	6.9±0.05^a	14.3±0.09^a	4.5±0.35a	6.8±0.10^a	67.5±0.6^d

NFE= Nitrogen free extract, Different letters in the same column represent a significant trend. ± indicates SD from 3 individual measurements. Different letters in the same column represent a significant difference in minerals contents in date bars.

Table 4. Minerals Contents of Date Based Snack Bars (mg/1000g)

Treatment	Fe	Mg	Zn	Mn
T_0	66.5±2.8[a]	410.4±4.8[d]	10.9±0.1[d]	4.3±0.3[d]
T_1	17.3±1.1[b]	665.1±3.7[c]	16.6±1.1[c]	10.4±0.4[c]
T_2	17.4±0.14[b]	842.4±3.4[b]	18.2±1.2[b]	11.4±0.6[b]
T_3	16.4±0.1[c]	1074.3±9.2[a]	19.1±1.1[a]	12.6±0.4[a]

Fe= Iron, Mg= Magnesium, Zn= Zinc, Mn= Manganese. Different letters in the same column represent a significant trend. ± indicates SD from 3 individual measurements. Different letters in the same column represent a significant difference in minerals contents in date bars.

Table 5. Macronutrients Constituents of Date Based Snack Bars

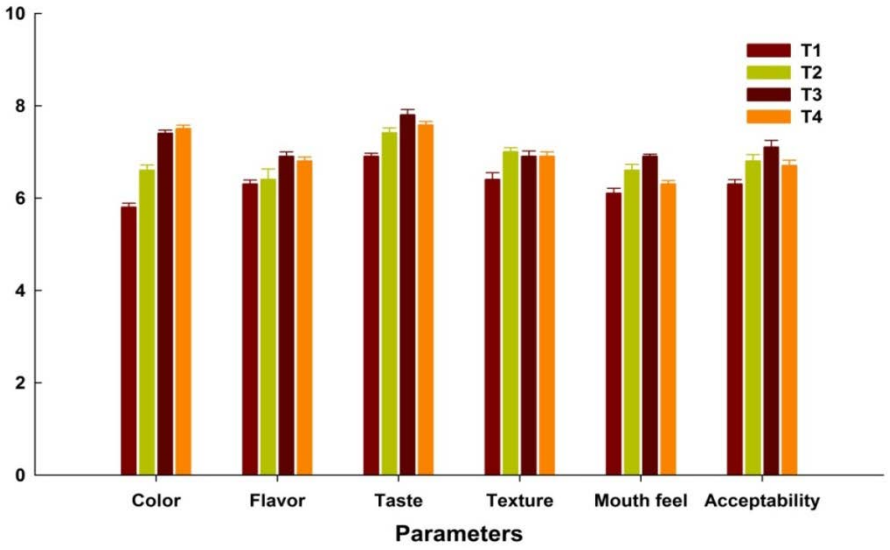
Macronutrients Constituents	T_o	T_1	T_2	T_3
Total sugars%	50.7±0.3a	47.5±0.3b	46.3±0.6c	45.9±0.3d
Reducing sugars%	45.3±0.29a	41.35±0.3b	39.9±0.3c	39.6±0.2c
Non reducing sugars	5.3±0.03a	6.1±0.1b	6.4±0.1b	6.3±0.1b
Brix	64.2±0.2a	58.2±0.9b	52.22±0.9c	48.0±0.9d
Acidity %	0.3±0.01a	0.4±0.02a	0.4±0.04a	0.4±0.03a
Free fatty acids%	0.02±0.005a	0.04±0.0017a	0.05±0.001a	0.06±0.008a
Calorific value (kcal)	367.4±1.1b	368.1±1.3ab	368.9±1.6ab	369.3±1.2a

T_o = Snack bars without white oat, T_1= Snack bars with 15 g white oat, T_2= Snack bars with 25g white oat, T_3= Snack bars with 35g white oat. Different letters in the same column represent a significant trend. ± indicates SD from 3 individual measurements.

Table 6. Mean Values for Total Plate Count and Mold Count (LOG_{10}cfu/g)

Treatment	TPC	Yeast and mold
T_0	3.0±0.11[a]	2.1±0.9[a]
T_1	2.9±0.1[a]	1.9±0.1[a]
T_2	2.3±0.3[a]	1.6±0.2[a]
T_3	2.2±0.1[a]	1.4±0.10[a]

TPC= Total plate count. Similar letters in the same column represent a non-significant trend. ± indicates SD from 3 individual measurements.



T_o = Snack bars without white oat, T_1= Snack bars with 15 g white oat, T_2= Snack bars with 25g white oat, T_3= Snack bars with 35g white oat.

Figure 3. Sensory evaluation of date based snack bars

Significant difference ($p< 0.05$) was found in mineral contents of all treatments shown in Table 4. Highest level of Fe (66.5±2.8mg/1000g) while lowest of Mg, Zn and Mn were observed in control treatment. Mg content was highest in T_3 (1074.3±9.2mg/1000g) followed by T_2, T_1 and T_0. Zinc (19.1±1.1amg/1000g) and Mn (12.6±0.4mg/1000g) contents were highest in T_3 while lowest value was recorded in control treatment.

Table 5 presents the macronutrients constituents of date bars. Total sugars ranged from 50.7±0.3% to 45.9±0.3% in date bars and significant variation found among treatments. Reducing sugars are high as compared to non-reducing sugars in all treatments as dates contain mainly reducing sugars such as glucose and fructose. Acidity, caloric value and free fatty acid contents were varied insignificantly among treatments.

Table 6 shows the microbial count of snack bars as it is crucial to determine the microbial activity as this is an important attribute to any food product for its shelf stability. The highest count observed in T_0 (3.0±0.1cfu/g) while lowest in T_3 (2.2±0.1cfu/g).

Figure 3 represents the sensory evaluation of bars. For color, highest score were given to T_3 (7.5±0.08), followed by T_2 and T_1 but lowest ranking on hedonic scale was for

T_0. For flavor, the highest score was recorded for T_2 (6.9±0.10). For texture highest score on hedonic scale were given to T_1 (7.0±0.09), followed by T_2, T_3 and lowest score to T_0. For taste, the highest score was recorded for T_2 followed by T_1 and T_3 and T_0. The judges were asked to rate the overall acceptability of the final product on the basis of 9-point hedonic scale. They gave the highest score (7.1 score) to T_2, followed by T_1 and T_3 and lowest to T_0.

4. Discussion

The main focus of the current study is to make the local produced dates ready to use in shape of fruit bars, and promote health benefits and economic status of the community. Therefore, this study exploring the sensory and nutritional value of date based snack bars with oat supplementation.

Water Activity is a measure of free water that is present in sample and available to react with or attach itself to another material. It ranged from 0 to 1. Ability of micro-organisms to survive is also dependent on water activity. Lower the water activity, lower will be microbial count. It is also known that the water activity should be below 0.6 for commercial snack foods to limit or inhibit surface mold growth. Addition of ingredients that can reduce water activity in snack foods by binding water in their matrix is an important processing tool to enhance shelf stability of snack foods [20]. As we used oat in manufacturing of date bars, it reduced the water activity level which can enhance shelf stability.

It is worth to highlight the fact that the hardness and water activities observed for our product are in the acceptable range as observed in previous studies made from different date varieties [6,13]. This is a critical observation that provides assurance to our product as commercial value.

Moisture content of snack food bars is important as it affects stability, quality and shelf life of fruit bar. Date paste used for preparation of date bar contained moisture contents about 28%, which is similar to that observed by [16,21] who studied chemical composition (10 to 30% moisture) of 20 date varieties of Pakistan and Saudi Arabia. Other studies have also shown similar moisture content levels in date bars [12]. According to a study [22] fat content of date varieties varies between 0.1 to 1.4% and the fat content of the dates used in our study is within this range. White oat showed more lipid contents (8.56%) as compared to date paste. While excess in small amount of fat may be considered as “unhealthy”, there is a trade off with respect to minimizing moisture content and water activity that ultimately increase the shelf life of the product. Oat has been considered as good source of low cost protein. As compared to other cereals, oats contain high protein and fat contents which have functional and nutritional potential. According to another study [23] oat contains 9 to 14% protein with unique amino acid profile, while dates consist of less protein contents. These results also support the fact that the novel snack bars we have developed contain appropriate levels of protein content [24,25] that suitable for human consumption. The fiber content observed in our product is similar to that of previously reported oat based baked energy bars [26]. The above mentioned results regarding the change in proximate composition are also in close agreement with the findings of Munir et al., [6] who observed proximate parameters varied significantly among treatments of date bars.

It could observe that with the addition of oat in date paste, that Mg, Zn and Mn levels were increased. It might be due to the higher mineral contents in oat as compared to dates. So these novel snack bars can be recommended to combat the micronutrient deficiency in humans.

Dates have an edge over other sweet confections, as they not only give natural sugars, avoiding the addition of external sugar, but fructose provides a better sweet taste than sucrose with low in glycemic index. The sugar levels in our snack bars are similar to those observed in other snack products [12,27]. The addition of oat increased fat, protein and fiber constituents. However, provides significant nutritional and health benefits. These bars could be recommended for reducing caloric diets with more nutrients for weight conscious people.

A decrease in total plate count (TPC) and yeast and mold (Y&M) count might be due to gradual decrease in moisture contents among treatment. The microbial count observed in our sample is in a similar range observed in previous studies [28,29].

Sensory quality evaluation is undertaken to gain better insights by the behavior of complex mechanisms in a food product [30]. For marketing purpose, results on sensory quality evaluation are of more value, because they give in depth insight with regard to product preference and acceptability. Findings of our sensory scores are in accordance with recommended values of Besbes study [31].

5. Conclusion

It has been observed that the addition of oats have positive effect on acceptability, liking and nutritional value of date fruit based snack bars. Because of high protein, fat, fiber and mineral contents with a delicious sweet taste, these novel date bars would be attractive for consumers as alternative to conventional snacks available in the market. Economical raw material and easy manufacturing method would boost and motivate the food manufacturers and farmers for cottage as well as international industry.

Conflict of Interest

All authors have reviewed and approved the final manuscript. The authors declare no conflict of interest.

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