



# Effect of substitution of glucose syrup with date syrup on the nutritional quality of Granola bar

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**ABSTRACT**— Granola bar is a ready- to- eat snack food that is highly nutritious due to the presence of different ingredients such as oat, cashew nut and puffed rice. They are rich in protein, dietary fiber, vitamins and minerals. They consumed in place of breakfast or in between meal to temper hunger for people on the go. In order to make granola bar even more nutritious and healthy, the sugar content can be substituted with natural sweeteners. Therefore, the overall objective of this study was to produce 5 high energy nutritious granola bars by combining oat, puffed rice, corn flakes, cashew nut, chickpea, raisins and substituting the glucose with date syrups namely: (GBA 100% glucose syrup:0 % date syrup (Control); (GBB 75% glucose syrup: 25% date syrup); (GBC 50% glucose syrup: 50% date syrup); (GBD 25% glucose syrup: 75% date syrup); and (GBE 100% date syrup: 0 % glucose syrup). Microbial load, nutrient composition, sensory evaluations were performed. Flaxseed had the highest total viable count, fungal count and chickpea has the highest Salmonella Shigella count. On dry weight basis, moisture content ranged from (1.05±0.0 to 1.07±0.0); protein (8.5±0.02 to 12.6±0.05); fiber (0.53±0.04 to 1.1±0.02). GBC has the highest moisture content (1.07±0.0). GBE was scored higher in taste (4.05), chewiness (3.65), aftertaste (3.75) and overall acceptability (4.05). GBC scored (4.05) in color and crunchiness (4.25). In conclusion, date syrup can be substituted for glucose syrup in the production of granola bars because the bars are generally acceptable by consumers.

**KEYWORDS:** Granola bar, Date syrup, Chickpea

## 1. INTRODUCTION

In recent years, individuals travel long distances from their places of residence to work, and may not have time to prepare nutritious meal. The ingestion of a balanced diet is the most effective and the safest way to prevent or avoid health problems like diabetes, malnutrition, obesity and heart disease [15]. As the awareness of these health conditions increase, there has been a shift in eating habit of consumers. Recently, the focus is on foods enriched with dietary fiber and micronutrients such as omega-3 fatty acids, phytosterols [8]. Cereal or granola bars can be consumed for breakfast or in between meals to produce greater reductions in hunger and an increase in fullness compared to conventional low-calorie cookies [21], which in turn result in reduction of fatigue and improve concentration. They are convenient and popular, which make them an ideal food format to deliver fruit-derived phenolic antioxidants and fiber [33]. Cereal bars, contain diversified food ingredients such as oat, puffed rice, chickpea, cashew nuts, raisins, glucose syrup for agglutination and some other ingredients [2]. Oat (*Avena sativa*) has been used as food and fodder since ancient times. Oat grain is an ingredient in a wide range of food products including breakfast cereals, porridge, cookies, breads and muffins, crackers and snacks, beverages, meat extenders and baby foods. It is one of the richest sources of the dietary soluble fiber beta-glucan [35], also contains more lipids than other cereal crops and is rich in unsaturated fats, including the essential fatty acid linoleic acid [32]. Oats contain unique antioxidants, called avenanthramides, which has a potential of reducing cardiovascular risks [9], as well as the vitamin E-like compounds, tocotrienols and tocopherols which are known to play important role in disease prevention [24]. Furthermore, consumption helps in decreasing blood glucose levels, prevents constipation and facilitates good colonic health [8]. Cashew (*Anacardium occidentale* L.), often referred to as ‘wonder nut’, is one of the most valuable

processed nuts traded on the global commodity markets [29]. Some of the products derived from the nuts include the roasted kernel snacks, kernel oil, cashew nut shell [1]. Cashew nut is reported to be rich in protein and carbohydrate [30], mostly unsaturated fatty acid [28], essential amino acids, vitamins and minerals [23]. Chickpea (*Cicer arietinum* L.) is an annual legume, a good source of carbohydrates and protein, constituting about 80% of the total dry seed mass [11], [18] compared to other pulses such as bamabara nut, lentils and beans. Furthermore, chickpea is cholesterol free and is a good source of dietary fiber, vitamins and minerals. Chickpea consumption is reported to have some physiologic benefits that may reduce the risk of chronic diseases and optimize health [36].

According to [25], the main bioactive compounds in flaxseed include alpha-linolenic acid (ALA), lignans and fiber and four common forms of flaxseed available for human consumption include whole flaxseed, ground flaxseed, flaxseed oil and partially defatted flaxseed meal [26]. Furthermore, flaxseed's usage as a food ingredient has increased due to the positive results from health studies involving ALA, an omega-3 fatty acid [20]. For the production of granola bars, glucose syrup is used for the purpose of agglutination. Glucose syrup is a product of hydrolysis from potato, corn, cassava and more. Glucose syrups are essentially industrial sugars used in the manufacture of food products, and are mainly consumed in the confectionery industries [12]. However, persistent consumption of sugar causes harmful chronic health effects such as obesity, diabetes and cardiovascular disease [10]. Recently, the search for natural sweeteners such as date as substitute for sugar has been intensive. For example, date syrup was used as sweetener in ice-cream [34], Gaz- Iranian confectionary [5] and other food products [7]. Dates (*Phoenix dactylifera*) are high in nutrients such as fiber, vitamins, minerals and antioxidants [4]. Dates have an excellent nutrition profile particularly if they are dried which increases their calorie content more than most fresh fruit. Also, the fiber present can benefit the digestive health, by preventing constipation. Therefore, the overall objective of this study is to develop a low sugar, high energy nutritious granola bar using various cereals such as oat, puffed rice, corn flakes, nut (cashew nut) and legume (chickpea) and substituting glucose syrup with date syrup.

## 2. MATERIALS AND METHODS

### 2.1 Materials

About 500 g of Oat (*Avena sativa*); 300 g of puffed rice cereal (infinity); 200 g of flaxseed (*Linum usitatissimum*) (Herbs connect); 500 g of raw Chickpea (*Cicer arietinum*); 1 kg dried date fruits (*Phoenix dactylifera*) and locally roasted Cashew nuts (*Anacardium occidentale*) (chukwuebuka natural foods) were purchased from Shoprite supermarket. Other ingredients include glucose syrup (Baker Champion Co.), raisins, butter, vanilla flavour were purchased from a local market in Lagos state. All ingredients were transported to the Food Science and Technology Laboratory at Bowen University immediately after purchase and stored at ambient temperature until used.

### 2.2 Preparation of date syrup

Dried date fruits were sorted to remove dirt, bad dates, de-pitted and washed. Then about 200 g of dried date samples were placed in 1000 mL of water heated and boiled for 20 min and then blended using Binatone blender (BLG- 555, Hong Kong China) according to [27]. The slurry was filtered through cheese cloth and hand pressed. The residue pulp was rewashed with 1 L hot water (80-85°C) for 10 min and filtered twice. The date juice was then centrifuged (Centurion Scientific, K3 Series, North America) at 8000 g for 10 min according to [14]. Furthermore, the clear extract was concentrated in a water bath set at 100 OC until the volume was reduced to a third.



### 2.3 Preparation of Chickpea

Following [11] with slight modification, approximately 200 g of chickpea was soaked in 375 mL of water with 1g of salt for 1 h. The soaked chickpea was dehulled and roasted at about 180 0C on cassava flakes (gari) for 20 min and then crushed into smaller pieces.

### 2.4 Preparation of roasted cashew nut

Roasted cashew nut was reduced by crushing into smaller pieces

### 2.5 Preparation of Flaxseed

Approximately 100 g of flaxseed was milled in a blender ((BLG- 555, Hong Kong China) until a fine powder was obtained.

### 2.6 Preparation of Granola bars

The details of formulation for the five (5) samples of granola bars are presented in Table 1. Briefly, dry ingredients (oat, puffed rice, cornflakes, raisins and flaxseed) were mixed separately before the addition of previously crushed cashew nuts and chickpea. For agglutination of granolas, the wet ingredients (glucose syrup, brown sugar, water, and oil) were prepared in a stainless- steel container, heated until it boils and is immediately mixed with dry ingredients until a uniform mixture was obtained. This mixture was placed on a slab and levelled with a roller pin. After cooling, the mixture was cut into rectangular bars with a constant weight of approximately 25 g each according to [3].

**TABLE 1:** formulation details of the ingredients to prepare Granola bar

Ingredients	Granola bar Samples				
	GBA*	GBB	GBC	GBD	GBE
Oat (g)	15	15	15	15	15
Cornflakes (g)	10	10	10	10	10
Puffed rice (g)	05	05	05	05	05
Chickpea (g)	10	10	10	10	10
Cashew nuts (g)	10	10	10	10	10
Raisins (g)	10	10	10	10	10
Flaxseed (g)	4	4	4	4	4
Brown sugar (g)	10	10	10	10	10
Oil (g)	10	10	10	10	10
Glucose syrup (g)	10	7.5	5	2.5	0
Date syrup (g)	0	2.5	5	7.5	10
Vanilla flavour (mL)	2	2	2	2	2
Water (mL)	6	6	6	6	6

GBA = Granola bar with 100 % glucose syrup (control); GBB= Granola bar with 75% glucose syrup 25% date syrup; GBC= Granola bar with 50% glucose syrup 50% date syrup; GBD= Granola bar with 25% glucose syrup 75% date syrup; and GBE = Granola bar with 100% date syrup

### 2.7 Microbiological analysis

Microbial analysis was carried out on the raw materials: Date (*Phoenix dactylifera*) syrup, roasted cashew nut, glucose syrup, roasted chickpea and flaxseed, using Plate count agar for total viable count, Salmonella Shigella agar for Salmonella and Shigella count and Potato dextrose agar for fungi count. About 1 g of each raw material was weighed into 9 mL of peptone water (Himedia Lab., India) and further serial dilution up to

10-3 was prepared for each raw material as described by [22]. Using the pour plate method, about 1 mL of last dilution was transferred into the petri dishes in duplicate. Samples with plate count and Salmonella Shigella agar were incubated at 37 °C for 24 h, while Potato dextrose agar was incubated at 28 °C for 72 h. The observed colonies were enumerated and the microbial load were calculated.

### **2.8 Proximate Composition of Granola bar samples**

Moisture, protein, ash, fat and fiber contents were determined as described by [6]. Values are reported on dry weight basis, the carbohydrate content was determined by difference and energy was calculated using Atwater conversion factors in Kcal (4 Kcal, 4 Kcal, and 9 Kcal), for protein, carbohydrate and fat respectively.

### **2.9 Mineral Determination**

Calcium and potassium were determined according to [6] method. The elements calcium (Ca) was determined using Atomic Absorption Spectrometer (PG 990, United Kingdom) at wavelength of 422.7 nm. While potassium (K) concentration in the samples were determined by Flame Photometry (Jenway PFP7, United Kingdom) at wavelength of 766.4nm.

### **2.10 Water Activity of Granola bar Samples**

Water activity ( $a_w$ ) value of each Granola bar was obtained using a hygrometer (Decagon Aqualab series 3TE, USA) chilled mirror.

### **2.11 Physical Analysis (Color Determination)**

The color of the granola bar samples was assessed by the method described by [16]. The Hunter Lab color coordinates system, L\*(Lightness) a\*(redness), b\*(yellowness) values were recorded. The Commission Internationale de l' Eclairage (CIE) tristimulus L\*a\*b\*parameters were determined using a color meter CR-410 (Konica Minolta, Inc., Japan). Multiple measurements (10 points) of L\*, a\*and b\* parameters were determined by placing the sensor of the colorimeter on the sample. All measurements were done in triplicates.

### **2.12 Sensory evaluation**

Sensory evaluation was carried out by 30 untrained panelists of cereal bars. The granola samples were coded, cut into bite size pieces and served randomly. The panelists were provided with water to rinse pallet in between tasting and samples were scored on a 5-point hedonic scale. Where 5 = like extremely, 3 = neither like nor dislike, 1 = dislike extremely was used [19], [31]. The attributes evaluated include color, crunchiness, chewiness, aroma, taste, after-taste and general acceptability.

### **2.13 Statistical Analyses of Data**

The statistical analyses were conducted with IBM SPSS version 20, using one-way ANOVA. Statistical differences were tested for at ( $p < 0.05$ ). Duncan test was used to separate the mean values.

## **3. RESULTS AND DISCUSSION**

### **3.1 Microbial load (cfu/g) of raw ingredients for Granola bars**

Total viable count (TVC) ranged from ( $3.0 \times 10^3 \pm 1.4^b$  to  $8.6 \times 10^4 \pm 3.7^a$  CFU/g); Salmonella-Shigella ranged from (<1 to  $3.7 \times 10^5 \pm 0.8^a$  CFU/g); and fungal count ranged from ( $6.1 \times 10^4 \pm 0.6^a$  to  $1.6 \times 10^5 \pm 0.8^a$  CFU/g) as presented in Table 2. Flaxseed had the highest total viable count ( $8.6 \times 10^4 \pm 3.7^a$  CFU/g) and fungal count ( $1.6 \times 10^5 \pm 0.8^a$  CFU/g), while Cashew nut has the lowest TVC of ( $3.0 \times 10^3 \pm 1.4^b$  CFU/g) and glucose syrup has the lowest value of ( $6.1 \times 10^4 \pm 0.6^a$  CFU/g). Chick pea has the highest Salmonella-Shigella count of

( $3.7 \times 10^5 \pm 0.8$  CFU/g) while flaxseed has the lowest of  $<1$ .

**TABLE 2:** Microbial load (CFU/g) of selected raw ingredients used for production of granola bar

Raw Ingredients	Microbial load (CFU/g)		
	Total Viable	<i>Salmonella-Shigella</i>	Fungal
Date syrup	$5.3 \times 10^4 \pm 2.4^{ab}$	$1.5 \times 10^4 \pm 0.0^b$	$6.4 \times 10^4 \pm 0.7^a$
Cashew nut	$3.0 \times 10^3 \pm 1.4^b$	$5.1 \times 10^4 \pm 3.8^b$	$8.1 \times 10^4 \pm 1.8^a$
Glucose syrup	$2.0 \times 10^4 \pm 1.8^{ab}$	$6.6 \times 10^3 \pm 0.6^b$	$6.1 \times 10^4 \pm 0.6^a$
Chickpea	$4.3 \times 10^4 \pm 1.2^{ab}$	$3.7 \times 10^5 \pm 0.8^a$	$6.5 \times 10^4 \pm 0.8^a$
Flaxseed	$8.6 \times 10^4 \pm 3.7^a$	$<1$	$1.6 \times 10^5 \pm 0.8^a$

Values are mean of duplicate, Duncan separation of means with same alphabets is not different ( $P < 0.05$ ) in each column. CFU/g: Colony-forming unit/g

### 3.2 Proximate composition of granola bars

Nutritional composition of the various granola bars is presented in Table 3. Results are reported on dry weight basis and indicate that there were significant differences ( $p < 0.05$ ) in moisture, protein, fat, crude fiber and ash contents. Moisture content ranged from ( $1.05 \pm 0.0$  to  $1.07 \pm 0.0$ ); protein ranged from ( $8.5 \pm 0.02$  to  $12.6 \pm 0.06$ ); ash ranged from ( $1.6 \pm 0.06$  to  $2.2 \pm 0.03$ ); fat ranged from ( $8.3 \pm 0.09$  to  $14.4 \pm 0.2$ ); crude fiber ranged from ( $0.5 \pm 0.05$  to  $1.1 \pm 0.02$ ); and carbohydrate ranged from ( $72.1 \pm 0.4$  to  $78.3 \pm 0.0$ ). GBC (granola bar with 50 % glucose syrup and 50 % date syrup) was observed to have the highest moisture ( $1.07 \pm 0.00^a$ ) and protein ( $12.6 \pm 0.06^a$ ) contents while GBB (granola bar with 75 % glucose syrup and 25 % date syrup) had higher fat ( $14.4 \pm 0.20^a$ ) and ash ( $2.2 \pm 0.03^a$ ) contents than others. GBB and GBD (granola bar with 25 % glucose syrup and 75 % date syrup) had the lowest moisture content compared to other bars. Overall, each of the granola bar is an excellent source of carbohydrate and energy. The protein, moisture, fat and ash contents are within range of the report of [3] but contradicts the crude fiber values. Further, the nutritional composition of the bars in this study is above the reports of [2]. The addition of date syrup significantly increases the carbohydrate content of the bars. According to [14] date fruit is nutritive, containing about (70-76 %) carbohydrate substances.

**Table 3:** Nutritional Composition of granola bar samples on dry weight basis  
Granola bar samples

Parameters (%)	GBA	GBB	GBC	GBD	GBE
Moisture	$1.06 \pm 0.00^b$	$1.05 \pm 0.00^c$	$1.07 \pm 0.00^a$	$1.05 \pm 0.00^c$	$1.06 \pm 0.00^b$
Protein	$11.5 \pm 0.06^b$	$9.1 \pm 0.05^d$	$12.6 \pm 0.05^a$	$10.9 \pm 0.09^c$	$8.5 \pm 0.02^c$
Fat	$13.3 \pm 0.14^b$	$14.4 \pm 0.20^a$	$8.7 \pm 0.03^d$	$8.3 \pm 0.08^e$	$12.8 \pm 0.02^c$
Fiber	$0.86 \pm 0.03^c$	$0.53 \pm 0.04^e$	$0.74 \pm 0.02^d$	$0.99 \pm 0.02^b$	$1.1 \pm 0.02^a$
Ash	$2.1 \pm 0.02^a$	$2.2 \pm 0.03^a$	$1.6 \pm 0.06^c$	$1.7 \pm 0.33^c$	$1.9 \pm 0.03^b$
CHO	$72.1 \pm 0.4^d$	$73.5 \pm 0.36^c$	$76.1 \pm 0.06^b$	$78.3 \pm 0.14^a$	$75.7 \pm 0.00^b$
Energy Kcal	454.1	460.0	433.1	431.5	452.0

Values are mean  $\pm$  SD of triplicate; Duncan separation of means with same alphabets are not different ( $p < 0.05$ ) in each row. GBA = Granola bar with 100 % glucose syrup (control); GBB= Granola bar with 75% glucose syrup + 25% date syrup; GBC= Granola bar with 50% glucose syrup + 50 % date syrup; GBD= Granola bar with 25% glucose syrup + 75% date syrup; and GBE = Granola bar with 100% date syrup.

### 3.3 Mineral Composition

The result of the mineral (Ca and K) content of the samples is presented in Table 4. Each of the granola bar differ significantly ( $p < 0.05$ ) in the minerals analyzed. Calcium content ranged from ( $105.6 \pm 1.2$  to  $159.5 \pm 0.6$

mg/kg). Potassium content ranged from (233.3±6.4 to 295.4±0.9 mg/kg). Granola bar with 50 % glucose syrup and 50 % date syrup (GBC) was observed to have the lowest values in the two minerals analyzed. Furthermore, granola bar with 75 % glucose syrup and 25 % date syrup (GBB) showed the highest mineral content.

### 3.4 Water Activity of granola bar samples

Observed values for water activity of the samples are also presented in Table 4. Values were statistically different ( $p < 0.05$ ) for each granola bar formulation, ranging from (0.367 to 0.527). Since water activity is the measure of available water that allows microbial growth, sample GBD is the least sample that will allow growth of undesirable microorganisms compared to other samples. Most bacteria require water activity of 0.9 to 1, while some yeasts have been documented to grow at  $a_w$  of 0.65 [17]. As described by [37], low-moisture foods (LMFs) have been defined as those food products with a water activity ( $a_w$ ) below (0.85). These bars can be considered as “low-moisture” food and therefore does not need refrigeration to prevent microbial growth.

**Table 4:** Mineral content (mg/g) and water activity ( $a_w$ ) of granola bar samples

Parameters	Granola Bar Samples				
	GBA	GBB	GBC	GBD	GBE
<b>Calcium</b>	145.9±1.2 <sup>b</sup>	159.5±0.6 <sup>a</sup>	105.6±1.2 <sup>e</sup>	119.3±0.3 <sup>d</sup>	128.7±1.2 <sup>c</sup>
<b>Potassium</b>	287.3±2.1 <sup>b</sup>	295.4±0.9 <sup>a</sup>	233.3±6.4 <sup>e</sup>	235.6±1.1 <sup>d</sup>	255.8±1.0 <sup>c</sup>
<b>Water Activity (<math>a_w</math>)</b>	0.512±0.00 <sup>b</sup>	0.419±0.00 <sup>d</sup>	0.526±0.0 <sup>a</sup>	0.367±0.00 <sup>c</sup>	0.485 0.00 <sup>c</sup>

Values are mean ± SD of triplicate; Duncan separation of means with same alphabets are not different ( $p < 0.05$ ) in each row. GBA = Granola bar with 100 % glucose syrup (control); GBB= Granola bar with 75% glucose syrup + 25% date syrup; GBC= Granola bar with 50% glucose syrup + 50% date syrup; GBD= Granola bar with 25% glucose syrup + 75% date syrup; and GBE = Granola bar with 100% date syrup.

### 3.5 Color Composition of Granola bar samples

The mean values for the color intensity of the granola bar samples are presented in Table 5. There were significant statistical differences ( $p < 0.05$ ) in the color composition of all the granola bars. The  $L^*$  values ranged from (36.36± 0.2 to 43.4 ± 0.2),  $a^*$  value ranged from (6.49± 0.07 to 8.90±0.12) and  $b^*$  value ranged from (13.8±0.1 to 17.2±0.1). The lowest  $L^*$  value was that of sample GBA that is because only glucose syrup was added while the other bars had varying content of date syrup. Sample GBC, the 1:1 combination of glucose syrup and date syrup increased the lightness and yellowness in GBC sample. GBE, granola bar with 100 % date syrup had the highest  $a^*$  (redness) value of (8.90± 0.12<sup>a</sup>) and significantly different from other granola bars.

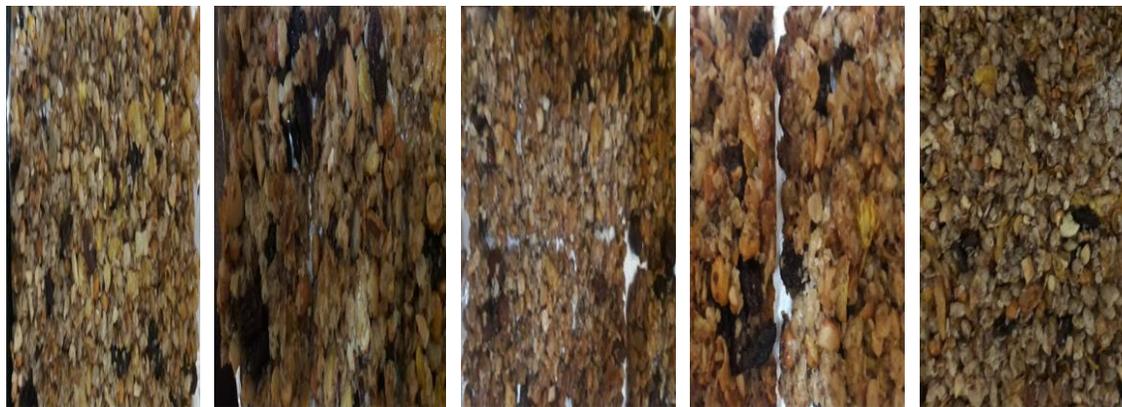
**Table 5:** Color composition of Granola bar samples

Samples	Color Composition		
	$L^*$	$a^*$	$b^*$
<b>GBA</b>	36.36 ±0.2 <sup>d</sup>	6.49 ±0.07 <sup>d</sup>	13.83 ±0.11 <sup>d</sup>
<b>GBB</b>	36.42± 0.2 <sup>d</sup>	6.79 ±0.2 <sup>c</sup>	14.01 ±0.33 <sup>d</sup>
<b>GBC</b>	43.39± 0.2 <sup>a</sup>	7.88± 0.2 <sup>b</sup>	17.24± 0.12 <sup>a</sup>
<b>GBD</b>	41.86± 0.3 <sup>b</sup>	6.70± 0.05 <sup>c</sup>	15.68± 0.07 <sup>b</sup>
<b>GBE</b>	37.46± 0.1 <sup>c</sup>	8.90± 0.12 <sup>a</sup>	15.04± 0.10 <sup>c</sup>

Values are mean ± SD of triplicate; Duncan separation of means with same alphabets are not different

( $p < 0.05$ ) in each row. GBA = Granola bar with 100 % glucose syrup (control); GBB= Granola bar with 75% glucose syrup 25% date syrup; GBC= Granola bar with 50% glucose syrup 50% date syrup; GBD= Granola bar with 25% glucose syrup 75% date syrup; and GBE = Granola bar with 100% date syrup.

After production, various granola bars were cut into smaller pieces and presented in Figure 1.

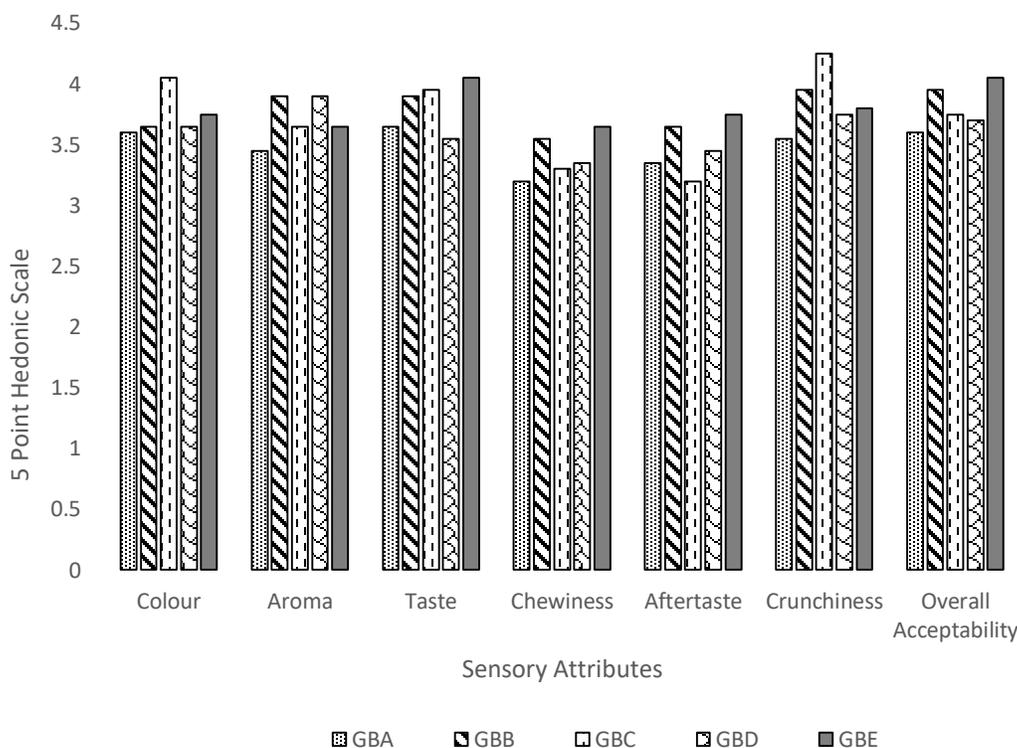


**Figure 1:** GBA                      GBB                      GBC                      GBD                      GBE

GBA= Granola bar with 100 % glucose syrup; GBB= Granola bar with 75 % glucose syrup +25 % date syrup; GBC= Granola bar with 50 % glucose syrup + 50 % date syrup; GBD = Granola bar with 25 % glucose syrup + 75 % date syrup; and GBE= Granola bar with 100 % date syrup

### **3.6 Sensory Evaluation of granola bar**

Figure 2 shows the mean values of sensory evaluation for the various granola bars by panelists. Scores for color ranged from ( $3.60 \pm 0.1$  -  $4.1 \pm 1.0$ ) with sample GBC (50 % glucose syrup and 50 % date syrup) as the most preferred while taste ranged from ( $3.6 \pm 1.2$  –  $4.05 \pm 0.8$ ) with sample GBE (100 % date syrup) having the highest score. Sample GBA (100 % glucose syrup) and sample GBD (75% date syrup and 25% glucose syrup) having the lowest. Color and taste are the important sensory attribute which to large extent certify the acceptability of a food product [13]. Aroma ranged from ( $3.45 \pm 0.8$  –  $3.90 \pm 0.9$ ) with sample GBD (75% date syrup and 25% glucose syrup) having the highest score and sample GBA (100 % glucose syrup) having the lowest score. For crunchiness score ranged from ( $3.55 \pm 0.9$ –  $4.25 \pm 0.9$ ) with sample GBC having the highest value and sample GBA having the lowest value. Chewiness ranged from ( $3.2 \pm 1.4$  –  $3.65 \pm 1.1$ ) with sample GBE having the highest score and sample GBA with the lowest score. Aftertaste score ranged from ( $3.2 \pm 1.2$ –  $3.75 \pm 1.1$ ) with sample GBD having the lowest score. Overall acceptability score ranged from ( $3.6 \pm 0.9$  –  $4.05 \pm 0.8$ ) with samples GBE and GBA having the highest score and lowest score respectively. Using Duncan separation, there were no significant statistical differences ( $p < 0.05$ ) in the sensory attributes scored except in crunchiness between the granola samples. The substitution of glucose syrup with date syrup improved the color, aroma, taste, chewiness, after-taste, crunchiness and overall acceptability of granola bar samples in this study.



**Figure 2:** Values are mean of twenty panelists; GBA= Granola bar with 100 % glucose syrup; GBB= Granola bar with 75 % glucose syrup +25 % date syrup; GBC= Granola bar with 50 % glucose syrup + 50 % date syrup; GBD = Granola bar with 25 % glucose syrup + 75 % date syrup; and GBE= Granola bar with 100 % date syrup

A Spearman rho correlation coefficient was calculated for the relationship between the various treatments and sensory attributes (taste, aroma, chewiness, crunchiness, color, after-taste and overall acceptability) of granola bars. The correlation between various treatments of granola bars and sensory attributes was observed to be weak. However, a strong positive correlation was found between taste ( $\rho(100) = .657^{**}$ ,  $p .000$ ); aroma ( $\rho(100) = .617^{**}$ ,  $p .000$ ); chewiness ( $\rho(100) = .493^{**}$ ,  $p .000$ ); crunchiness ( $\rho(100) = .505^{**}$ ,  $p .000$ ); color ( $\rho(100) = .364^{**}$ ,  $p .000$ ); and after-taste ( $\rho(100) = .388^{**}$ ,  $p .000$ ), indicating a significant relationship between sensory attributes and overall acceptability of the granola bars (Table 6).

**Table 6:** Spearman’s  $\rho$  Correlation Coefficients between various granola bars and sensory attributes

	Sensory Attributes						Overall Acceptability
	Taste	Aroma	Chewiness	Crunchiness	Color	Aftertaste	
Method of Treatment	$\rho(100)=.05$ $p<0.557$	$\rho(100)=.099$ $p<0.326$	$\rho(100)=.078$ $p<0.440$	$\rho(100)=.044$ $p<0.663$	$\rho(100)=.039$ $p<0.701$	$\rho(100)=.087$ $p<0.387$	$\rho(100)=.082$ $p<0.419$
Taste		$\rho(100)=.645^{*}$ $p<0.000$	$\rho(100)=.350^{*}$ $p<0.000$	$\rho(100)=.425^{*}$ $p<0.000$	$\rho(100)=.300^{*}$ $p<0.002$	$\rho(100)=.267^{*}$ $p<0.007$	$\rho(100)=.657^{*}$ $p<0.000$
Aroma			$\rho(100)=.361^{*}$	$\rho(100)=.386^{*}$	$\rho(100)=.380^{*}$	$\rho(100)=.328^{*}$	$\rho(100)=.617^{*}$



	*	*	*	*	*
	p<0.000	p<0.000	p<0.002	p<0.001	p<0.000
<b>Chewiness</b>		$\rho(100)=.412^*$ * p<0.007	$\rho(100)=.202^*$ p<0.044	$\rho(100)=.308^*$ * p<0.002	$\rho(100)=.493^*$ * p<0.000
<b>Crunchiness</b>			$\rho(100)=.312^*$ * p<0.002	$\rho(100)=.335^*$ * p<0.001	$\rho(100)=.505^*$ * p<0.000
<b>Color</b>				$\rho(100)=.273^*$ * p<0.006	$\rho(100)=.364^*$ * p<0.000
<b>Overall Acceptability</b>				$\rho(100)=.388^*$ * p<0.000	

\*\* Correlation is significant at the 0.01 level (2-tailed). \* Correlation is significant at the 0.05 level (2-tailed).

#### 4. CONCLUSION

The result from this study shows that date syrup can be used as substitution for glucose syrup in the production of granola bars. Date syrup improves the carbohydrate and fiber contents. The sensory evaluation shows that granola bars with date syrup was acceptable by all consumers. Granola bars from this study can provide the individual with balanced nutrition and it helps in improving the health by proving bioactive and functional compounds.

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