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Development and physico-chemical analysis of granola formulated with puffed glutinous rice and selected dried Sunnah foods

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Abstract

The need for nutritional and functional foods has increased. Consumers, these days, do not eat snacks only to provide satisfaction for their hunger, but also to supply essential nutrients to body. The objective of this study was to develop six formulations of granolas/cereal bars using different combination of Sunnah fruits such as dates *(Phoenix dactylifera)*, raisins (*Vitis vinifera* L.) and figs *(Ficus carica)*. The cereal bars were formulated using dry raw materials (glutinous rice, black Cummins, etc.) and binding agents (honey and glucose syrup). The cereal bars were assessed for water activity and proximate composition. It was observed that the sample B, made with 70 g of glucose syrup, 100 g honey and 450 g of total fruits had the highest value of moisture (18.73%) as compared to other formulations ($P< 0.05$). There were no differences in protein contents of the cereal bars formulated. Ash contents of the formulations were significantly different ($P< 0.05$) in samples B and F; the values ranged between 0.97% and 1.88%. The fat contents were significantly different with formulation B having the highest fat content (10.72%) and carbohydrate contents were affected by fibre contents; samples with lower crude fibres had higher carbohydrate contents which also reflect in the energy contents of the granola/cereal bar samples. Lowest a_w (water activity) was observed in the samples with lower fruit contents which could be as a result of their lower moisture contents. According to the results, incorporation of glutinous rice flakes with different composition Sunnah foods and binding agents; honey and glucose syrup can be used to formulate cereal bars with appreciable proximate and energy contents.

Introduction

In recent years, consumers demand in the aspect of food product development has changed significantly (Torres *et al*., 2011). Betoret *et al*. (2011); Brouns and Vermeer (2000) indicated that foods today are not intended only to provide satiety and to provide necessary nutrients; they are also consumed to prevent nutrition-related diseases and enhance physical and mental well-being of consumers. These types of foods are termed as functional foods. The functional foods offer an outstanding opportunity to improve the quality of products. Functional food products used to be fortified with vitamins and/or minerals. The focus, nowadays, has shifted to foods enriched with dietary fibre (DF) and micronutrients such as omega-3 fatty acids, phytosterol (Betoret *et al*., 2011). Dietary fibre possesses many physicochemical functions which contribute to physiological attenuation such as cholesterol and fat binding, decrease in blood glucose levels, prevention of constipation and facilitation of good colonic health. The most widely used cereals as dietary fibre source for products containing cereals are: wheat, oat, barley, rice, rye (Foschia *et al*., 2013). For this reason, the main cereal used in this study is glutinous rice. Glutinous rice is converted to flake which is used in the production of cereal bars.

Selected Sunnah fruits like raisins, dates and figs are combined with the cereal used and agglutination syrups (glucose syrup and honey) in different combinations to give desired DF content asides the satisfaction of hunger and provision of necessary nutrients. All these foods are mentioned in the Holy Quran and are endorsed by the Prophet Muhammad because of their rich nutrient values and their healing properties (Islamweb Staff, n.d). The Sunnah foods consist of the recommended food of the Prophet (PBUH) such as milk, honey, dates, habbatus sauda (black seeds), vinegar and many more. Sunnah foods are among the numerous teachings of Prophet Muhammad (PBUH) that greatly improves our health and our overall life (Ishak *et al.*, 2013).

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Consumers tended to have a great liking for consumption of snacks nowadays (Bower and Whitten, 2000). Because of the growing consumers' demand for healthy, natural and convenient foods, attempts are being made to improve snack foods nutritional value by modifying their nutritive composition. Cereal bars are popular and convenient foods which make them an ideal food format to deliver fruit-derived phenolic antioxidants and fibre (Sun-Waterhouse *et al*., 2010). Cereal bars stand out among fast foods due to their balanced of nutritional content and convenience (Silva *et al*., 2013). Cereal bar, "granola" is a dry granulated cereal product which has a lower water activity (Macedo *et al*., 2013).

Cereal bars are made from a compressed mixture of cereals and dried fruit. Generally, the glucose syrup is the aggregator element of the bar ingredients providing quick energy absorption (Silva *et al*., 2013). Dutcosky *et al.* (2006) opined that increased consumption of cereal bars is associated with the change of lifestyles and the need of fast meals and snacks. Consumers have easily accepted cereal bars because they are believed to be a nutritionally balanced high-fibre snacks. Also, because they have an adequate balance between energy, fat, protein, vitamins, minerals, fibre and whole grains are beneficial to consumer health (Ryland *et al*., 2010). Lima (2004) reported that the greatest challenge in obtaining a good cereal bar is a combination of many ingredients with main functionality like minerals, vitamins, proteins, fibres, binding agents and turns them into a product with flavor, aroma, texture and decent appearance, while trying to achieve specific goals nutrients.

It has been observed that processing of Sunnah foods has not received much attention. In the Holy Qur'an, Muslims are enjoined to consume Sunnah foods. Eating healthy foods and not excessively are encouraged in the Halal diet. As a result, Muslims who keep Halal diet will never overeat and become obese. Allah has repeatedly emphasised the consumption of Halal food in the Qur'an: "O mankind! Eat of that which is lawful and wholesome in the earth, and follow not the footsteps of the Devils. He is an open enemy for you". (Al- Quran. Al-Baqarah 2:168). The Sunnah fruits used in this study are figs *(Ficus carica)*, raisins (*Vitis vinifera* L.) and dates *(Phoenix dactylifera)*. The fruits are mentioned in the Holy Quran and Hadith as beneficial fruits. Prophet Muhammad (PBUH) also said "If I had to mention a fruit that descended from Paradise I would say it is the fig, because the fruits of Paradise do not have pits... eat from these fruits for they prevent hemorrhoids & piles and help gout"(Tib Nab Awi, Hadith 467,page 486). Imam Ali (PBUH) refers to the grape and says: The grape is both a fruit and a food; it is sweet and delicious. Imam Ali (PBUH) not only refers to grape as a useful fruit, he also introduces it as a wholesome food. Grape is effective in removing sorrow, stress and depression. Prophet Muhammad (PBUH) said "Dates are able to strengthen stomach, liver, memory, to grow body development, cure illness and as food and drink that sated." (Ibnu Qayyim in Tib An Nabawi).

This research main aim was to formulate cereal bar from selected Sunnah fruits and glutinous rice flakes with honey and glucose syrup as a binding agent. The physicochemical properties of the developed formulations were investigated; which included moisture, fat, fibre, protein, ash, carbohydrate and water activity.

Materials and Methods

Sample preparation

The glutinous rice and other ingredients: glucose syrup, honey, the dried fruits (dates, figs and raisins), black cumin and saffron were purchased at TESCO, (Nilai, Malaysia). All the chemicals used for the study were of analytical reagent grade.

Preparation of puffed glutinous rice

Glutinous rice was thoroughly cleaned and soaked in water, with 0.5 g of saffron added, for 24 hours. The soaked glutinous rice was steamed and dried overnight at temperature 155^{o}C using an Excalibur Food Dehydrator Parallex (USA) to a moisture content of 6.75%. The dried glutinous rice flakes was stored in a dry plastic container with a cover/lid in a cool dry place.

Preparation of puffed glutinous rice and Sunnah food granolas

The dried fruits (dates, figs and raisins) were diced. Black cumin was added to the dried fruits in a stainless steel bowl. The glucose syrup and honey were heated in a pot on gas burner to homogenize the binding agents. The heated binding agents were poured into the bowl that contained the dry ingredients and thoroughly mixed with stirring stick. The contents were heated in an oven at 100°C for 15 minutes. After heating in the oven, the mixture (granola/cereal bar) was removed from the oven and allowed to cool before cutting into rectangular shapes; 11 cm long, 3 cm wide and 1.5 cm thick. It was prepared according to the method used by Freitas and Morreti (2006). The formulations for the

Table 1. Formulations of binding agents: honey and glucose syrup and dried ingredients (GRF, dates, figs, raisins and black cumin) with different incorporation for each of the formulation.

Ingredients (g)	Formulations					
	A	B	C	D	E	F
GRF	200	200	200	200	200	200
Dates	150	150	100	100	50	50
Figs	150	150	100	100	50	50
Raisins	150	150	100	100	50	50
BC	3	3	3	3	3	3
GS	70	140	70	140	70	140
Honey	100	50	100	50	100	50

Abbreviation: GRF (Glutinous rice flake); BC (Black cumin); GS (Glucose syrup).

six granolas were shown in Table 1.

Proximate analysis of puffed glutinous rice and Sunnah food granola/cereal bar

The granolas were evaluated for their physicochemical features, in triplicates (n=3). The crude protein N×6.25 was determined by the Kjedahl method, total lipids was analysed by the Soxhlet method, ash was determined by burning the samples at 550ºC, total dietary fibre was determined by Gerhardt method, moisture analyser was used to determine the moisture content of the cereal bars (AOAC, 2000). Carbohydrate was calculated by the difference method (FAO, 1998; AOAC, 2000).

Water activity determination

The water activity (a_w) was determined by a hygrometer (Aqualab, Decagon 3TE, USA) (Favetto *et al*., 1983).

Energy contents determination

Energy contents were calculated by formula: (% Carbohydrate × 4) + (%Protein × 4) + (%Fat × 9), (Kristin, 2010).

Statistical analysis

Data obtained were analysed using the MINITAB (16.2.1 version software). All determinations were performed in triplicate. The statistical analyses were conducted using one-way ANOVA procedures. Statistical differences were tested for at $P<0.05$. Tukey's test was used to differentiate between the mean values.

Results and Discussion

Moisture contents

Moisture contents of granolas made from puffed glutinous rice and Sunnah foods are shown in Table 2. The moisture contents of the bars varied, based on the percentages of fruits added (Freitas and Moretti, 2006). The moisture contents of the six formulations ranged between 11.35% and 18.73%. The moisture contents of the experimental bars were lower (20.26 and 21.40 %.) than the moisture contents of bars produced by Santos *et al*. (2011). Santos *et al*. (2011) formulated their bars with jackfruits. This showed that the moisture contents in this work were better than that of Santos and his co-researchers (2011) because lower moisture contents would elongate the shelf stability of the product.

The results of moisture contents obtained by Souza *et al.* (2014), 7.19% - 8.24%, who made cereal bars with whole flour of pseudo-cereals new cultivars; their bars probably had a lower moisture contents compared to the bars in this work as a result of different in cereals and fruits used in the formulation. Amount of fruits added to the ingredients could also be responsible for higher moisture content. The higher the fruit contents, the higher the moisture contents. The moisture contents were significantly different ($P<0.05$). The values of the moisture contents of formulations A-D were not different significantly (Table 2) due to the amount of fruit contents in the samples while formulations E and F were significantly from them because of lower amount of fruits added.

Another corroborating finding is the study carried out by Pagamunici *et al.* (2014). The moisture contents followed the same trend. Torres *et al.* (2011) obtained an average of 21.01% for cereal bars containing jackfruit seed and jenipapo. The values obtained were higher than those found in this work. The fruits used in this bar contributed to the moisture contents. Al-Farsi *et al*. (2007) reported that moisture and carbohydrate are the predominant components in dates and their by-products. Low value of moisture contents indicated that these granola bars can be stored for a long period of time without spoilage and it would not be vulnerable to microbial growth (Oloyede, 2005).

Table 2. Proximate analysis values of Sunnah cereal bars

Parameters	Formulations					
	A	B	C	D	E	F
Moisture (%)	16.41[a]	18.73[a]	17.02[a]	17.12[a]	11.35[b]	12.90[ab]
Protein (%)	3.38[a]	3.56[a]	3.58[a]	4.04[a]	3.91[a]	3.52[a]
Fat (%)	10.30[a]	10.72[a]	9.78[ab]	8.93[b]	7.31[c]	7.32[c]
Crude Fibre (%)	9.39[b]	6.32[c]	13.42[a]	4.24[d]	1.81[e]	1.94[e]
Ash (%)	1.71[ab]	1.88[a]	1.28[ab]	1.41[ab]	1.03[ab]	0.97[b]
Carbohydrate (%)	58.31[c]	58.80[c]	54.92[d]	64.25[b]	74.59[a]	73.35[a]

*Means in rows and columns with different superscripts differ ($p < 0.05$).
A (Sunnah foods – 450 g, honey – 100 g, glucose syrup – 70 g), B (Sunnah foods – 450 g, honey – 50 g, glucose syrup – 140 g), C (Sunnah foods – 300 g, honey – 100 g, glucose syrup – 70 g), D (Sunnah foods – 300 g, honey – 50 g, glucose syrup – 140 g), E (Sunnah foods – 150 g, honey – 100 g, glucose syrup – 70 g), F (Sunnah foods – 150 g, honey – 50 g, glucose syrup – 140 g).

Protein contents

The protein contents of the granolas/cereal bars were low. Fruits, which were the main ingredients of the granolas, generally have low protein content. This was in line with the work of Santos *et al.* (2011). The protein contents in their work ranged between 4.60% and 4.80%. It can be concluded that glutinous rice and dried Sunnah fruits could also be used to formulate granolas of appreciable protein contents. The granolas could be agreed upon to be a nutritious snack. Torres *et al.* (2011) obtained an average protein content of 0.05%. The values in this work were higher compared to the values in their study. Pagamunici *et al.* (2014) values of 6.83%-7.66% were higher than the values obtained in this work probably because of high cereal contents.

The protein content increased progressively and uniformly with the increase in grain concentrations in the cereal bar formulations, this was in agreement with studies accomplished by Enriquez *et al.* (2003). Cereal bars/granolas usually have low protein content (Mahanna and Lee, 2010). The data on the crude protein showed non-significant difference in the formulations (Table 2). The addition of the fruits resulted in the insignificant increase in the protein contents because the fruits are low in crude proteins. This was in agreement with study carried out by Rehman *et al.* (2012).

As puffed glutinous rice is gluten-free, it also contributed to the low protein content recorded in this study. Generally, gluten-free products possess low protein content (Segura and Rosell, 2011). Ananthan *et al*. (2013) obtained a protein content of 10.49%. This higher protein content was as a result of cashew nuts and flaxseed used in their formulations. Previous study by Torres *et al.* (2011) showed that the protein content of cereal bar produced by using exotic fruits also had low protein content, approximately 0.05%. The quantity of protein obtained in this study might be different because of the ingredients/fruits are different. The incorporation of Sunnah fruits, binding agents such as honey and glucose syrup, with puffed glutinous rice produced low protein contents but higher than previous research of Torres *et al.* (2011).

Fat contents

The fat results in this work ranged between 7.31% and 10.72% as shown in Table 2. This was in consonance with the result of Souza *et al*. (2014). They concluded in their work that gluten-free granolas had average of 11.82% total fat. The fat result obtained in this study was highly comparable to the fat results obtained in the work of Ananthan *et al*. (2013). The little difference in the fat contents could be attributed to the difference in the ingredients used for the formulations of the granolas (cereal bars). The sample also possessed higher fat contents when compared to the work of Ryland and his co-researchers (2010), an average of 7.61% except formulations E and F, (Table 2) which could be as a result of higher puffed glutinous rice contents.

The fat contents of the samples prepared by Ryland *et al.* (2010) ranged between 7.46% and 8.21%. The fat composition of the granola bars formulated with Agave tequilana by Zamora-Gasga *et al.* (2014), ranged between 14.17% and 15.60%. The difference could be traced to the vegetable oil and soy lecithin used in their formulations. Mendes *et al*. (2013) obtained moisture, 11.85%; ash, 2.09%; protein, 9.91%; fats, 14.55%; and carbohydrates, 61.61%; from a cereal bar formulated with fruit peels and baru. The fat in this study was comparable to the

fat composition obtained Mendes *et al.* (2013). The high fat contents recorded in formulations A and B were probably due to the combined fats in the fruits. The results were in agreement with Souza *et al*. (2014) and Rehman *et al*. (2012).The fat compositions were higher than those of cereal bars formulated by addition of dried murici, 4.70% (Guimaraes and Silva, 2009) but comparable to the bars made from pulp of baru and almond in three different formulation, whose compositions was between 10.48 and 11.06%.

Contrary to other researches that presented granolas with higher fat contents than cereal bars formulated in this present work, it could be due to the addition of fruits that are lower in fats, according to findings by Lima *et al*. (2010). Freitas and Moretti (2006) analysed cereal bars formulated with different ingredients and discovered that all bars had lower fat contents. There was a gradual increase in fat content with increasing composition of fruits. The trend was also observed by Rehman *et al*. (2012) in the physicochemical characterization of apricot-date bars. The fat compositions in the present study were higher than the fat the fat content obtained by the Moura *et al*. (2013), a fat content of 4.70%. Rehman *et al*. (2012) also obtained a range of 7.30 – 7.32% of fat in their granola bars which correspond to the values obtained in formulations E and F in this study. The slightly higher fat contents in the bars might be important to replace the energy used during physical activities as a result of the exhausted energy during exercise (Grden *et al*., 2008).

Crude fibre contents

The fibre results in this work ranged from 1.81% to 13.42% as shown in Table 2. This was closer to the result of obtained by Mendes *et al*. (2013) in cereal bars made with baru almond and pulp. The composition had average fibre contents of 18.13%. The fibres obtained in this research were similar to the levels found by Lima *et al.* (2010), the contents ranged between 14.86 and 16.73%. The higher fibre results obtained in their research were due to different in fibre contents of the fruits used in the bar formulations. It was evident from the results that the fibre contents were directly proportional to the amount of fruits used in formulating the cereal bars. It could be compared to the results obtained by Rehman *et al.* (2012), their study on apricot-date bars yielded fibre contents that ranged from 5.66-6.14%. Moura *et al*. (2013) obtained a fibre content of 13.40% which is very closer to the highest fibre contents of the cereal bars formulated in this present work.

Ash contents

The ash contents of the bars ranged from 0.97 – 1.88% (Table 2). The increase in fruit contents led to the gradual increase in ash contents of the cereal bars. There was a noticeable change in the ash contents of the granolas/cereal bars; this was in line with the work of Zamora-Gagsa *et al.* (2014). The ash contents obtained in the study of chemical composition and in vitro starch hydrolysis of cereal bars formulated with Agave tequilana ingredients yielded ash results that varied between 0.95 and 1.05% (Zamora-Gagsa *et al*., 2014). The results were comparable to the ash results of the granolas/cereal bars formulated with Sunnah foods and puffed glutinous rice. Lima (2004) used cashew to produce cereal bars, the author obtained 1.63% ash which was in the scope of the ash contents of the cereal bars obtained in this study.

There was significant difference ($P<0.05$) among the formulations' ash contents. The formulations presented ash contents similar to those of Souza et al. (2014) and Pagamunici *et al*. (2014), they obtained 1.59-1.81% and 1.34-1.37% of ash in their bars produced from a new cultivar of *Amaranth* and whole flour of pseudo-cereal new cultivars respectively. Mendes *et al*. (2013) reported that cereal bars made with fruit peels and baru had ash content of 2.09%.

Ash content was connected to the mineral content of the formulation ingredients. The ash results in this study could be traced to the Sunnah foods which could be regarded as origin of minerals, notably calcium, zinc, iron and magnesium as stated by Fernandes *et al*. (2010) and Lima *et al*. (2010), who used baru almond in his formulation of cereal bars and obtained ash content of 3.03%. Cecchi (2003) revealed that cereals have total ash contents between 0.30 and 3.30%; cereal bars made with glutinous rice flakes and Sunnah foods in this research showed significant ash contents, contributing to the supply of minerals in the bars.

Similarly, there was little difference among the ash contents of the formulations, except B and F. The two formulations were totally significantly different from each other. Formulation B had the highest ash content probably because of higher fruit contents compared to formulation F with lower fruit compositions. It could be deduced that the fruits contributed to the ash contents of the formulations (Fernandes *et al*., 2010; Lima *et al.*, 2010).

Carbohydrate contents

Comparing the total carbohydrate contents among the six formulations, there were significant differences ($P< 0.05$), see Table 2. The carbohydrate contents of the samples ranged from 58.31 to 74.59%.

Table 3. Energy contents and water activity values of Sunnah cereal bars

Parameters	Formulations					
	A	B	C	D	E	F
Energy(Kcal)	339.47^{c}	345.90^{c}	322.06^{d}	353.54^{b}	379.80^{a}	373.37^{a}
Water activity	0.597^{a}	0.586^{a}	0.577^{ab}	0.590^{a}	0.587^{a}	0.557^{b}

*Means in rows and columns with different superscripts differ ($p < 0.05$).

This was comparable to the results obtained by Souza *et al*. (2014), the carbohydrate contents obtained in their study ranged between 68.33 and 71.57%. They further reported that gluten-free products, in which glutinous rice belongs, present high carbohydrate contents. The carbohydrate composition in these Sunnah fruit-based bars was higher than the previous study of Reyland *et al.* (2010). The average carbohydrate contents recorded in their cereal bars was 13.38%. Mendes *et al*. (2013) reported 61.61% as the carbohydrate content of their cereal bar made with fruit peels and baru.

The results in this present work were therefore comparable to some samples having higher carbohydrate contents for their cereal bars. The high contents of carbohydrate found in the granolas/ cereal bars made with glutinous rice flakes and Sunnah fruits were in agreement with those found by Freitas and Moretti (2006); their cereal bars were formulated with high vitamin and protein contents, 60.97%. The results were also comparable to those obtained in the study done by Carvalho (2008) who formulated cereal bars with *Lecythis pisonis* Camb., (63.90%); also within the range of results of the same author for cereal bars formulated with *Dipteryx lacunifera* Ducke and *Sterculia striata* St. Hill. Et Naud, 69.30 and 70.70% respectively. The high carbohydrate compositions were due to the addition of puffed glutinous rice and honey in the formulation of the cereal bars (Mendes *et al.*, 2013). The honey and glucose syrup contribute to high carbohydrate contents in cereal bars (White and Doner, 1980). The incorporation of dried Sunnah foods and the binding agents (honey and glucose syrup) produced cereal bars with high carbohydrate content with desirable nutritional values.

Energy contents

The energy values of the cereal bars formulated with puffed glutinous rice and Sunnah foods in this research varied between 322.06 Kcal and 379.80 Kcal (Table 2). The energy contents of the cereal bars were significantly different ($P < 0.05$). Lima *et al*. (2010) reported that the energy contents for cereal bars made with baru almond and pulp (337.37 Kcal) and cereal bars made with macauba nuts (348.66 Kcal) but the energy levels were lower to those found in the work of Carvalho (2008) who in his study prepared cereal bars with *Sterculia striata* St. Hill et Naud, *Lecythis pisonis* Camb., and *Dipteryx lacunifera* Ducke nuts added with the inclusion of pineapple peel; the energy levels varied between 407.50 and 434 Kcal.

Formulations E and F showed higher energy contents, 379.80.and 373.37 Kcal respectively. This was attributed to lower fruit contents, i.e. higher cereal to fruit ratio (Mendes *et al*., 2013). Souza *et al*. (2013) reported an average of 180.39 Kcal of energy content in their study. This was quite lower to the levels obtained with cereal bars formulated with Sunnah foods as their fruit base. The overall formulations produced higher or appreciable energy contents.

Besides, the carbohydrate contents of the cereal bars were close to other previous studies (Shaheen *et al*., 2013 and Mendes *et al.*, 2013), with values of 325.46 – 386.96 Kcal and 416.99 Kcal respectively. The values were also in agreement with the levels obtained by Mourao *et al*. (2009) who obtained values from 377 to 404 Kcal. However, the value of 284.00 Kcal recorded by Moura *et al*. (2013) was lower than the values obtained in this study. Thus, the puffed glutinous rice and the Sunnah foods could be considered as high caloric value cereal bars.

Water activity

The values obtained in Table 3 showed the water activity of the formulations and their overall effects on the cereal bars. The water activity of the formulations was statistically different ($P < 0.05$). The values ranged from 0.557 to 0.597. Water activity is a significant tool to forecast available water in foods. Its level defines growth of undesirable microbes, CCP (critical control point), food hazards, packaging requirements and standards for various preserved foods (Fontana, 2000).

The data (Table 3) shows that the treatments (varying fruit composition) had significant effect on water activity, a_w. Moisture contents increased because of gradual addition of Sunnah foods in different formulation. The highest water activity,

a_w, (0.597) was observed in formulation A which together with formulation B contained the highest quantity of Sunnah foods (a total combination of 450 g each) against the lowest a_w contained in formulation F (0.557) which had the lowest Sunnah foods, a total combination of 150 g. The increasing trend was observed in the formulations. This trend tallied with the observations of Estevez *et al*. (1995), who discovered that water activity reduced from 0.710 to 0.520 at 0 and 60 days during storage in cereal and nut bars.

Sharon (2009) in their study reported that preferable water activity for cereal bars should be between 0.450 and 0.570. The results of water activity in this research were not too far from these values. According to Rehman *et al.* (2012), the results found in their work, using apricot and date to formulate bars, ranged from 0.534 to 0.546; data obtained for Sunnah fruit-based bars were comparable to their values.

Contrary to the results obtained by Souza *et al.* (2014) for the water activity of bars formulated with whole flour of pseudo-cereals new cultivar. They found water activity that varied between 0.430 and 0.470. The difference noted in the values when compared to those obtained for Sunnah fruit-based cereal bars was attributable to the difference in ingredients/fruits and the type of cereal employed. According to Ananthan *et al*. (2013), cereal bars formulated in their research with flaxoat and nut presented water activity in the range of 0.330 to 0.730. It was further stated that when the cereal bars were stored for 45 days, no visible microbial growth that could cause spoilage was observed at 0.730 water activity. The results in this study were however, higher than the levels obtained by Moura *et al*. (2013) and comparable to the levels obtained by Shaheen *et al*. (2013) with water activity levels of 0.684-0.704 and 0.580-0.597 respectively.

The cereal bars/granolas formulated in this study presented low water activity which contributed to prevention of microbial growth (Souza *et al*., 2014). It could be concluded that the formulation of a nutritious cereal bar from puffed glutinous rice and Sunnah foods followed the process to final formulation which assisted the cereal bars to present appreciable water activity values (Ryland *et al*., 2010).

Conclusion

The proximate and water activity analysis displayed the features of Sunnah food-based granolas. The analysis of granolas from Sunnah foods and puffed glutinous rice were compared with previous research values. The findings revealed that puffed glutinous rice and dried Sunnah foods provided substantial amount of carbohydrates, proteins, fats, dietary fiber, and energy contents that were of good nutritional values. The lipid, ash moisture, fibre, carbohydrate and energy values were all in the range of the values supported by previous studies. Therefore, to make the granolas a complete one on the nutrient value, the protein content must be improved upon. A legume or a nut may be added. The improved protein will contribute to the production of cereal bars/granolas of high nutritive values.

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