CHAPTER IV

MINERAL CONTENTS, SENSORY PREFERENCE AND ACCEPTABILITY STUDIES OF CEREAL BARS MADE FROM GLUTINOUS RICE FLAKES AND *SUNNAH* FOODS

4.1 INTRODUCTION

There have been growing interests recently from consumers, researchers and the food industry, into food and ways in which it may assist in maintaining human health. The major function played by diet in hindering and treating illnesses is universally accepted (Nagai et al., 2006). At the same time there has been increase in fast-foods and snacks consumption which has made market of cereal bar to increase (Brito et al., 2004). As a result of rising demand by the consumers for wholesome, convenient and natural foods, efforts are being intensified to enhance nutritive values of snack foods by modifying their nutritive constituents. Granolas, a well-accepted and standard RTE food would be perfect to supply fibre and fruit-derived phenolic antioxidants (Sun-Waterhouse et al., 2010).

Ready-to-eat breakfast cereals (RTE-BC), the group which cereal bar belongs, are defined as "processed grain formulations suitable for human consumption without further cooking" (Fast, 1987). Cereals are usually used in the preparation cum formulation of RTE-BC.

Puffed Glutinous rice, which is gluten-free was used to produce cereal bars in this study because oat, barley, rye and wheat which are rich in gluten might predispose consumers to an inflammatory procedure in the small intestine villi, with subsequent degeneration and low absorption of nutrients in affected people (Fasano et al., 2008).

Granolas stand out among snacks because of their balanced nutritient composition and accessibility (Silva et al., 2013). Cereal bar is a dry granulated cereal product with a lower water activity (Macedo et al., 2013). Dutcosky et al. (2006) reported that increased cereal bars' consumption is related to the change in lifestyles and the need of convenience foods and snacks. Consumers have readily acknowledged cereal bars because they are believed to be a nutritiously balanced high-fibre convenient foods. Also, due to their satisfactory equilibrium between energy, vitamins, protein, minerals, fat, fibre which make cereal bars to be 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 vitamins, minerals, fibres, proteins, binding agents and process the ingredients into a product with texture, aroma flavor and decent appearance, at the same time trying to attain specific target 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 is regarded as a way of worshipping God (Allah) for Muslims (Addeen et al., 2014). A set of dietary rule called "Halal" (legal, permitted by Allah) is prescribed by Islamic law. This dietary rule lists the permitted food and prohibits the consumption of foods not obtained or prepared according to Islamic rules (Regenstein et al., 2003; Bonne & Verbeke, 2008). "Halal" also means the aspects of reliable, food quality, wholesome, hygiene and safety. Muslims must strive to obtain halal food of good quality (Sam & Alvarado, 2001). 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 fruit of the date palms are eaten worldwide; they are an important part of the diet in the Middle East. Dates are being consumed in present time for their pleasing flavour, their biting texture and their aroma as well as their use for flavouring foods, beverages and medication (Vayalil, 2002). Consumption of 100 g of dates has the possibility of providing 32.5 – 42.5 g of protein which satisfies the RDA of protein for children and adults. As reported by Iqbal et al. (2006), the crude protein contents of dates is greater than those recorded for foods that are rich in protein; cowpea seeds (24.70%), *mucuna flagellipes* (24.90%), lentil (26.10%), *Parkia biblosa* (20.90%), Tamarindus indica (20.90%) and greenpea (24.90%). Amoo et al. (2006) reported that the protein content of dates is comparable with values obtained for soybeans (35%).

Carbohydrates supply the essential calories in the human diets. They are easily digested and utilization of dietary fats is promoted. Carbohydrate also reduces wastage of protein (Christian & Ukhun, 2006). Dates supply the "essential" lipids which are not manufactured by human being and they have to be provided by food. High calorific values in dates contribute to the sense of satiety when consumed (Crisan & Sands, 1978).

The major mineral component in cereal bars is calcium. Its existence in the bars assists in contribution to the bioavailability and absorption of other essential minerals (Hathcock, 2004). The minerals are vital for the upkeep of biological systems because they partake as co-factors in body metabolism reactions (Hathcock, 2004). Presently, many human health problems are related to diets. Micronutrients take part in several

biological processes in human body. Sufficient intake of some micronutrients is essential for the prevention of deficiency illnesses. Malnutrition is of main concern for many Third World countries (Ozcan, 2004; Leterme et al., 2006; Kumari et al., 2004).

Minerals are vital for activation of enzyme, bone formation, gene expression, haemoglobin composition; lipid, amino acid and carbohydrate metabolism. They are also necessary for normal cellular functions (Institute of Medicine, 2004, 2001 & 2000b). Some inorganic mineral elements (zinc, calcium potassium etc.) play a significant function in the maintenance of normal glucose tolerance and in the release of insulin from beta islets of Langerhans (Choudary & Bandyopadhayay, 1999). In human diet, protein quality and quantity are very important (Jami et al., 2010). It was suggested by WHO/FAO that children who are in the age range of 1-10 years should have a daily intake of 0.88 g per kg body.

Mineral elements in food have variety of functions and importance. Zinc performs a very important role in the structure of cellular membrane and function, assist in maintenance of sufficient quantities of vitamin A in the body. It functions as a strong antioxidant and is required for development and growth of healthy body tissues, regulation of insulin and appropriate immune function. Poor balance of blood fluid electrolyte and malformed action of enzymes are linked to insufficient sodium, zinc, magnesium and potassium because they are the most needed elements in the human body cells (Ekop, 2007). New values for DRI of sodium, zinc, magnesium, and potassium, have been determined. Nutritionally, these elements are greatly important in dates.

The daily recommended intake value for potassium is 4700 mg/day. The values of DRI for zinc, sodium and magnesium for males and females as proposed by the Food

and Nutrition Board, Institute of Medicine (IOM) are 8 and 11 mg/day, 1500 mg/day and 320 and 420 mg/day, in that order. All date varieties are able to provide adequate quantities of these aforementioned elements (IOM, 2004).Calcium is the most abundant mineral in the body. Calcium normalizes many cellular processes and has vital structural role in living organisms. Tandogan & Ulusu (2005) stated that skeletal muscle structure and function, polymerization of fibrin and conduction of impulses in the nervous system are controlled by calcium. The value of the DRI for Ca (calcium) is 1000 mg/day (IOM, 2004).

Manganese is required for normal function of the brain; also it aids protein and carbohydrate metabolism. It is essential for collagen formation, fatty acid and cholesterol formation and (Leterme et al., 2006). Manganese's DRI values for males and females are 2.3 and 1.8 mg/day in that order. Daily consumption of dates could easily fulfil manganese DRI values.

Copper is a multi-purpose mineral which maintains life. It is important to the human right from foetal growth to the older age. Absence of copper makes human nervous system and cardiovascular system not to function normally. In addition, copper speeds up healing of wound by via blood flow increase to the affected area and also through oxygen movement round the body (WHO, 1998). The authorized copper's DRI value is 0.9 mg/day (IOM, 2004). Dates are an excellent high-energy food, rich in carbohydrates, dietary fiber and minerals such as calcium, magnesium, manganese, copper, nickel, chromium, potassium and zinc.

Current research has demonstrated that young adults that are between ages of fifteen and twenty-four years of age, representing 62.5 percent of the consumers of granolas (Brito et al., 2004).

The determination of acceptance by the consumer is a fundamental part in a development and improvement process of products. Among these most applied approaches used to measure acceptance of products is the hedonic scale, in which consumers convey their acceptance following a pre-established scale, based on terms such as like and dislike (Mori et al., 1998; Silva et al.,2005).

Thus, the main aim of this study was to formulate cereal bar with *Sunnah* fruits using puffed glutinous rice and honey and glucose syrup as a binding agent. The mineral contents of the cereal bar samples were evaluated. The objective of this research was to determine acceptability and preference of the samples (sensory evaluation) and mineral contents of cereal bars made from *Sunnah* foods.

4.2 MATERIALS AND METHODS

4.2.1 Sample Preparation

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

4.2.2 Preparation of puffed glutinous rice

Puffed glutinous rice was prepared as described in Chapter 3.

4.2.3 Preparation of puffed glutinous rice cereal bar

The preparation has been described in Chapter 3.

4.2.3.1 Mineral Content Analysis

A mixture containing 4 mL 65% HNO_3 and 2 mL 30% H_2O_2 (Fisher Scientific) was used to digest each of the samples. Standard solutions of the mineral elements (zinc, sodium, manganese, magnesium, copper, iron and calcium) were prepared by diluting stock solutions of 1000 mg/L supplied by Perkin Elmer. Ultrapure water Mili-Q System Milipore (PURELAB classic, ELGA) was used throughout the experiment (Manjusha et al., 2007). Quartz vessels were cleaned by soaking overnight in 10% (v/v) HNO_3 followed by rinsing with ultrapure water and dried before used.

The cereal bar samples were blended using Panasonic blender (MX-335) and a Perkin Elmer microwave reaction system model Anton Paar Multiwave 3000, programmable for time and power between 600 and 1400 W, equipped with eight high-pressure quartz vessels was used to digest the glutinous rice flakes cereal bar samples. A Perkin-Elmer Analyst 800 atomic absorption spectrometer (AAS) equipped with graphite furnace (GFAAS) and AS 800 auto sampler was used in this study.

The operating conditions of the spectrophotometer for the determination of the mineral elements (zinc, sodium, manganese, magnesium, copper, iron and calcium) were: Lamp EDL; Current 380 mA; Wavelength 193.7 nm; Slit 0.7 nm; Mode AABG; The Processing peak area included Read time of 5.0 s; and three Replicates. Graphite furnace atomisation was conducted using 20 lL sample volume and 5 lL matrix modifier volume. The program's temperature was: drying 30 s at 110°C + 30s at 130°C; pyrolysis 20 s at 1200°C (all with gas flow 250 mL/min); atomisation 5 s at 2000°C with zero gas flow; cleaning 3 s at 2450°C with 250 mL/min gas flow.

4.2.3.2 Sensory Evaluation

A panel of 60 untrained panelists was selected; they were not sensitive to any ingredients used for the formulation of the *Sunnah* fruit-based granolas. They were given instruction to evaluate the sensorial characteristics like texture, appearance, colour, taste and overall acceptance. A 9-point Hedonic scale with 1 = dislike extremely, 5 = neither like nor dislike and 9 = like extremely was used (Stone & Sidel, 1993). Sensory analysis was performed in the sensory laboratory with apposite temperature in open setting. The test was conducted 2 days after the production of the cereal bars. The sensory evaluation is shown in Appendix II.

The sensory evaluation of the sample was conducted to evaluate the six formulations of the cereal bars to compare which formulation received the consumer acceptance and fulfill their expectations. The samples were labeled with random 3-digit numbers and served on white plate together with a clean water to clean the palate (Moura et al., 2013). Panelists guzzled water to rinse their palates prior to proceeding to the next sample (Kayacier et al., 2014). The test was conducted in individual booths (Moura et al., 2013). Sensory analysis is a mean to choose the best sample of a product (Villavicencio et al., 2007).

4.2.3.3 Statistical Analysis

All determinations were performed in triplicate. The statistical analyses were executed using one-way analysis of variance (ANOVA) procedures. Significance between means was tested at $P<0.05$. Tukey's test was used to separate the mean values. All analyses were done with MINITAB (16.2.1 version software).

4.3 RESULTS AND DISCUSSION

4.3.1 Mineral Contents

Table 14: Mineral composition of the *Sunnah* cereal bars in mg/kg.

	Formulations					
Element (mg/kg)	**A**	**B**	**C**	**D**	**E**	**F**
Sodium	170.79^{b}	235.86^{a}	164.65^{bc}	115.09^{cd}	95.09^{d}	70.54^{d}
Calcium	482.89^{a}	473.38^{a}	333.89^{ab}	319.13^{ab}	203.72^{b}	186.54^{b}
Magnesium	160.14^{a}	159.08^{a}	141.52^{ab}	124.48^{ab}	106.30^{ab}	88.00^{b}
Iron	36.97^{a}	41.46^{a}	39.19^{a}	41.52^{a}	39.12^{a}	33.64^{a}
Zinc	46.83^{a}	40.99^{a}	48.24^{a}	29.79^{a}	33.32^{a}	50.95^{a}
Copper	12.19^{a}	11.86^{a}	12.73^{a}	13.73^{a}	13.73^{a}	12.79^{a}
Manganese	12.52^{a}	14.40^{a}	14.53^{a}	15.99^{a}	15.99^{a}	17.05^{a}

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

A (*Sunnah* foods – 450g, honey – 100g, glucose syrup – 70g), **B** (*Sunnah* foods – 450g, honey – 50g, glucose syrup – 140g), **C** (*Sunnah* foods – 300g, honey – 100g, glucose syrup – 70g), **D** (*Sunnah* foods – 300g, honey – 50g, glucose syrup – 140g), **E** (*Sunnah* foods – 150g, honey – 100g, glucose syrup – 70g), **F** (*Sunnah* foods – 150g, honey – 50g, glucose syrup – 140g).

The mineral percentages of the bar formulations are shown in Table 14 and Figure 7. The *Sunnah* cereal bars had 70.54-235.86 mg/kg for sodium; 186.54-482.89 mg/kg for calcium; 33.64-41.52 mg/kg for iron; 29.76-50.95 mg/kg for zinc; 12.52-17.05 mg/kg for manganese; 11.86-13.73 mg/kg for copper; and 88.00-160.14 mg/kg for magnesium. Ananthan et al. (2013) in their work obtained 68.34 mg/kg of calcium, 6.00 mg/kg of iron and 2.48 mg/kg of zinc. The minerals observed in this work were higher than those obtained by Ananthan and his co-researchers. In comparison to Ananthan and others (2012), protein rich composite cereal bar produced; 8.9 mg/kg calcium, 8.2 mg/kg iron and 2.8 mg/kg zinc. The *Sunnah* cereal bars formulated were

of higher mineral contents compared to that of Ananthan et al. (2012) because they presented higher mineral contents than that of Ananthan and co-authors (2012). The results obtained in this work were higher which made this glutinous rice a better cereal for production of cereal bars.

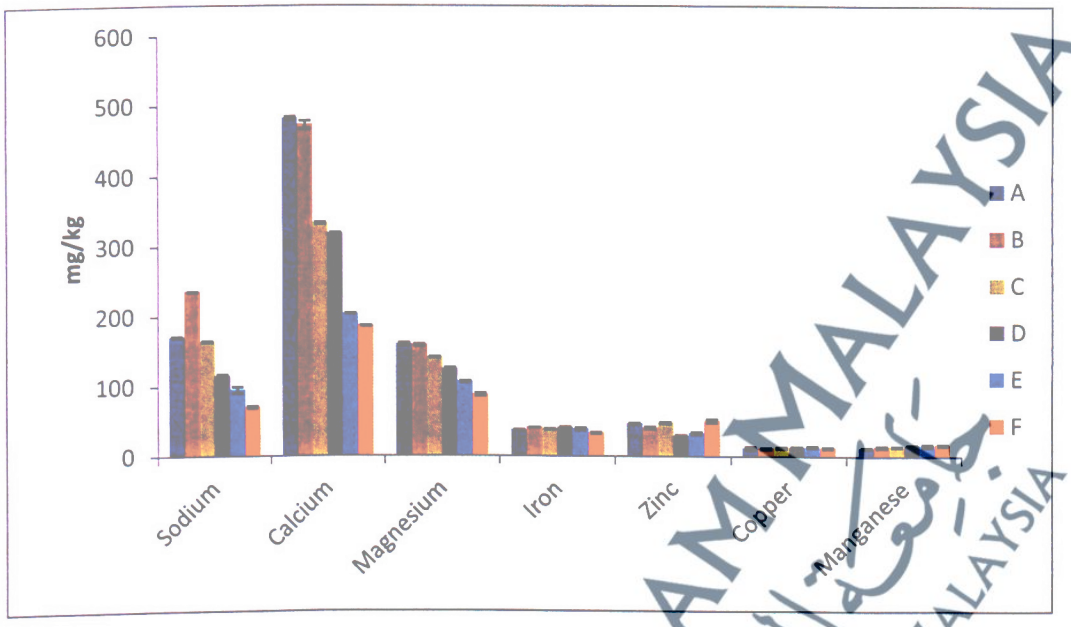
As displayed in Table 14 and Figure 7, magnesium and calcium were higher than other minerals for all the samples. The values obtained in this study were comparable to the results obtained in the work Pagamunici et al. (2014a), (Figure 7). Magnesium play a crucial role in a wide range of biochemical and physiological actions and the incidence of calcium in the products enhance the increase in bioavailability and absorption of magnesium, manganese and zinc. The composition of trace minerals; zinc and manganese were not significantly varied ($P>0.05$). According to Hathcock (2004), these trace minerals are vital for the repairs of biological systems because they contribute as co-factors in metabolic processes. Similar results were obtained by Pagamunici et al. (2014a) and Souza et al. (2014) who studied cookies and granola respectively. Nonetheless, the results obtained in the formulations in this study were higher than results obtained by Rehman et al. (2012), in their studies of apricot-date bars. They reported that apricot-date bars had sodium (22.79 – 23.36 mg/kg), calcium (101.02 -102.59 mg/kg), iron (4.85 – 5.05 mg/kg), manganese (0.75 – 1.02 mg/kg) and zinc (2.65 – 2.75 mg/kg). *Sunnah* cereal bars are higher in mineral elements than the apricot-date bars.

The levels of minerals obtained in the study of Rehman et al. (2012) were lower because dried apricots contained smaller quantities of calcium, zinc, iron, sodium and manganese (Rehman et al., 2012) than raisins, dates and figs used in the formulation of *Sunnah* cereal bars. Al-Hooti et al. (1997), in their study of date bars containing

oat, skimmed milk powder, almonds, and sesame found iron, sodium, zinc and calcium contents to be 4.30, 40.50, 2.97 and 166.30 mg/kg respectively. The minerals in the bars formulated with *Sunnah* foods in this study were higher than the levels found by Al-Hooti and his co-researchers (1997).

Table 14 and Figure 7 showed that the major mineral elements were magnesium and calcium for all the formulations. Magnesium plays a significant role in a wide range of biochemical and physiological processes. The presence of calcium in the bars would contribute to the increment of bioavailability and of zinc, manganese and magnesium (Pagamunici et al., 2014b). Pagamunici et al. (2014a) reported that a gluten-free bar containing whole flour from a new cultivar of *amaranth* had calcium contents that ranged from 2380.11 to 2648.20 mg/kg. The results obtained in this research (Figure 7) were lower to the calcium levels of Pagamunici & co-authors (2014a). Furthermore, the levels of other minerals in the bars formulated by Pagamunici et al. (2014b) are as follows: copper (23.74 - 27.46 mg/kg), iron (115.61 – 127.48 mg/kg), magnesium (2594.19 – 3001.86 mg/kg), manganese (38.77 – 41.05 mg/kg), and zinc (53.43 – 67.64 mg/kg). With the exception of magnesium, calcium and iron, all other levels obtained for the rest of the minerals were closer to the results obtained in this study, Figure 7. The higher levels of the calcium and magnesium observed in their bars could be attributed to the *amaranth*, linseed flour and banana used in their formulations. These ingredients are rich in calcium. The bars in this research were also rich in calcium and magnesium.

Figure 7: Mineral levels of *Sunnah* cereal bars in *mg/kg*.



A (*Sunnah* foods – 450g, honey – 100g, glucose syrup – 70g), **B** (*Sunnah* foods – 450g, honey – 50g, glucose syrup – 140g), **C** (*Sunnah* foods – 300g, honey – 100g, glucose syrup – 70g), **D** (*Sunnah* foods – 300g, honey – 50g, glucose syrup – 140g), **E** (*Sunnah* foods – 150g, honey – 100g, glucose syrup – 70g), **F** (*Sunnah* foods – 150g, honey – 50g, glucose syrup – 140g).

Copper and iron levels did not vary significantly ($P>0.05$). Sodium varied significantly ($P<0.05$) among the samples. For calcium, formulations **A** and **B** varied significantly from formulations **E** and **F**. This was as a result of the difference in the fruit contents. Formulations **A** and **B** had more fruits than other formulations; **E** and **F**. This actually reflected in the calcium contents. Formulations **C** and **D** contained appreciable calcium levels, 333.89 mg/kg and 319.13 mg/kg respectively. Increase in the fruit contents resulted in the increase in the calcium contents of the formulations. The trend was observed in the results of Pagamunici et al. (2014b) and Al-Hooti et al. (1997) in the bars they formulated with dates, sesame, oat and powdered skimmed milk.

Magnesium contents of the samples did not vary significantly statistically (P>0.05) among samples except formulation **F** which had the lowest content of magnesium, 88.00 mg/kg. There was significant increase in all the minerals analysed as the levels of the incorporated fruits increases.

4.3.2 Sensory Analysis

The sensory scores of appearance, colour, taste, texture and overall acceptability assigned by the panelists are presented in Table 15. The highest mean appearance score was recorded by **B**, (6.40), though the scores were not significantly different (P >0.05) from other formulations. **D** had the highest mean score of 6.57 for colour which was not significantly different at (P > 0.05) from E, (Figure 8), which had a higher score for taste. It was observed that the texture scores were significantly different at (P < 0.05). Formulation **C** obtained highest texture score, 6.22. The highest mean for overall acceptance was obtained by formulation **C**, 6.58; but the scores were not different significantly (P > 0.05).

The cereal bars were similar in respect in term of appearance, which were not significantly different for all the formulations (P<0.05). Freitas & Moretti (2006) produced cereal bars with banana flavor. The scores obtained in this research were higher than those obtained in the work of Freitas & Moretti (2006); (appearance – 6.39, taste – 6.42, texture – 5.29 and overall liking – 6.14) and also to the sensory results, (Table 15), obtained in this work were close to those obtained by Carvalho et al. (2011). The results in their work were as follows: appearance (6.70-7.50), colour (6.80 – 7.60), flavor/taste (6.10- 6.90), texture (6.50 – 7.30) and overall acceptance (6.20 – 7.10). However, Santos et al. (2011) obtained the following sensory results for their cereal bars made with jackfruit: 6.10 – 6.90 (colour), 5.90- 7.10 (taste), 5.70-6.60

(texture) and 6.30 to 7.10 for global impression. Results obtained in this study (Figure 9) were comparable to the results of Santos et al. (2011). Brito et al. (2004) reported that the sensory scores of homemade cereal bars were 4.20 -6.60 (appearance), and colour (0.90 – 3.40) was below the scores obtained for cereal bars made with puffed glutinous rice and *Sunnah* fruits, (6.03 – 6.57). With regards to the overall acceptance (6.10-6.90), the acceptance scores of the bars in this research were similar to those observed for *Sunnah* bars in this work, (6.12 – 6.40).

Table 15: Sensory Analysis Results of the *Sunnah* cereal bars

Formulations	Appearance	Colour	Taste	Texture	Overall acceptance	I.A (%)
A	6.22^{a}	6.20^{a}	6.00^{a}	5.33^{ab}	5.85^{a}	65.00
B	6.40^{a}	6.53^{a}	6.28^{a}	5.83^{ab}	6.45^{a}	71.67
C	6.35^{a}	6.37^{a}	6.43^{a}	6.22^{a}	6.58^{a}	73.11
D	6.35^{a}	6.57^{a}	6.28^{a}	5.87^{ab}	6.42^{a}	71.33
E	6.12^{a}	6.25^{a}	6.45^{a}	5.83^{ab}	6.40^{a}	71.11
F	6.18^{a}	6.03^{a}	6.32^{a}	5.07^{b}	6.13^{a}	68.11

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

Abbreviations: I.A (Index of Acceptability), **A** (*Sunnah* foods – 450g, honey – 100g, glucose syrup – 70g), **B** (*Sunnah* foods – 450g, honey – 50g, glucose syrup – 140g), **C** (*Sunnah* foods – 300g, honey – 100g, glucose syrup – 70g), **D** (*Sunnah* foods – 300g, honey – 50g, glucose syrup – 140g), **E** (*Sunnah* foods – 150g, honey – 100g, glucose syrup – 70g), **F** (*Sunnah* foods – 150g, honey – 50g, glucose syrup – 140g).

Figure 8: Bar graph of sensory analysis showing consumer acceptance of *Sunnah* cereal bars

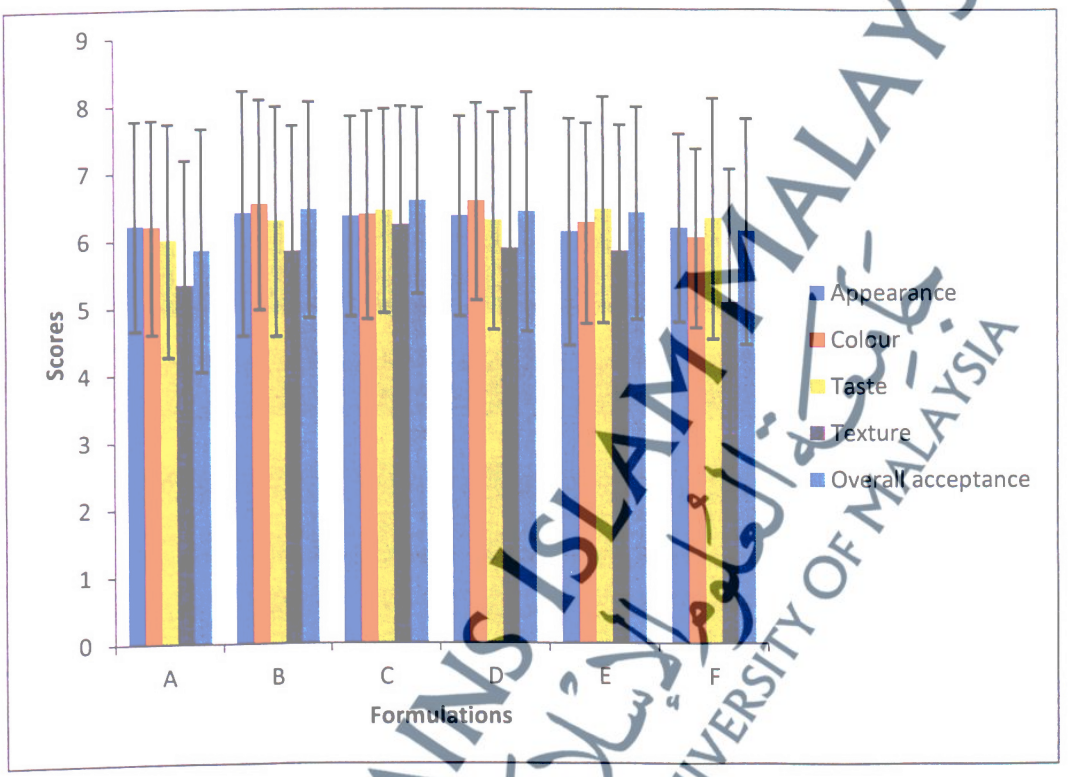
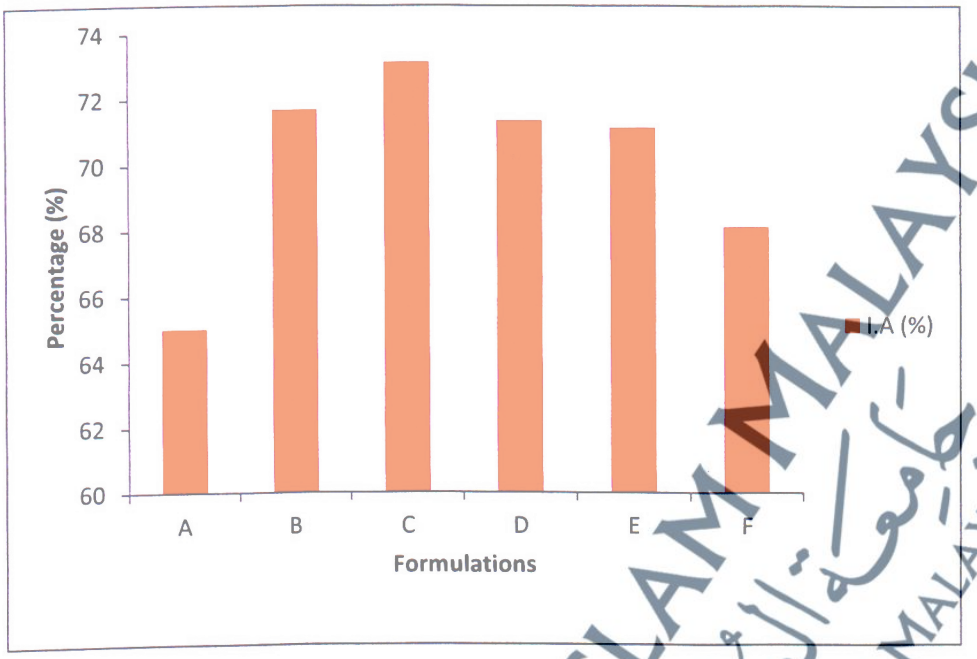


Figure 9: Index of Acceptability of the *Sunnah* cereal bars by the consumers



The results in this research were comparable to the results obtained in the studies on food bar made from whole flour from a new cultivar of *Amaranth* (Pagamunici et al., 2014a). The scores for appearance ranged between 7.34-7.64, texture, 6.88-7.38, and overall acceptance, 6.91-7.38. The bars were regarded as well accepted once the index of acceptability was greater than 70%, (Figure 9). The formulations showed no significant differences ($P>0.05$), (Lawless and Heymann, 2010). However, formulation **C** had the highest mean score for texture which might have contributed to its being the formulation with the highest acceptance; this followed the results obtained by Ananthan et al. (2013).

The mean values for taste score of the *Sunnah* fruit-based bars vary from 6.00 to 6.45. The minimum score (6.00) was obtained by formulation **A** while formulation **E** had maximum value (6.45) for taste; it shows that there was no significant effect of fruit composition in taste with the samples of the bars. The mean values for colour of the

cereal bars varied from 6.03 to 6.57. The minimum score (6.03) for colour was obtained by formulation **F** while formulation **B** has maximum colour value (6.57). The mean values for appearance and overall acceptance texture also did not vary significantly (P>0.05) among different formulations (Table 15).

The average scores for texture ranged between 5.33 and 6.22. Formulation **A** had the lowest score while formulation **C** has highest score. There was a significant difference among the formulations' textures at (P< 0.05). The mean values for overall acceptability score of the *Sunnah* fruit-based bars indicated that formulation **C** has maximum 6.58 score, (Figure 8). The overall acceptability of different formulations was in conformity with the results of Al-Hooti et al. (1997) who presented that global acceptance score of 6.90 to 7.30 in date-bars. The sensory scores in this study were very much in agreement with the findings of Shaheen et al. (2013) who reported colour scores of 5.10 to 7.80; appearance scores of 5.55 to 7.95, taste mean score of 5.50 – 7.75, texture scores between 5.85 and 7.80; and overall acceptance of 5.70 to 7.80.

The results obtained in this study; (Table 15) were comparable to the findings of Moura et al. (2013). The sensory results in their study revealed as follows: appearance (6.60), overall acceptance (7.00), texture (6.90) and taste (7.00). The findings in this work (Table 15 and Figure 8), were within the range obtained by these authors; Moura et al. (2013). The results were comparable to the data found by Souza et al. (2014). They formulated three different samples of cereal bars using whole flour of pseudo-cereals of new cultivars. Their formulations had 6.98 – 7.19 for appearance, 7.01 – 7.74 for taste, 6.95 – 7.34 for texture while overall acceptance ranged between 7.03 and 7.40. Results in this research were comparable.

There was no significant difference (P> 0.05) in the appearance of the *Sunnah* cereal bar samples. This corroborated the findings of the work done by Pagamunici et al. (2014a). The scores of the appearance of their bars ranged from 7.34 to 7.64, the scores of the appearance of the *Sunnah* foods-based cereal bars in this study were closer (6.12 – 6.40). The scores of the other attributes of the bars in the study of Pagamunici et al. (2014a) are as follows: taste (6.83 – 7.38), texture (6.61 – 6.92), and overall acceptance (6.91 – 7.38). The results obtained for the *Sunnah* cereal bars formulated with *Sunnah* foods and puffed glutinous rice (Table 15), were comparable to the findings of Pagamunici and co-authors (2014a).

Texture and taste were the most significant attributes of cereal bars (Rooney et al., 1996). Honey and glucose syrup imparted a pleasant and sweet taste on the samples. Mahanna et al. (2009) verified that the most important sensory attribute to consumer is taste. In the sensory panel (n=60), all samples evaluated were rated acceptable (average > 5.00) for the attributes evaluated (Table 15). These attributes were taste, texture, appearance, colour and overall acceptance. It was observed that the attributes (appearance, taste, colour and overall acceptance) showed no variation in the six formulations of the samples (P>0.05). Texture attribute of the formulations were significantly different (P< 0.05). Formulation **C** obtained the highest scores, regarding texture (6.22) and overall acceptability (6.58). Baixauli & co-researchers (2008) studied the effect of gradual resistant starch in baked products; they obtained scores closer the scores obtained in this research for sensory qualities such as texture (5.70 – 6.80), appearance (5.60 – 7.80), taste (6.50-6.90) and overall acceptability (6.40-6.60). Formulation **C** was the most acceptable, with I.A (index of acceptability) of 73.11%, (Figure 9).

Furthermore, Silva et al. (2013) formulated cereal bars were with cassava flour and incorporation of dehydrated banana and ground cashew nuts as the fruit base. The results of the sensory analysis were not far from the findings obtained in this study. They obtained 7.40, 7.28, and 7.78 for colour, texture and taste respectively. The results obtained in this study/research compared favourably with their findings. The difference in the scores was as a result of different ingredients. More so, sensory is a subjective test.

4.4 CONCLUSION

Sunnah foods' incorporation into the cereal bars changed the mineral profile of the samples. It has been observed that it is possible to formulate cereal bars with *Sunnah* foods. These *Sunnah* foods are very rich in minerals especially calcium when compared to cereals. The research showed that *Sunnah* cereal bars possessed high mineral compositions. The *Sunnah* cereal bar as a snack was acceptable by the consumers as shown by the sensory evaluation results. Increase in *Sunnah* food contents of the bars increased the mineral levels of the final products significantly. Formulation C with 300g of total fruits received the highest scores of acceptability among the panelists. The index of acceptability corroborated this assertion. The usefulness of *Sunnah* foods in the formulation with respect to the high sensory scores was attributed to the high taste and texture of the bars containing high fruit contents; formulation C compared to other samples, had the highest scores for taste and texture. Texture and taste increased the palatability and acceptance of the formulation.