Enhanced Knowledge in Sciences and Technology Vol. 1 No. 2 (2021) 201-207

EKST

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/ekst
e-ISSN : 2773-6385

Development Of High Iron And High Energy Snack Bar: Nutritional Content Analysis And Sensory Evaluation

Nur Alyaa Saffa Saini[1], Faridah Kormin[2]*, Nurul Alyani Zainol Abidin[1], Nurul Akhma Zainol Abidin[1]

[1]Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia, Pagoh Education Hub, 84600 Pagoh, Johor, MALAYSIA

[2]Center of Research Sustainable Uses of Natural Resources, Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia, Pagoh Education Hub, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/ekst.2021.01.02.024
Received 19 June 2021; Accepted 14 July 2021; Available online 29 July 2021

Abstract: A snack bar is gaining interest from community due to its functional benefits. Either it is high in calories for energy or protein for muscle gain. In this growing market, it is important to seize the open opportunity. High energy bar is common in the market. However, not with high iron. The aim of this study is to develop energy bar with high level of both calories and iron. Besides, it is also to evaluate the acceptance on the snack bar when added with *Moringa oleifera* seeds, green pumpkin seeds, apricots, and cranberries. Design expert mixture design was utilized to optimize the formulation of these ingredients. The results show formulation 2 with the highest calories (0.53 cal/g) and iron content (0.55 mg/L) while formulation 3 has the lowest for calorie (0.41 Cal/g) and formulation 1 has the lowest for iron content (0.24 mg/L). Overall, formulation 2 consist of 7.2% protein content, 42.9% total sugar content, 14.9% total fat content, and 2.1% dietary fiber. In conclusion, the proximate analysis of protein, fat and sugar content exceeded the value of previous research, but dietary fiber, iron and energy content does not exceed as the value of previous research was 100 g or per serving. In addition to the nutritional content analysis, the sensory evaluation is showing a positive acceptance from the consumers.

Keywords: Snack Bar, *Moringa Oleifera* Seeds, Iron Content, Energy Content, Sensory Evaluation

**Corresponding Email: faridahk@uthm.edu.my*

1. Introduction

There is an increasing trend on food fortification to enhance nutritional value, to replace any nutrient losses during processing, and to ensure the production of food is in adequate quantities to meet the needs of society [1]. Snack bar has a good sensory and nutritional characteristic due to their high carbohydrates, proteins, lipids, and mineral content. Generally, snack bars in the market are not recognized as a functional food as it lacks nutrient value and does not meet the requirement of a balanced diet [2]. The new formulation or innovation of snack bar not only has high energy content but it also high in mineral content especially iron content, which is important in the body and can abate hunger [3].

Iron deficiency is very well known across every region of the world as 30 – 50 % of anemia in children is caused by iron deficiency. Based on the World Health Organization (WHO) Global Anemia Database [4], the global iron deficiency statistic shows that pre-school children are the largest (76.1 %) among the demographic groups which indicate the importance of early-stage dietary food consumption—then followed by a non-pregnant woman (73.5 %), a pregnant woman (69.0 %), a male (40.2 per cent), an elderly woman (39.1 %) and, potentially, a school-aged boy (33.0 %). The total consumption of recommended daily intake (RDI) is approximately 18 mg per day. The prescribed iron dietary allowances for people can be seen based on their gender, age, and condition. Each of the groups has a particular amount of iron intake to fulfill their nutrients in their daily lives.

Ingredients in the snack bar should have a high iron and calories for it to provide for the anemic patients to support active lifestyle. *M. oleifera* seeds is added to increase the iron content in the bar. The intake of this snack bar is to enable the body to acquire a recommended nutrient. Other ingredients, especially dried fruit, will increase the bar's antioxidant content [5].

In this study, snack bar with *M. oleifera* seeds is developed to add a variety of healthy snack bars. *M. oleifera* is rich in iron which can help to increase iron content in the snack bar. Usually, a snack bar is fortified to increase the value of protein [6, 5]. In the present study, a snack bar is enriched with plant-based iron sources to produce a high iron snack bar. Consumers tend to look out for simple food, ready-to-eat (quick meals), which can also enhance satiety and go through all those mid-morning hunger strikes [7]. So, the feeling of fullness can avoid overconsumption that can lead to chronic diseases such as obesity and overweight.

The objectives of this research are to develop high iron and energy snack bar with granola as base, to evaluate consumers' acceptance granola snack bar added with the 4 additional ingredients (*M. oleifera* seeds, green pumpkin seeds, apricots, and cranberries).

2. Materials and Methods

2.1 Raw materials

All raw materials were obtained from Pagoh's local grocery shop. almond flake, green pumpkin seeds and sunflower seeds was baked at 160 ℃ for 8 to 10 minutes and let cool and set aside. Next, apricots, cranberries, and the *M. oleifera* seeds were chopped finely. After that, all ingredients were mixed well and poured into a non-stick muffin cup mold thinly. Finally, the mixture was baked at 160 ℃ for 6 to 10 minutes or until the mixture melted.

2.2 Nutritional content analysis

2.2.1 Calories count- Bomb calorimetry

Firstly, all instrument was set up in a fume hood. Then, 20 ml of water was fill up into an empty test tube and the initial temperature of water ($T_{initial)}$ was measured by a thermometer. Next, a mass of the empty evaporating dish was weighed and recorded. After that, 1.0 g of snack bar and placed on the

previous evaporating dish placed below the test tube containing water. Next, the sample was burned completely, and the final temperature of water (T_{final}) was measured and recorded. Then, the burned sample was cooled down before weighing the mass of dish with ash and any left-over burned sample together. The same step was taken for other samples [1].

2.2.2 Iron count- Atomic Absorption Spectrophotometry (AAS)

10 grams of sample was weighed and put into a crucible. Then, the sample was placed into a muffle furnace at 550°C until it turned into ash. After it was completely turned into ash, the mixture of nitric acid (HNO_3) and water was added and heated at low flame to remove any carbonaceous residue in the ash. Next, a few drops of concentrated HNO_3 were added to the sample until it dissolves and transferred to a 100 mL volumetric flask. After that, the flask was filled up by using distilled water until it reaches the mark on the flask, and it was used as a stock solution for analysis of iron content by AAS. Next, an air-acetylene flame in AAS setting by wavelength (248.3 nm) for iron concentration in the range from 2.5 to 10 mg/L. Duplicate readings were taken for each sample of formulation and calculated the average to get a more accurate reading [8].

2.2.3 Proximate analysis

a. Protein content

Protein content in the sample was determined by using Kjedahl method according to Association of Official Analytical Chemists (AOAC) Official Method 2001.11.

b. Total sugar content

Lane Eynon general volumetric method of AOAC Official Method 923.09 & 968.28 was used to measure the amount of inverted sugar in the sample. Finally, the total sugar content was obtained by using the formula Eq 1.,

$$\text{Total sugar content} = \frac{\text{Factor} \times 100}{\text{Titration (mL)}} \qquad Eq\ 1.$$

c. Total fat content

Soxhlet method was used to determine the total fat content of the sample especially food with minor modification [9]. Fat content contamination was calculated by the formula Eq 2.,

$$\%\ \text{Crude fat} = (W_2 - W_1) \times \frac{100}{S} \qquad Eq\ 2.$$

d. Dietary fiber content

Dietary fiber content was determined by using enzymatic digestion with minor modification [10]. Total dietary fiber can be calculated by using the formula Eq 3.,

$$\%\text{Total dietary fiber} = \frac{\text{mg residue} \times (100\text{-PC-CC}) - \text{mg blank}}{\text{mg sample}} \qquad Eq\ 3.$$

2.3 Sensory Analysis

50 untrained respondents were selected randomly to participate in the sensory evaluation. Each respondent was given 15 formulations of the snack bar to be tested and answered according to the 9-points hedonic scale.

3. Results and Discussion

3.1 Nutritional content analysis

3.1.1 Iron content

As shown in Table 1, formulation 2 has the highest iron concentration, 0.55 mg/L while Formulation 3 has the lowest iron concentration, 0.24 mg/L. The iron content of the snack bar was compared with a commercialized snack bar. Oat-based snack bar and commercial Quaker Oatmeal were used. The value of iron content was 33.64 – 41.52 mg/kg and 6 mg per 100 g respectively. From that, the value of iron that obtained from all three sample does not exceed the commercialized product. This mainly due to differences in the ingredients content of the product. Because oat-based snack bar contains oatmeal, butter, and honey which cause high iron content in the bar. Because oatmeal has 4.7 mg per 100 g, butter has around 0.5 mg per 100 g and honey has around 0.42 mg per 100 g based on Diet & Fitness.

Table 1: Iron concentration of the snack bar

Formulation Snack bar	Ferrum concentration (mg/L)
1	0.24±0.04
2	0.55±0.03
3	0.30±0.01

3.1.2 Calories content

From the value obtained, the calorie content of each formulation was calculated as shown in Figure 1 whereas Formulation 2 has the highest calorie content (78.67 Cal/100g) and followed by Formulation 1 (75.67 Cal/100g) and Formulation 3 (68.67 Cal/100g) respectively.

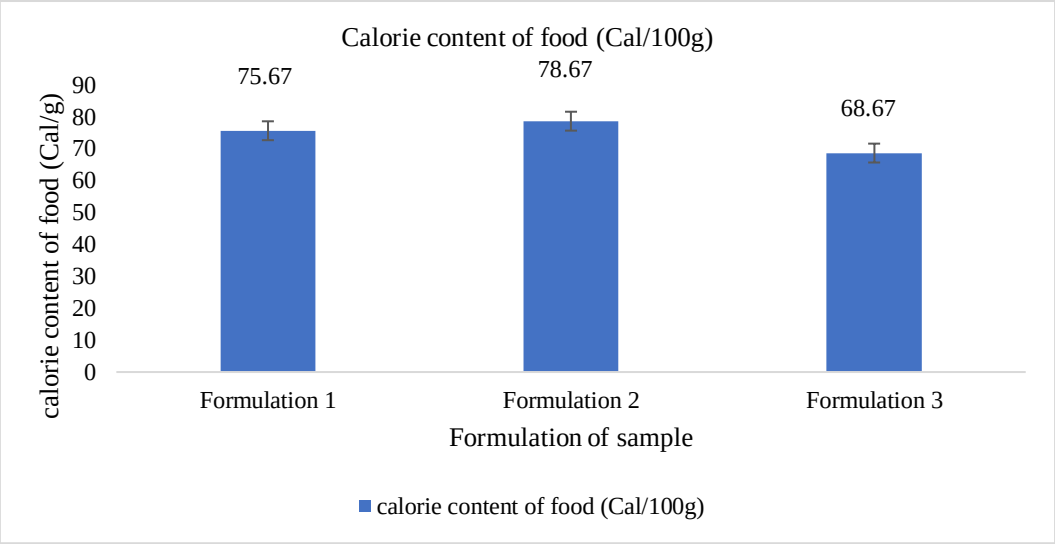

Figure 1: Calorie content of each three formulations after optimization

Higher calorie content can cause by ingredients such as nuts and seeds. This is because almond flake and green pumpkin seeds have quite high fat content that can contribute to more calorie content. Almond flakes have 575 kcal per 100 g and about 50% of its contents are fat [11]. While green pumpkin seeds have 559 kcal per 100 g of calorie content with a fat content of 49.05 g [12]. From this value, it can be evaluated that as the increase in fat content, it will also increase the value of calories [13]. This

is because, during the burning of a sample, the sample that has more fat content will burn the longest with cause more significant difference between the initial temperature with final temperature of the water when burning the sample under the test tube containing distilled water.

3.1.3 Proximate analysis

Table 2: Nutritional content of Formulation 2

Nutritional content	Protein	Total sugar content	Total fat content	Dietary fiber
Formulation 2	7.2 %	42.9%	14.9%	2.1%

The nutritional content that being analyzed were protein content, total sugar content, total fat content and dietary fiber content as shown in Table 2 are only for the optimized formulation: Formulation 2. Based on Table 2, the protein content of formulation 2 obtained was 7.2 %, like commercial snack bar, InGO "Muesli Bar with Cranberries" ranging of 6 – 10 % [14]. However, the value of fat content (14.9 %) is higher than " InGO "Muesli Bar with Cranberries", 3 %. [14]. It also contains 2.1 % of dietary fiber which make it considered as low in fibre because according to European Parliament and the Council Regulation (2006, No.1924/2006), any food sample must at least have 3 % of fiber to be considered as rich in fiber food. The total sugar content of formulation 2 can be considered as high (42.9%) as when compared with Nestle "Fitness Strawberry" and Laima "Get Up! Cherry" that in range 23 – 42%.

The protein content of the sample was in range because it contains nuts and seeds (almond flakes, green pumpkin seeds, and sunflower seeds) because nuts and seeds are a good source of macronutrient especially protein and fat content [15]. This sample has a high number of cranberries based on Table 2, but it does not contribute much to dietary fiber as stated in [16] that dried cranberries have only 4.57% (per 100g) of dietary fiber. Finally, high sugar content of this sample was contributed by dried cranberries because dried cranberries have higher sugar content than undehydrated one. As water is removed during dehydration process, sugar component in it become more concentrated which increase its sugar content.

Based on Malaysia Dietary Guideline, the protein content and dietary fiber of the sample can be considered as low because it less than 10% of Nutrient Reference Value (NRV) per 100 g and less than 3 g per 100 g respectively. While for fat content and sugar content were as considered as high because the value obtained were exceeded the Malaysian Dietary Guideline, fat more than 1.5 g per 100 g.

3.2 Sensory evaluation

A sensory evaluation was done by using 50 untrained panelists in range of 15 to 29 years old (14 males, 36 females) at a residential college in University Tun Hussein Onn Malaysia (UTHM) to evaluate consumer acceptance towards this snack bar. Each panelist needed to evaluate all the formulation based on colour, odour, texture, saltiness, sweetness, sourness, bitterness, aftertaste, and overall acceptance by using 9-points hedonic scale for the degree of likeness. All sensory attributes were statistically significant except for colour. This indicates that the panelists were able to differentiate all sensory attributes except for colour. This is because the addition of *M. oleifera* powder as natural colouring was added in the same amount in each formulation, hence showing no significant difference between each formulation. For the other attributes, since the formulations differ in type of other ingredients, they showed a significant difference between each formulation. These results are desirable. In other words, the panelists are able to successfully differentiate each difference between formulations. Although the amount of *M. oleifera* is the same in each formulation, bitterness and aftertaste show a significant difference. This is because the amount of ascorbic acid is different in each formulation. Even though

the main function of ascorbic acid is to increase iron bioavailability, it can also be used as taste masker where the bitterness and aftertaste of the sample is masked making them more acceptable.

Table 3: Summary of ANNOVA table for sensory acceptance

Sensory Attributes	Sum of square	Degree of freedom	Mean square	F-value	P-value	Significant
Colour	3.55	13	0.2730	2.00	0.2639	Not significant
Odour	3.89	13	0.2990	11.76	0.0144*	Significant
Texture	2.92	13	0.2242	14.76	0.0094*	Significant
Sourness	7.29	13	0.5604	7.88	0.0300*	Significant
Saltiness	5.52	13	0.4245	13.47	0.0112*	Significant
Sweetness	3.30	13	0.2538	20.22	0.0052*	Significant
Bitterness	6.94	13	0.5339	47.90	0.0010*	Significant
Aftertaste	4.07	9	0.4524	5.20	0.0149*	Significant
Overall acceptance	6.45	13	0.4964	9.10	0.0231*	Significant

p-value (<0.05)

4. Conclusion

From the findings, Formulation 2 showed the highest calorie content and iron content while formulation 3 has the lowest for calorie and formulation 1 has the lowest for iron content. Overall, formulation 2's protein, fat and sugar content exceeded the value from previous research. But dietary fiber, iron and energy content does not exceed that value. Dietary fiber value was lower than expected. In addition to the nutritional content analysis, the sensory evaluation is showing a positive acceptance from the consumers.

Acknowledgement

This research was made possible by funding from research grant number H676 provided through the UTHM contract-grant scheme. The authors would also like to thank the Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] J. D. Floros, R. Newsome, W. Fisher, G. V. Barbosa-Canovas, H. Chen, C. P. Dunne, J. B. German, R. L. Hall, D. R. Heldman, M. V. Karwe, S. J. Knabel, T. P. Labuza, D. B. Lund, M. Newell-McGoughlin, J. L. Robinson, J. G. Sebranek, R. L. Shewfelt, W. F. Tracy, C. M. Weaver and G. R. Ziegler, "Feeding the world today and tomorrow.," *The Importance of Food Science and Technology,* vol. 9, pp. 572-599, 2010.

[2] A. M. Estevez, B. Escobar and V. Ugante, "Use of Mesqui cotyledon (Prosopis chilensis) in manufacturing of cereal Bars," *Archivos Latinoamericanos de Nutrici´on,* vol. 50, pp. 148-151, 2000.

[3] L. H. Ho, J. Y. Tang, S. Mazaitul Akma, H. Mohd Aiman and A. Roslan , "Development of novel energy bar by utilizing local Malaysian ingredients," *International Food Research Journal,* vol. 23, no. 5, pp. 2280-2285, 2016.

[4] B. de Benoist, E. McLean, I. Egli and M. Cogswell, "Worldwide prevalence of aneamia (1993-2005)," *WHO Global Database on Aneamia Geneva.*

[5] S. Rodrigues, C. R. Gomes-ruffi, M. E. Lage, F. S. Becker, A. Alexandre, M. Melo, F. de Alves and C. Damiani, "Oxidative stability of cereal bars made with fruit peels and bar nuts packaged in different types of packaging," vol. 33, no. 4, pp. 730-736, 2013.

[6] A. Ahmad, U. Irfan, R. M. Amir and K. S. Abbasi, "Development of high energy cereal and nut snack bar," *International Journal of Agriculture and Biological Sciences,* pp. 13-20, 2017.

[7] V. Y. Njike, T. M. Smith, K. Shuval, I. Edshteyn, V. Kalantari and A. L. Yaroch, "Snack food, satiety, and weight," *Advances in Nutrition (Bethesda, Md)*, vol. 7, no. 5, pp. 866-878, 2016.

[8] T. E. Siong, K. S. Choo and S. M. Shahid, "Determination of iron in foods by the atomic absorption spectrophotomteric and colorimetric methods," vol. 12, no. 3, pp. 315-322, 1989.

[9] D. L. Durkee, C. Machado, G. Fukuda and S. S. Nielsen, "Development and sensory evaluation of snack bars with bean-based filling," *CFW Research*, vol. 51, no. 6, pp. 313-318, 2006.

[10] B. V. McCleary, "Dietary fiber analysis," *Proceedings of the Nutrition Society*, vol. 62, no. 1, pp. 3-9, 2003.

[11] C. N. Ford, M. M. Slining and B. M. Popkin, "Trends in dietary intake among US 2 to 6 years old children (1989-2008)," *Journal of the Academy of Nutrition and Dietitics*, vol. 113, pp. 35-42, 2013.

[12] A. H. Dar, S. A. Sofi and R. Shafiya, "Pumpkin as the functional and therapeutic ingredients: A review," *International Journal of Food Science and Nutrition*, pp. 168-173, 2017.

[13] A. Hoefling and F. Strack, "High calorie content evokes conflicting implicit and explicit evaluations in restrained eaters," *The Tempting Effect of the Forbidden Foods*, vol. 51, no. 3, pp. 680-689, 2008.

[14] S. Aleksejeva, I. Siksna and S. Rinkule, "Composition of cereal bars," *Journal of Health Sciences*, pp. 139-145, 2017.

[15] G. Brufau, J. Boatella and M. Rafecas, "Source of energy and macronutrients," *British Journal of Nutrition*, vol. 96, no. S2, pp. S24-8, 2006.

[16] B. R. Cvetkovic, B. V. Filipcev, M. I. Bodroza-Solarov, Z. M. Bardic and M. B. Sakac, "Chemical composition of dried fuirt as a value-added ingredient in bakery products," *Food Processing, Quality and Safety*, vol. 1, no. 2, pp. 15-19, 2009.