Effect of Additional *Hoodia Gordonii* and Seaweed (*Kappaphycus Alvarezii*) Powder on the Sensory and Physicochemical Properties of Brown Rice Bar

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**ABSTRACT**

Awareness of the nutritional content of food has increased with the emergence of various health products in the market. Cereal bar is one of the beneficial foods among consumer that concern on their healthy food. This study was conducted to develop a brown rice bar that contain active ingredients (*H. gordonii* and seaweed powder) and to determine the effect on sensory evaluation and physicochemical properties (colour, texture and proximate analysis) of this product. This study was consist with two phase in which the first phase consist of development of ten formulation were undergo colour, texture and sensory analysis to choose the best formulations. Control (*H. gordonii*: 0%, seaweed: 0%) and two best formulations that consist of formulation 6 (*H. gordonii*: 1.6%; seaweed: 2.8%) and formulation 9 (*H. gordonii*: 2.4%; seaweed: 2.8%) were chosen to undergo the second phase which is proximate analysis. Base on the result, there have a significant different (p>0.05) on proximate analysis except for the protein and moisture content. It shows that *H. gordonii* is a good source of fiber when adding in a bar.

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**INTRODUCTION**

Nowadays snack foods are substantial contributors to daily energy intake in Malaysia. The changes in lifestyle of the population cause increase the demand on healthy snack food among the population. The cereal bar is one of the type of snack bar which can be characterized as easily consume, healthy, readily available and small sized products. It is introduce due to the combining properties of its nutritional quality that either to improve or substitute snacks between meals, to complement meals, or simply to gain an energy in a healthy way (Ryland *et al*. 2010). Because the snacks food composition gives the influences on the metabolism and energy balance, attempts are being made to improve cereal bar nutritional value by modifying their nutritive composition.

Research by Green *et al*. (2000) reported that high carbohydrate snack promote lower total energy intake compare with high fat snack. Brown rice is one of the sources of carbohydrate. The germ and bran layer that do not remove during milling process give more nutritional component such as protein, lipid, dietary fiber, mineral and vitamin compare to white rice (Heinemann *et al*. 2005; Ito *et al*. 2005; Lamberts *et al*. 2007). Even though the brown rice has rich in nutrient, the fat that contain in bran and germ make it become easily rancid thus less acceptable then white rice. Thus popularity and convenient properties of cereal bar would be an ideal format to deliver the nutrient content in brown rice by make it become as a carrier in this healthy cereal snack.

Less development has been done on the snack that contain active ingredient that can give satiety to consumer. *Hoodia Gordonii* (*H. gordonii*) is a group of species *Apocynaceae* plant (bruyns 2005) that comes from South Africa and Namibia. This plant is traditionally used by San People of Southern Africa during hunting. The active component of glucoside in *H. gordonii* make it one of the popular herbal supplements that are believed to have an appetite suppression effect (Rahul *et al*. 2007). Even though studies have proof that the consumption of *H. gordonii* can reduce food intake but this plant is still not applicable in food industry. Furthermore, there have no paper that discuss on the physicochemical affect on additional this active ingredient into food product.

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Other than that, the used of seaweed is becoming popular among Malaysian due to the rich of polysaccharides, minerals, proteins and vitamin that contain in seaweed (Kumar et al. 2007). One of the red species of seaweed is *Kappaphycus alvarezii* that become highly demanded for its cell wall polysaccharide with is most important source of kappa carrageenan. However the fishy smell of seaweed makes it become less consumable among consumer. In order to make it more commercialize, a medium is needed to mask this fishy smell. Thus, an effort on additional of this seaweed into food product such as snack can be seen as a potential to supply the benefit that contain in seaweed.

This research objective is to develop new brown rice bar product and to determine the effect of additional *hoodia gordonii* and seaweed (*kappaphycus alvarezii*) powder on the sensory and physicochemical properties of brown rice bar.

**MATERIALS AND METHODS**

**Material:**

The brown rice puff was purchase from Grain Season Sdn Bhd. Collagen, *Hoodia gordonii*, seaweed kappaphycus alvarezii and guar gum was purchase from Jururunding Teman, Batu Caves. Other raw material to produce brown rice bar such as honey, cereal, almond, chocolate chip and butter were purchase from Yummies Bakery Supply, Bangi. The seaweed was wash with water to remove impurities and drained. Then, it was dried at 50°C for 48h and grind using grinder (universal cutting mill, model: UCM 19, Germany) to make fine powder (0.25mm). Almond was baked for 5 min and cooled.

**Brown rice bar formulation:**

The brown rice bars were prepared according to formulation presented in Table 1. 10 formulations were developed with different quantity of the *H. gordonii* and seaweed powder. Honey, butter, guar gum, sucralose, *H. gordonii*, seaweed powder and collagen were heated to 95°C in a pan for 30 seconds. The dried mixed of brown rice puff, cereal, almond and chocolate chip were added into the pan and make the mixture mixed well. Then, the bars were molded (9x3x1, 5cm) and baked in an oven at 180°C for 14 minutes. After that it was cooled and store in a cool dry place at 25°C.

**Colour analysis:**

The surface colour of brown rice bar was analyzed by using a handheld colorimeter (Minolta Chroma Meter CR-300 series, Osaka, Japan). The result express in the CIE LAB which is L* = lightness (where 0=black, 100= white), a* (+a*= redness, -a*= greenness) and b* (+b*= yellowness, -b*= bluelessness) with compared to a standard white calibration plate (CR-A44) with a wide-area illumination.

**Texture analysis:**

Texture analyzer Shimadzu (model: AGS-J 500N, Japan) was used to determine the brown rice bar hardness. The brown rice bars were compressed by 25% of its initial height under the influence of a load cell of 50 N forces. A cylindrical probe having a diameter of 1.27 cm was used during measurements. The data were reported as the average of three replicates.

**7-point hedonic scale sensory analysis:**

The acceptability of brown rice bar was determined by using the 7 point hedonic scale (Aminah 2004). Sensory tests were conducted using 30 staff and student panelists from National University of Malaysia. A seven rating scale was used for evaluate aroma, colour, hardness, crunchiness, sweetness, aftertaste and overall acceptability.

**Proximate analysis:**

Base on the sensory evaluation, control and other two best formulations were choosing to undergo proximate analysis. Soxhlet method was used to determine fat content while protein as N x 6.25 was determined by Kjedahl method. Crude fiber was determined using gravimetric test; moisture was analyzed in an oven at 105°C for 24 hours, ash was evaluated by burning the sample at 550°C. Carbohydrate was calculated by the difference method (100-water-protein-lipid-ash-fiber) (AOAC 1990).

**Statistical analysis:**

All data were expressed as means ± standard deviations. Data were analyzed by 1 way ANOVA using SAS version 6.12 (SAS Institute, North California). Turkey test was used to compare differences between samples. Significant difference was considered at the level of P<0.05. All experiments were done in triplicates.

**RESULTS AND DISCUSSIONS**

Result of color $L^* a^* b^*$ for each sample of brown rice bar are presented in table 2. Results indicate colour difference with the additional of seaweed powder and *H. gordonii*. All formulation showed significant differences (p <0.05) for color space $L^*$ except in formulation 2, 3 and 7. Formulation 5 was significantly higher (lighter colour) (p <0.05), while formulation 4 shows significantly darker (p <0.05) when compare to other formulation. This is agreement with the natural yellowish colour of *H. gordonii* and brown colour of seaweed powder that cause the sample to become darker.
Formulation 2 and 3 exhibit the lowest value whereas Mean values with the same alphabets within the same row are not significantly different (p ≤ 0.05).

Table 2: Colour of brown rice bar

<table>
<thead>
<tr>
<th>Sample</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>54.13±0.06*</td>
<td>7.61±0.40*</td>
<td>22.75±0.36*</td>
</tr>
<tr>
<td>1</td>
<td>54.85±0.40*</td>
<td>7.22±0.34*</td>
<td>20.40±0.52*</td>
</tr>
<tr>
<td>2</td>
<td>56.75±0.05*</td>
<td>8.44±0.49*</td>
<td>18.28±0.36*</td>
</tr>
<tr>
<td>3</td>
<td>56.18±0.76*</td>
<td>6.64±0.21*</td>
<td>17.99±0.47*</td>
</tr>
<tr>
<td>4</td>
<td>49.73±0.54*</td>
<td>9.42±0.39*</td>
<td>20.82±0.90*</td>
</tr>
<tr>
<td>5</td>
<td>59.54±0.19*</td>
<td>5.74±0.05*</td>
<td>21.49±0.33*</td>
</tr>
<tr>
<td>6</td>
<td>50.52±0.34*</td>
<td>7.74±0.08*</td>
<td>22.34±0.51*</td>
</tr>
<tr>
<td>7</td>
<td>56.75±0.11*</td>
<td>7.42±0.33*</td>
<td>23.99±0.70*</td>
</tr>
<tr>
<td>8</td>
<td>53.93±0.37*</td>
<td>6.28±0.10*</td>
<td>19.64±0.79*</td>
</tr>
<tr>
<td>9</td>
<td>57.76±0.33*</td>
<td>6.24±0.34*</td>
<td>20.79±0.07*</td>
</tr>
</tbody>
</table>

Mean values with the same alphabets within the same row are not significantly different (p ≤ 0.05).

Table 3: 7-point hedonic scale sensory evaluation for brown rice bar

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aroma</th>
<th>Colour</th>
<th>Texture</th>
<th>Crispness</th>
<th>Sweetness</th>
<th>Aftertaste</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>4.81±1.20*</td>
<td>4.81±1.27*</td>
<td>5.00±1.44*</td>
<td>5.23±1.21*</td>
<td>5.11±1.31*</td>
<td>5.11±1.11*</td>
<td>5.15±1.16*</td>
</tr>
<tr>
<td>1</td>
<td>4.69±1.32*</td>
<td>4.19±1.58*</td>
<td>4.69±1.33*</td>
<td>4.66±1.14*</td>
<td>4.42±1.10*</td>
<td>4.61±1.07*</td>
<td>4.65±1.00*</td>
</tr>
<tr>
<td>2</td>
<td>4.92±1.29*</td>
<td>5.04±1.11*</td>
<td>5.34±1.26*</td>
<td>5.54±1.07*</td>
<td>5.30±1.08*</td>
<td>4.31±1.07*</td>
<td>4.31±1.41*</td>
</tr>
<tr>
<td>3</td>
<td>4.62±1.13*</td>
<td>4.65±1.02*</td>
<td>4.92±1.23*</td>
<td>5.85±1.76*</td>
<td>5.07±1.13*</td>
<td>5.11±1.18*</td>
<td>4.92±1.13*</td>
</tr>
<tr>
<td>4</td>
<td>4.77±1.36*</td>
<td>5.19±0.94*</td>
<td>5.23±1.14*</td>
<td>5.46±1.07*</td>
<td>5.15±1.12*</td>
<td>4.19±1.35*</td>
<td>4.20±1.41*</td>
</tr>
<tr>
<td>5</td>
<td>4.35±1.55*</td>
<td>4.65±1.47*</td>
<td>4.65±1.44*</td>
<td>5.00±1.26*</td>
<td>4.80±1.29*</td>
<td>4.76±1.24*</td>
<td>4.69±1.29*</td>
</tr>
<tr>
<td>6</td>
<td>4.69±1.32*</td>
<td>4.58±1.24*</td>
<td>5.26±1.15*</td>
<td>5.69±1.01*</td>
<td>5.11±1.31*</td>
<td>5.34±1.01*</td>
<td>5.34±0.94*</td>
</tr>
<tr>
<td>7</td>
<td>4.62±1.27*</td>
<td>4.69±0.97*</td>
<td>5.11±1.38*</td>
<td>5.27±1.46*</td>
<td>3.26±1.07*</td>
<td>3.46±1.50*</td>
<td>3.15±1.35*</td>
</tr>
<tr>
<td>8</td>
<td>4.72±1.34*</td>
<td>4.96±1.22*</td>
<td>5.34±1.29*</td>
<td>5.69±1.19*</td>
<td>5.23±1.24*</td>
<td>3.42±1.39*</td>
<td>5.19±1.36*</td>
</tr>
<tr>
<td>9</td>
<td>4.42±1.06*</td>
<td>4.58±1.17*</td>
<td>4.92±1.20*</td>
<td>5.26±1.12*</td>
<td>5.31±1.09*</td>
<td>4.84±1.50*</td>
<td>4.85±1.32*</td>
</tr>
</tbody>
</table>

Mean values with the same alphabets within the same row are not significantly different (p ≤ 0.05).

Table 4: Proximate analysis for brown rice bar

<table>
<thead>
<tr>
<th>Sample</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Moisture (%)</th>
<th>Fiber (%)</th>
<th>Ash (%)</th>
<th>Carbohydrate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>15.18±0.57*</td>
<td>10.47±0.39*</td>
<td>4.09±0.42*</td>
<td>5.61±0.30*</td>
<td>2.36±0.01*</td>
<td>62.30±1.67*</td>
</tr>
<tr>
<td>6</td>
<td>12.38±0.01*</td>
<td>11.75±0.18*</td>
<td>3.74±0.07*</td>
<td>3.14±0.18*</td>
<td>2.59±0.02*</td>
<td>66.58±0.44*</td>
</tr>
<tr>
<td>9</td>
<td>17.26±1.13*</td>
<td>10.90±0.65*</td>
<td>3.63±0.18*</td>
<td>1.78±0.18*</td>
<td>2.67±0.05*</td>
<td>57.77±0.09*</td>
</tr>
</tbody>
</table>

Mean values with the same alphabets within the same row are not significantly different (p ≤ 0.05).

For a* value, formulation 4 showed the highest significant differences (p <0.05) while formulation 2 gives lowest significant difference (p <0.05). Formulation 2 and 3 exhibit the lowest value whereas formulation 7 had the highest b* value which indicated blueness going towards yellowness. The increase of yellow colour of sample is associated with the colour of H. gordonii itself. This is correlate
with other research that shows the colour of H. gordonii is from gray-green to gray brown (Chrystian et al. 2010).

The hardness ranges were between 5.02 N to 14.77 N as shown in figure 1. Control showed significant differences (p <0.05) when compared with formulation 1, 5, 6, 7 and 9. Formulation 1, 5 and 6 showed the lowest significant different (p<0.05) when compared to other formulations. Increasing the quantity of H. gordonii in a ratio of 0.8 g to 1.6 g gives a less hard texture to sample. Roberta and Balick (2007) stated that H. gordonii plant can normally grow and thrive in hot weather conditions (40 °C) or low weather (-3°C) on dry ground. This can describe the nature of H. gordonii, which easily attract water from the air and thus makes the sample less hard than other samples.

The sensorial preference of the sample is shown in table 3. All formulations presented a good sensorial acceptability in a general standpoint. Regarding colour, formulation 1 with the lower content of seaweed powder (1.2g) and H. gordonii (0.8g) give the lower significant different with sample 3, 8 and 9. Considering crunchiness, formulation 6 and 8 obtained the highest grade but did not significantly different (p>0.05) from formulation 2.

Formulation 1 gives the lowest acceptability in term of sweetness. Increase the quantity of H. gordonii lower the acceptability for the attribute aftertaste. It is shown that panelists were able to detect the bitter aftertaste when H. gordonii is added into a quantity of 2.4g. This can be proof by the result of aftertaste that shows the formulation 7 and 8 give the lowest score of aftertaste when compare to other samples. For the overall acceptability, it shows that sample 6 give the highest significant different (p<0.05) while sample 2 and 5 give the lowest significant different when compare to others. Based on this sensory evaluation, two best formulations (sample 6 and sample 9) with control have been chosen to undergo proximate analysis.

The proximate analysis of brown rice bar is presented in table 4. No significant different (p>0.05) were observed for protein and moisture content for the entire sample. The range of moisture content on the three samples is low, ranging from 3.63% - 4.09%. Moisture content of a snack is considered important because it can affect the stability of the product during storage (Erqun et al. 2010). The low moisture content can help in prolonging life and improving quality of sensory (labuza & Hyman 1998). Theoretically, adding H. Gordonii will increase the moisture of the sample due to the nature of it which easily attracts water.

Formulation 6 give lowest significant different (p<0.05) for fat content compare to control and formulation 9 whereas formulation 9 contained highest fiber and followed by control and formulation 6 respectively. According to FSANZ (2008) requirement stated that a fiber content of 4.5g per serving would allow claim of “a good source of fiber”. Such results provide rough approximation for food labeling that formulation 9 and control may qualify for the claim of “a good source of fiber”.

The present of H. gordonii and seaweed powder increase the ash contents for the formulation 6 and 9. Ash contain was found to be similar in formulation 6 and 9, but the control had the lowest ash contents. This give the positive correlation with finding from Faizal et al., (2012) that found ash content is the second largest component in seaweed.

Data obtained showed that carbohydrate content is highest other than proximate content. Formulation 6 showed the highest carbohydrate content (66.58%) followed by the control (62.30%) and formulation 9 (57.77%). The addition of seaweed and H. gordonii on formulation 6 can improve the carbohydrate content. This is because carbohydrate is the primary component in dried seaweed. Ident et al. (2012) reported that the carbohydrate content in dried kappaphycus alvarezii seaweed species is 66.66%. High contain of carbohydrate also affected by the brown rice. This can be referred to study that conducted by Thomas et al. (2013) who found that total carbohydrate content in brown rice is 78.21%.

Conclusion:

In overall, it is beneficial to incorporate two type of active ingredient (H. gordonii and seaweed powder) into snack bars. H. gordonii and seaweed powder have influenced differently the colour, texture, sensory and proximate analysis. It also shows that H. gordonii and seaweed powder are a good source of fiber when adding in a bar.

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REFERENCES