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Utilization of vegetables and tubers flour in development of soft-textured high fibre bar for healthy ageing

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Development of a soft-textured high fibre bar was conducted to utilize the nutrients from vegetables and tubers, as a nutritious snack that easy to consume for the elderly to maintain their health. In a previous study, selected tubers namely sweet potato flour and tapioca flour were successfully substituting wheat flour in the formulation. In this study, the effect of incorporating vegetable flour at different percentage levels on fibre, protein, calcium, vitamin D3, texture and product acceptance of the bar were studied using Response Surface Methodology. Green spinach and pumpkin flour were chosen as independent variables (0-4% based on Baker's percent). The result showed that this product had a high total dietary fibre (>6%) and source of protein (>5%). Statistical analyses of total dietary fibre, calcium content and vitamin D3 showed a significant ($p \leq 0.05$) increment when the percentage level of green spinach flour increased, but protein value was not significantly ($p > 0.05$) affected by both green spinach and pumpkin flours. However, the higher level of green spinach flour used in the formulation was negatively ($p \leq 0.05$) affected the overall acceptability of the product due to the unpleasant taste and smell of the flour. Meanwhile, the texture would become softer and brittle when the percentage level of green spinach flour and pumpkin flour increased. This work demonstrated that the application of vegetables and tubers has the potential to be processed into flour and may replace wheat flour in bar preparation to enhance the nutritional quality of the product.

Keywords: Soft-textured bar, dietary fibre, spinach flour, pumpkin flour, sweet potato flour, tapioca flour, nutritional properties

INTRODUCTION

Vegetables and tubers such as green spinach, pumpkin, tapioca and sweet potato, are rich in fibre and minerals that are needed to maintain body health. Fibre is needed for a healthy digestive system, protein is important for muscle strength and cell renewal, and minerals are essential for body metabolism (Hazen, 2014; Paddon-Jones and Rasmussen, 2009). The total dietary fibre in green spinach, pumpkin, tapioca and sweet potato flours were high, ranging from 13% to 49% (Mokhtar et al. 2018). Reports from the previous study also showed that green spinach flour, pumpkin flour and sweet potato flour were a source of protein (>5%) and rich in calcium content (Mokhtar et al. 2018). Mokhtar et al. (2018) also indicated that green spinach contains vitamin D3, which plays a primary physiological role in maintaining extracellular calcium ion levels in the human body, as well as supports muscle health and helping to reduce the risk of fractures resulting from falls (Mithal et al. 2009). Hence, it is worthwhile to exploit and utilize the nutrients from those vegetables and tubers in the development of food product specifically for elderly.

The elderly needs complete nutrition to sustain their body health. Shahar et al. (2001) reported that older people are susceptible to malnutrition. Ageing may lower the efficiency of the body at using and storing the nutrients in the food that was consumed. Furthermore, the elderly were easily losing appetite and hence, tend to eat less. As a consequence, their body would not get all the nutrition needed. Hisckson (2006) stated that the elderly are a vulnerable group undergoing physiological changes, and may be experiencing dental problems and difficulty in swallowing, which can lead to eating problems and malnutrition. Nevertheless, all the nutrients are still in demand by their bodies and some are more essential for bone, muscle and brain health. Lack of nutrients may affect their nutritional, physical and also to their emotion. Therefore, the elderly may need to make an extra effort to get enough nutrients to fulfill the gap. Supplement the main meal with nutrient-dense snacks should be considered. Potential food products can be tailored to enhance the nutritional status and health of the elderly by fortifying food with functional ingredients which may enhance the nutritive value of developed products (Baugreet et al. 2017).

There are various forms of products with nutritious claimed for the elderly in the market such as protein-enriched, high calcium and high fibre products supplement which promote facilitating muscle strength, bone growth and healthy colon. Most products can be found in the form of milk and premixes but not in a bar or compact form that easy to carry and consume anywhere. Available fibre or protein bars in the market has rough-textured, contain various types of lumpy legumes and do not easy to chew, hence are not suitable for the elderly to consume. Therefore, a designated bar that has a soft and smooth texture that easily to chew should be developed to vary nutritious product choices for the elderly instead of milk, shakes or pills. The development of tailored nutrient-dense foods should be easily accessed, appealing and appropriate sensorial attributes that would be consumed frequently (den Uijl et al. 2016). Furthermore, products with beneficial attribute such as ready-to-eat, easy-to-open, and easy-to-bite and chew would help to fulfill the elderly's nutritional and functional needs (Baugreet et al. 2017).

Adding vegetables and tubers flour in food products formulation in order to get an acceptable texture and taste without forgetting the nutritive side is one of the challenges in developing a new designated product. According to Baugreet et al. (2017), the development of food product for the elderly should consider the requirements for specific macro- and micro-nutrients, especially protein, calcium and vitamin D, as well as chemosensory acuity, chewing difficulties and poor swallowing ability. Therefore, the objective of this study is to determine the effect of green spinach flour and pumpkin flour on nutrient contents, physical quality and product acceptance. Moreover, the percentage of green spinach flour and pumpkin flour in the formulation of soft-textured high fibre bar for the elderly would be optimized.

MATERIALS AND METHODS

Preparation of raw material

Selected vegetables and tubers namely sweet potato, tapioca, green spinach and pumpkin, were purchased directly from local farmers at Sepang (sweet potato and tapioca), Klang (green spinach) and Federal Agricultural Marketing Authority or FAMA (pumpkin). All raw materials were peeled (sweet potato, tapioca and pumpkin) or cut thick stem and roots (green spinach), washed, sliced and dried in hot-air circulating dryer (Memmert, Germany) at 60°C until the moisture content reach <5% by using moisture analyzer (SARTORIUS MA 35). Dried raw materials were ground into powder (FRITSCH Universal Cutting Mill Pulverisette 19, Germany), packed in an oriented polypropylene/ aluminum/ polyethylene (OPP/Al/PE), sealed and stored at room temperature until further used.

Production of soft-textured high fibre bars

Figure 1 shows general steps on the production of a soft-textured high fibre bar. Selected tubers namely sweet potato and tapioca (flour form) were used and maintained at the highest level based on previous preliminary study, which fully replaces the use of wheat flour (100% based on Baker's percent). Baker's percentage or also known as Baker's Math is a notation method indicating the proportion of an ingredient relative to the flour used in a recipe when making baked goods such as biscuits, bread and cakes (Figoni, 2010). Eq. 1 shows the calculation of Baker's percentage which expresses a ratio in percentages of each ingredient's weight to the total flour weight (Wayne, 2009):

$$Baker's\ percentage = (Weight\ ingredient) / (weight\ flour) \times 100\%) \qquad \text{Eq. (1)}$$

where, weight ingredient refers to the ingredients. Meanwhile, weight flour refers to combination weight of sweet potato flour and tapioca flour.

A soft-textured high fibre bar was prepared from dough containing green spinach flour and pumpkin flour at different percentage level. The formula used was as follows (based on Baker's percent): 100% combination of sweet potato and tapioca flour (the percentages for each flour were studied in a previous study which successfully substitutes the wheat flour in terms of dough forming and product acceptance), 33% icing sugar, 0.5% baking powder, 1% skimmed milk, 17% eggs and 50% margarine. All materials were weighted accordingly. Icing sugar and eggs were creamed in a mixer (Panasonic MK-GB1WSK stand mixer) with a paddle beater for 3 min at 61 rpm (speed 1). Margarine was sliced into a small cube, added into the cream and mix for 2 min at speed 1. Baking powder, skimmed milk, flours (sweet potato flour and tapioca flour), green spinach flour (0-4%) and pumpkin flour (0-4%) were mixed separately before transferred in the mixture gradually, mixed for 6 min at 125 rpm (speed 2) and for 2 min speed 1 to obtain a homogenized dough. The dough pieces were sheeted to a thickness of 0.8 mm, cut using a bar mould (2 cm x 3 cm) and bake at 150°C for 12 min. After baking, bars were left to cool at room temperature and were wrapped tightly with aluminum/ polyethylene (Al/PE) pouches and kept until further analysis.

Figure 1: Flow chart for the production of a soft-textured high fibre bar

Experimental design

Response Surface Methodology (RSM) was applied to determine the effect of green spinach flour and pumpkin flour on nutrients content, texture and product acceptance of soft-textured high fibre bar. Percentages level of green spinach flour and pumpkin flour used in the formulations ranging from 0% to 4% based on Baker's percent (Table 1).

Table 1: Levels of independent variables in soft-textured high fibre bar formulations.

Independent variable level	Independent variables	
	Green spinach flour (%)	Pumpkin flour (%)
Low	0	0
Center	2	2
High	4	4

The experiments were designed based on a central composite design (CCD) and full factorial, giving a total of 13 combination tests. Soft-textured high fibre bar produced were analyzed at $p \leq 0.05$ with 1 replicate and 1 base block. The design had 4 cube points, 5 centre points in cube, 4 axial points, 0 centre points in axial and the centre point was repeated 4 times in order to calculate the repeatability of the method. The dependent variables were total dietary fibre, protein, calcium, vitamin D3, hardness, fracturability and product acceptance. Multiple regressions were applied to predict the linear, quadratic and interaction terms of independent variables in the response surface models. The following polynomial equation was used to relate the response with independent variables (Eq. 2):

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_{11} x_{12} + \beta_{22} x_{22} + \beta_{12} x_1 x_2 \quad \text{Eq. (2)}$$

where, y is the response calculated by the model and the coefficients of the polynomial were presented by β_0 (constant term), β1and β2 (linear coefficients), $\beta_{11}$and β_{22} (quadratic coefficients) and β_{12} (interaction coefficients). Surface plot showing combined effect of green spinach flour and pumpkin flour on dependent variables is applicable only for the significant ($p \leq 0.05$) interaction effects. All data were expressed as mean±standard deviation and were done in triplicate analyses. The software used was Minitab® 16.2 (Minitab Inc., Pennsylvania, USA).

Analyses of soft-textured high fibre bar

Determination of total dietary fibre

Total dietary fibre was determined in a Tecator Fibertec 1010 fibre digester according to enzymatic-gravimetric method 985.29 for total dietary fibre in food (AOAC, 2005) with some modifications. The sample size was reduced to 500 mg and mixed with reagent before incubated with heat-stable cu-amylase (Sigma Chemical Co., St. Louis, MO, USA) in boiling water bath for 30 min. The cooled assay solution pH was adjusted to 7.5 with 0.5 M NaOH. The pH of the suspension after protease (Sigma) incubation was adjusted to 4.5 with 0.5 M HCl. Total assay volume after amyloglucosidase (Sigma) digestion was about 30 ml. The residue and celite were removed from the crucible, ground and mixed well, and only 25mg were used for micro-Kjeldahl N determination. Correction for celite weight was made by dividing %N for residue plus celite by the ratio residue weight/ residue plus celite weight.

Determination of protein content

Protein content (N 6.25) was evaluated from 500 mg of sample using the Kjeldahl method 988.05 (AOAC, 2005) in a Tecator 2020 digestor and Kjeltec 1030 auto analyzer.

Determination of calcium content

Calcium content determination was performed according to AOAC method 927.02 (AOAC, 2005). The samples were digested in HNO_3/HlO_4 and calcium content was measured by atomic absorption spectrophotometer, using a Perkin-Elmer Lambda 35 atomic absorption (Perkin-Elmer, Norwalk, CT).

Determination of vitamin D3

Vitamin D3 was analysed according to AOAC 995.05 (AOAC, 1998) with slight modification. To 500 mg of sample, 500µl of with ethanolic KOH were added. The contents were shaken for 30 min at 60°C. Vitamin D3 was extracted by mixing two times (60 seconds each time) with 1 ml of hexane. The phases were separated by centrifugation at 1000 rpm for 10 minutes. The upper organic phase was transferred to a conical tube and dried under nitrogen. The residue was dissolved in an appropriate volume of acetonitrile for HPLC-UV analysis.

Determination of hardness and fracturability

Hardness and fracturability of bars were measured via the force, expressed in gram/sec using a texture analyzer (TA.XTPlus texture analyzer, Stable Micro system).

Product acceptance analysis

Product acceptance test was evaluated by 30 untrained geriatric/ elderly aged >55. The testing was conducted using a 7-point mimic hedonic scale. The samples were coded to avoid any bias.

RESULTS AND DISCUSSION

Data analyses of the experimental design showed the total dietary fibre of the soft-textured high fibre bar was varying from 11.06% to 24.77% (Table 2). These values indicated that the bars produced were high in dietary fibre (>6% for a solid product) based on Malaysia's Nutrition Labelling and Claims Guidelines (Department of Statistics, 2014). According to the Academy of Nutrition and Dietetics, USA, the consumption of adequate amounts of dietary fibre reduces the risk of constipation, appendicitis, diabetes, obesity, coronary heart diseases and gallstones (Academy of Nutrition and Dietetics, 2015). Statistical analyses in Table 3 showed total dietary fibre had significantly ($p \leq 0.05$) affected by green spinach flour. Total dietary fibre was significantly increased when spinach flour increased from 0% to 4%. This result might be due to the high content of total dietary fibre in green spinach flour which was 60% higher compared to pumpkin flour (Mokhtar et. al. 2018). The high content of total dietary fibre in soft-textured high fibre bar might also be contributed by sweet potato flour and tapioca flour which contained high total dietary fibre with the values of 13.76% and 49.96%, respectively (Mokhtar et al. 2018). Owing to the higher fibre content of these plant sources it could be assumed that the addition of green spinach, sweet potato and tapioca flour in food product formulation have a greater potential in overcoming dietary fibre malnutrition of the elderly. The result was in trend with reports by Hosamani et al. (2016) in composite biscuits with carrot, jackfruit and aonla powder, Ribeiro et al. (2015) in biscuits with the addition of cauliflower flour, and Hegazy et al. (2009) in wheat biscuits supplemented by fenugreek seed flour.

Table 2: Experimental designs for the formulation tests of soft-textured high fibre bar and analyses data

Run Order	Independent variables		Dependent variables*						
	Green spinach flour (%)	Pumpkin flour (%)	Protein (g/100g)	Total dietary fibre (g/100g)	Calcium (mg/ 100g)	Vitamin D3 (µg/100g)	Hardness (g/sec)	Fracturability (g/sec)	Product acceptance
1	0	4	8.41±0.12	11.06±1.12	55.15±3.14	3.20±0.00	5637.87±285.75	975.19±37.12	6.1±1.2
2	2	4	8.43±0.18	19.19±0.19	64.83±2.96	9.25±0.21	5784.87±444.40	906.39±38.71	5.9±1.0
3	4	4	8.56±0.14	24.76±0.37	75.92±2.26	20.20±0.42	6377.33±154.17	988.49±13.52	3.8±1.4
4	2	2	8.59±0.04	14.19±0.75	65.30±6.19	11.70±0.28	6205.32±361.78	1073.11±97.73	4.9±1.2
5	2	2	8.21±0.00	14.23±0.06	69.06±4.42	10.60±0.00	6214.43±286.92	1062.21±29.52	5.2±0.8
6	2	2	8.39±0.10	14.15±0.13	62.97±6.95	11.95±0.07	6236.15±342.28	1059.10±107.71	5.2±1.1
7	4	2	8.43±0.06	24.77±0.28	82.74±6.41	21.05±0.21	6889.80±404.46	1130.93±4.53	3.8±1.6
8	4	0	8.55±0.02	23.14±0.18	84.13±0.94	22.05±0.21	7139.30±786.65	1097.78±63.28	3.9±1.5
9	0	2	8.46±0.03	12.39±0.80	59.71±2.40	2.80±0.00	7239.58±1377.45	1111.41±199.15	5.2±1.3
10	2	0	8.23±0.04	20.90±0.13	62.08±9.25	13.25±0.07	6911.26±196.66	1135.47±75.74	4.8±0.8
11	2	2	8.47±0.05	14.80±0.18	60.96±7.64	10.65±0.21	6205.60±1352.68	1048.93±144.21	4.9±0.9
12	2	2	8.11±0.01	14.25±0.53	50.91±1.29	11.20±0.42	6294.54±461.62	1059.39±83.74	5.2±1.6
13	0	0	8.36±0.03	10.35±0.21	55.53±2.04	2.25±0.07	7563.04±765.83	1221.53±149.52	5.6±1.6

*Data are mean of triplicate determinations

Table 3: Second order uncoded regression coefficients for protein content, total dietary fibre, calcium, vitamin D3, hardness, fracturability and product acceptance of soft-textured high fibre bar

Regression coefficient	Protein	Total dietary fibre	Calcium	Vitamin D3	Hardness	Fracturability	Product acceptance
β_0	-	10.2150	53.0474	2.37500	7698.03	1219.48	5.38333
β_1	-	3.32250	7.01125	4.58750	-739.297	-80.1139	-0.0404762
β_2	-	-	0.491667	-	-337.628	-21.0204	0.125000
β_{11}	-	-	-	-	147.765	13.8513	-0.102381
β_{22}	-	-	-	-	-31.3915	-11.2089	-
β_{12}	-	-	-0.489375	-	72.7000	8.56532	-
R_2	-	80.73	84.31	97.45	91.96	95.92	87.10
p-value	-	0.000	0.001	0.000	0.000	0.000	0.000
Lack of fit p-value	-	0.151	0.256	0.273	0.001	0.017	0.045
Lack of fit F-value	-	2.42	2.03	1.35	56.55	12.58	6.64

β_0= constant term; β_1= linear coefficient of green spinach flour; β_2= linear coefficient of pumpkin flour; β_{11}= quadratic coefficient of green spinach flour; β_{22}= quadratic coefficient of pumpkin flour; β_{12}= interaction effect of green spinach flour-pumpkin flour; Confident interval (CI) = 95 %.

Protein is one of the major components of body tissues and an essential nutrient for body growth. The protein intake ratio to total energy for the elderly is higher compared to adults, placing the elderly at risk of protein deficiency (National Coordinating Committee on Food and Nutrition, 2017). The accepted value for the safe level of protein intake for an adult is 0.83 g/kg body weight/day with a protein digestibility-corrected amino acid score value of 1.0 (WHO/FAO/UNU, 2007). As shown in Table 2, the protein content of the soft-textured high fibre bar was between 8.11% to 8.59%. These values were higher enough to claim the product as "contains a source of protein" according to Malaysia's Nutrition Labelling and Claims Guidelines, which setting the protein value for solid products should be >5% (Department of Statistics, 2014). It was observed that protein content was not significant (p>0.05) for all test runs in the first order of regression coefficient. This showed that the protein content of the soft-textured high fibre bar had not affected by both green spinach flour and pumpkin flour. Although protein content in green spinach flour was high (28%) (Mokhtar et al. 2018), the percentage level of green spinach flour in the formulation was not enough to affect protein content in the bars. This might be due to the low level of percentage studied. The protein content of soft-textured high fibre bar might be contributed by sweet potato flour and tapioca flour which consist 100% of the formulation (from Baker's percent). Mokhtar et al. (2018) reported protein content for both sweet potato flour and tapioca flour were 8.77% and 1.67%, respectively.

Calcium plays a key role in skeletal mineralization, as well as a wide range of biological functions and is an essential element that is only available to the body through dietary sources (National Coordinating Committee on Food and Nutrition, 2017). Recommended nutrient index (RNI) for calcium is set at 1200 mg/day for women and 1000 mg for men, aged 51 years and above (IOM, 2011). Consuming a soft-textured high fibre bar could supply some of their calcium needs. The calcium content of the soft-textured high fibre bar was in a range of 50.91 mg/100g to 84.13 mg/100g (Table 2). From statistical analyses in Table 3, the calcium content of the bar was positively (p≤0.05) affected by green spinach flour and pumpkin flour. However, the combined effect of green spinach flour and pumpkin flour showed a negative effect on the calcium content of the bar (Figure 2). Mokhtar et al. (2018) reported that green spinach flour contained high calcium with values of 1438 mg/100g. Therefore, the higher the percentage level of green spinach flour in the formulation, the higher the calcium content. The result of increase in calcium content is in accordance with studies of cookies with acha and mung beans flours, and composite wheat bread with maize and orange sweet potato flours (Nanyen et al. 2016; Igbabul et al. 2015).

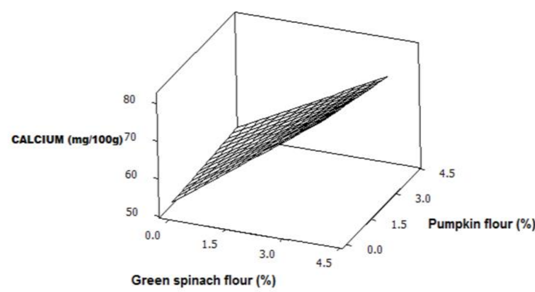

Figure 2: Combined effect of green spinach flour and pumpkin flour on calcium

Vitamin D plays an important role in controlling the absorbance of calcium from the intestine, through direct effects on bone and also through its effects on parathyroid hormone secretion (Holick, 2002). Deficiency of vitamin D in the body would result in decreased bone mineralisation, secondary hyperparathyroidism, and increased cortical bone loss which leads to osteoporosis and hip fractures (Rizzoli and Bonjour, 2004). As shown in data analyses (Table 2), the highest content of vitamin D3 was 22.05 µg/100g and the lowest was 2.25 µg/100g. Statistic results (Table 3) showed that vitamin D3 was significantly (p≤0.05) increased as the percentage level of green spinach flour in formulation increased. However, there was no significant (p>0.05) effect of pumpkin flour on vitamin D3 content. According to Mokhtar et al. (2018), vitamin D3 content in green spinach flour was higher than that in pumpkin flour where the values were 64% and 0.45%, respectively. The smaller amount of vitamin D3 in pumpkin flour might be the reason that vitamin D3 in the bar was not affected by pumpkin flour. Farzana et al. (2017) also reported the increase of vitamin D content in the development of vegetable soup powder with soy flour, mushroom, moringa leaf compared with commercial soup powder without incorporation of vegetables powder.

In order to fulfil the objective to produce a soft-textured high fibre bar, hardness has been analyzed as one of the dependent variables in this study. There was a requirement to determine the suitable values of green spinach flour and pumpkin flour which could contribute to the soft texture that easy to chew. As shown in Table 2, the hardness of the bar was in a range of 5637.87 g/sec to 7239.58 g/sec. The higher values of hardness showed the harder the texture of the bar produced. Results of the test runs on the hardness of soft-textured high fibre bar showed that the bar had softer texture when the percentage level of both flours used was high. As illustrated in Figure 3, the increment of both green spinach flour and pumpkin flour from 0% to 4% would decrease the hardness values. Statistically, the result showed that green spinach flour and pumpkin flour had significantly (p≤0.05) affected the bar hardness, where the value decreased when pumpkin flour and green spinach flour percentage level increased (Table 3). According to Kamaljit Kaur et al. (2017), the changes in texture are related to height differences. Incorporating spinach flour and pumpkin flour in the formulation may lower the density which increased the air pockets, and thereby decreasing the force of compression. Kamaljit Kaur et al. (2017) reported that incorporating banana flour in the formulation of muffin would increase the hardness of the muffin. The same pattern was also found in another study with biscuits supplemented with plantain and chickpea flour (Ritika et al., 2012).

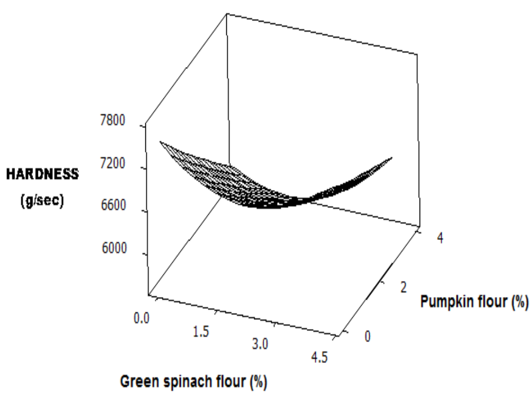

Figure 3: Combined effect of green spinach flour and pumpkin flour on hardness

A result for fracturability analyses of soft-textured high fibre bar showed that the value was varying from 906.39 g/sec to 1221.53 g/sec (Table 2). It was observed that the brittleness of the bar increases as the fracturability value becomes lower. The percentage level of both green spinach flour and pumpkin flour had a significant (p≤0.05) negative effect on bar fracturability (Table 3). The fracture ability decreased as both green spinach flour and pumpkin flour percentage increase from 0% to 4% (Figure 4). Since both green spinach flour and pumpkin flour were also the response variables that affected bar hardness, this could indicate that the softer the bar, the greater its capacity to fracture.

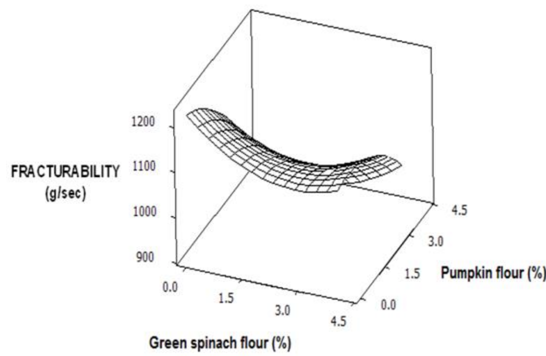

Figure 4: Combined effect of green spinach flour and pumpkin flour on fracturability

Product acceptance analysis was done with 30 male and female untrained elderly respondents aged more than 55 years old. The result showed that the soft-textured high fibre bar was well accepted by the respondents, where the lowest score was 3.8 and the highest was 6.1, out of a seven-point mimic hedonic scale (Table 2). From statistical analyses in Table 3, product acceptance showed a significant (p≤0.05) interaction effect of green spinach flour and pumpkin flour. The acceptability of the bar was increased when spinach flour decreased and pumpkin flour increased (Figure 5). It was observed that the highest score (6.1) for consumer's acceptance was noted initially in the formulation with the highest content of pumpkin flour (4%) without spinach flour (0%). This might be due to the strong bitter taste and unpleasant smell of green spinach flour which influenced product acceptance. Other studies also reported the well acceptance of biscuits incorporated with jackfruit powder, mango seed kernel, black carrot and breadfruit flour (Hosamani et al. 2016; Ashoush and Gadallah, 2011; Turksoy et al. 2011; Olaoye et al. 2007).

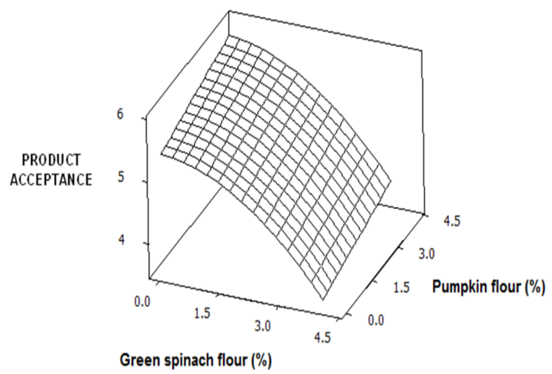

Figure 5: Combined effect of green spinach flour and pumpkin flour on product acceptance

CONCLUSION

The study has shown that the addition of green spinach flour and pumpkin flour to produce soft-textured high fibre bar are not only affecting the nutrient content but also product acceptance by target respondents which was the elderly group. In this study, green spinach flour was the most significant factor to enhance the nutrient content of the product. However, adding green spinach flour at a high level was not appropriate as it had not accepted by respondents. Soft-textured high fibre bar was successfully developed not only as a high total dietary fibre bar but also as a source of the protein product. Besides the elderly, soft-textured high fibre bar may be consumed by others who live in a hectic life that need such convenience food to stock up on stamina, seeking to add muscle and replenish energy for their busy daily routine.

CONFLICT OF INTEREST

The present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this study.

REFERENCES

Academy of Nutrition and Dietetics. (2015). Position of the academy of nutrition and dietetics: Health implications of dietary fiber. Journal of the Academy of Nutrition and Dietetics, 115: 1861–1870.

AOAC (2005). Official Methods of Analysis (15th edition). AOAC International, Arlington, VA, USA.

AOAC (1998). Official Methods of Analysis (16th edition). AOAC International, Arlington, VA, USA.

Ashoush, I.S. and Gadallah, M.G.E. (2011). Utilization of mango peels and seed kernels powders as sources of phyto chemicals in biscuit. World Journal of Dairy Food Sciience, 6(1):35–42.

Baugreet, S., Hamill, R.M., Kerry, J.P., and McCarthy, S.N. (2017). Mitigating Nutrition and Health Deficiencies in Older Adults: A Role for Food Innovation. Journal of Food Science, 82(4), 848-855.

Department of Statistics, Malaysia (2014). Food Act 1983 (Act 281) & Regulations (As at April 2020). Publisher & printed by MDC Publisher Printers.

den Uijl, L.C., Jager, G., de Graaf, C., Meiselman, H.L. and Kremer, S. (2016). Emotion, olfaction, and age: a comparison of self-reported food-evoked emotion profiles of younger adults,oldernormosmic adults, and older hyposmic adults. Food Qual Prefer 48, Part A:199–209.

Farzana, T., Mahajan, S., Saha, T., Nur Hossain, M. and Zahurul Haque, M, (2017). Formulation and nutritional evaluation of a healthy vegetable soup powder supplemented with soy flour, mushroom, and moringa leaf. Food Science Nutrition, 5:911–920.

Figoni, P.I. (2010). How Baking Works: Exploring the Fundamentals of Baking Science. New York: Wiley. pp. 9–11. ISBN 0-470-39267-3.

Hazen, R. (2014). Strategic nutrition for healthy aging technical paper. DSM, Netherlands.

Hegazy, A.I and Ibrahim, M.I. (2009). Evaluation of the nutritional protein quality of wheat biscuits supplemented by fenugreek seed flour. World Journal of Dairy and Food Sciences, 4(2):129-135.

Hickson, M. (2006). Malnutrition and ageing. Postgrad Med J, 82(962):2—8.

Holick, M. (2002). Vitamin D: the underappreciated D-lightful hormone that is important for skeletal and cellular health. Current Opinion Endocrinology Diabetes Obes, 9:87–98.

Hosamani, R., Jagadeesh, S.L., Suresha, G.J. and Tummaramatti, S. (2016). Fortification of carrot, jackfruit and aonla powder to enhance nutritional and sensory qualities of sweet. Journal of Nutritional Health & Food Engineering, 4(3):430–435.

Igbabul, B.D., Iorliam, B.M., and Umana, E.N. (2015). Physico-chemical and sensory properties of cookies produced from composite flours of wheat, cocoyam and African yam beans. Journal of Food Research. 4(2): 150-151.

IOM (2011). Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: TheNational Academies Press.

Kamaljit Kaur, Gurinderpal Singh and Navdeep Singh (2017). Development and evaluation of gluten free muffins utilizing green banana flour. Bioved, 28(2) : 359–365.

Mithal, A., Wahl, D. A., Bonjour, J.-P., Burckhardt, P., Dawson-Hughes, B., Eisman, J. A., El-Hajj Fuleihan, G., Josse, R. G., Lips, P. and Morales-Torres, J. (2009). Global vitamin D status and determinants of hypovitaminosis D. Osteoporos Int., 20:1807–1820.DOI 10.1007/s00198-009-0954-6.

Mokhtar, T.N., Khalid, K.H., Muhamad, N.F.H., Hussin, F. and Hassan, H. (2018). Screening on Nutritional Qualities of Selected Local Vegetables and Tubers Flour.In proceeding National Conference on Agricultural and Food Mechanization (NCAFM) 2018, Pullman Hotel, Kuching, Sarawak, Malaysia, 17-19 April 2018, pg. 280-283. ISBN: 978-967-936-661-7.

Nanyen, D., Dooshima, I.B., Julius, A. and Iorliam, B. (2016). Nutritional Composition, Physical and Sensory Properties of Cookies from Wheat, Acha and Mung Bean Composite Flours. International Journal of Nutrition and Food Sciences, 5(6): 401-406. doi: 10.11648/j.ijnfs.20160506.15

National Coordinating Committee on Food and Nutrition (NCCFN), Ministry of Health Malaysia (2017). Recommended Nutrient Intakes for Malaysia: A Report of the Technical Working Group on Nutritional Guidelines. ISBN: 978-967-12050-4-4.

Olaoye, O.A., Onilude, A.A. and Oladoye, C.O. (2007). Breadfruit flour in biscuit making: effects on product quality. African Journal of Food Science, page 20–23.

Paddon-Jones, D. and Rasmussen, B.B. (2009). Dietary protein recommendations and the prevention of sarcopenia. Curr Opin Clin Nutr Metab Care,12:86–90.

Ribeiro, T.C., Abreu, J.P., Freitas, M.C.J., Pumar, M. and Teodoro, A.J. (2015). Substitution of wheat flour with cauliflower flour in bakery products: effects on chemical, physical, antioxidant properties and sensory analyses. International Food Research Journal, 22(2): 532-538.

Ritika, B.Y., Baljeet, S.Y. and Nisha, D. (2012). Effect of incorporation of plantain and chickpea flours on the quality characteristics of biscuits. Journal of Food Science and Technology, 49(2):207–213.

Rizzoli, R. and Bonjour, J. (2004). Dietary protein and bone health. Journal of Bone and Mineral Research, 19:527.

Shahar, S., Earland, J. and Abd Rahman, S. (2001). Social and health profiles of rural elderly Malays. Singapore Medical Journal, 42(5): 208-213.

Turksoy, S., Keskin, S. and Ozkaya, B., (2011). Effect of black carrot (Daucus carota L. ssp. sativus Var. atrorubens) fiber addition on the composition and quality characteristics of cookies. Journal of Food Agriculture and Environment, 9(3&4):57–60.

Wayne, G. (2009). Professional baking. New York: John Wiley. p. 24. ISBN 0-471-78349-8.

World Health Organization/Food and Agriculture Organization/United Nations University (2007). Protein and Amino Acid Requirements in Human Nutrition Report of a Joint WHO/FAO/UNU Expert Consultation. WHO Technical Report Series no. 935. Geneva: WHO.