

Development of Whole Grain Carrot (*Daucus carota*) Chips

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ABSTRACT

Nutritious, high fiber the whole grain carrot (*Daucus carota*) chips were developed by incorporating whole-wheat flour and carrot (*Daucus carota*) as the main ingredients. Proximate analysis was done, and the results for the average percentage of ash in 5.000 g of whole grain carrot (*Daucus carota*) sample is 17.573 ± 5.099 %, average percentage of fat in 2 g of whole grain carrot (*Daucus carota*) sample is 10.55 ± 2.192 %, average percentage of crude fiber in 1 g of whole grain carrot (*Daucus carota*) sample is 7.5 ± 0.141 %, and its amount is more than targeted recommended fiber intake by Codex Alimentarius on Dietary Fiber in 2009, source of dietary fiber must contain more than 3 g per 100g. Besides, average percentage of crude protein in 0.3 g of whole grain carrot (*Daucus carota*) is chips 2.2178 ± 0.38863 and average percentage of moisture in 10 g of whole grain carrot (*Daucus carota*) chips sample is 3.195 ± 0.233 . The sensory analysis also was carried out to evaluate the acceptance and quality of the food product. Statistical analysis ANOVA was completed to test the hypothesis, and the results is there is a significant difference between in all of the 5 parameters test, which aroma, texture, acceptance, taste and the overall) between the commercialized whole-grain based snack product and the whole grain carrot (*Daucus Carota*) chips (P -value = 0.000). Commercialized whole-grain based snack product obtains high level of consumer acceptance compared to whole grain carrot (*Daucus carota*) chips.

Key words: Whole grain, Carrot, High fibre, Product development, Chip, Snack

INTRODUCTION

Developing food products is a market and customer-driven process. Nowadays, the consumer level of health awareness is increasing and current trends have changed. This is because people have been exposing to various campaigns done by the Ministry of Health Malaysia since 1991. They hear more about the importance of healthy eating, nutrition and diet in maintaining healthy well being and preventing disease.

The increasing awareness of consumer is shown in the changes to their shopping habits and they keenly choose products for their nutritional value and quality. Therefore, there is a need for developing nutrient-dense and high fiber snack. Currently in Malaysia, there is no commercial

cracker and snack product that combines both whole grain and carrot benefits. Thus, this research is to develop a snack product consist of wholegrain and carrot. The purpose of incorporating wholegrain flour and carrot is to increase the fiber content in the chips, and carrots also contain vitamins that are essential to human health, such as Vitamin A.

According to the reports from Euromonitor international, the Malaysian snack food market was valued at RM 630.47 million in 2010 and is increasing tremendously, which has grown up to 10.17% from 2009¹. Besides, according to Norimah *et al.*² from Malaysian Adult Nutrition Survey (MANS), total daily average intake of vegetable is only 1 cup per day, and the total intake of bean vegetable intake is only 1 cup per week. Moreover, according to United Nations Food and Agriculture

Organization (FAO) , it is shown that between 1980 and 2003, vegetable and fruits intake in Malaysia averaged about 78 grams of vegetables and 150 grams of fruits per capita per day³. Nevertheless, a total amount of fruits and vegetable intake of 228 grams per day is lower the 400 grams, or five servings, as recommended by WHO dietary guidelines.

Therefore, there is a need for developing and reforming the mainstream snack food market toward the healthy ones. By incorporating fiber into the snack, this would help to increase the fiber intake. Based on the pilot study done by Voedingscentrum⁴, the nutritional criteria for preferred snack are the saturated fat must less than 4g per 100g and the fiber must contain more than 2 gram per 100g. Besides, according to Codex Alimentarius on Dietary Fiber in 2009⁵, source of dietary fiber must contain more than 3 g per 100g. Although the snack food market looks like saturated, but the opportunities still exist for the production, innovation, and expansion of healthy and value-added snack.

Hence, this wholegrain carrot (*Daucus carota*) chips will consist wholegrain flour and carrots. The aim of this development is to produce whole grain carrots (*Daucus carota*) chips that contain at least 3g per 100g of fiber. The purpose of incorporating wholegrain flour and carrot is to increase the fiber content in the chips. Increasing the intake of high-fiber food could increase the total intake of dietary fiber, preferably whole grains, as recommended by Malaysian Dietary Guidelines 2010. Besides, carrots (*Daucus carota*) also contain vitamins that are essential to human health, such as Vitamin A. This product also will undergo nutritional proximate analysis and sensory evaluation to ensure the nutritional value and their acceptability.

According to Thunstrom⁶, the modern diet nowadays is contains empty calories and fat, and has proven to be a significant risk factor for several types of cancer, diabetes, cardiovascular disease, dental caries and osteoporosis, as well as obesity and overweight. They are the major risk factors of many of these chronic diseases.

Nevertheless, according to Menrad⁷ and Roberfroid⁸ today foods are not only for the purpose to provide essential nutrients, to satisfy hunger for humans but also to improve physical and mental well-being and avoid nutrition-related diseases of the people. During the last decades the people demands in the food and supply chain production has changed prominently. People now believe that foods can affect directly to their health^{9,10}

Therefore, healthier, nutrient-dense snack would play an important role. The increasing cost of healthcare, the steady increase in life expectancy, and the desire of older people for improved quality of their later years, are due to the increasing demand on such foods^{11,12,13}. Plant-based foods, such as vegetables, fruits, and whole grains, contain significant amounts of bioactive phytochemicals. It can deliver essential health benefits to reduce the risk of chronic diseases^{14,15,16}. Food is not just about what we eat, it is beyond the basic nutrition. Whole grains are rich sources of fibre, vitamins, minerals, and phytochemicals including phenolics, carotenoids, phytates, vitamin E, lignans, b-glucan, inulin, resistant starch, and sterols, while carrots (*Daucus carota*) contains essential vitamin for human health, for example, vitamin A.

Besides, consumers know that whole grain as a health-promoting food. In addition to its nutritional effect and benefits linked to its micronutrient and macro composition, it also can give favorable effects on weight management, cardiovascular diseases and diabetes¹⁷. While consumers perceive whole grain as healthy, they consume lesser than the daily recommended allowance. According to Hamaker¹⁸ This is because the lack of whole grain consumption can be classified into three types: (i) accessibility and availability: the lack of availability and accessibility of whole grain goods in usual supermarkets contribute to difficulty for consumers, and hence, reduce their consumption (ii) Texture and taste: consumers are not ready to sacrifice and compromise their taste for health. Foods consists whole grain like as whole meal bread are tasteless, chewy, tough and grainy or with a mealy texture; (iii) Communication with consumers: Whole grain food labeling is often inconsistent and unclear preventing the consumers to correctly recognize whole grain in the market.

Additionally, intake of whole grain has been steadily associated with reduced risk of obesity¹⁹. Cohort studies, prospective and epidemiologic of adult populations have reported an reverse relationship between whole grain intake and changes in waist circumference (WC) and body mass index (BMI) in men and women^{19,20,21}. However, in children, the effects of whole grains on health and illness are uncertain. There is one study by Steffen *et al.*, in 2003, conducted to 357 children in the 5th to 8th grade shown that increased intake of whole grains was linked to lower BMI²². These favorable effects however, the mechanisms are also not significant and clear. This is because of whole grain products contains rich amount of dietary fiber in most countries, it is difficult to isolated out the protection of fiber from whole grains.

Therefore, the aim is to produce a whole grain carrot (*Daucus carota*) chips. Hence, to meet the demand of the consumers that is more health conscious for nutrient-dense food product. The development of this whole grain carrot chips may helps to increase the total intake of dietary fiber by increasing intake of high fiber food. Besides, it has the potential opportunities for commercialization, get into the snack food market, hence, reforming the mainstream snack food market toward the healthy ones. This is due to the changing trends of consumer that actively choose food product based on quality and nutritional value.

MATERIALS AND METHOD

Ingredient selection and development of whole grain carrot (*daucus carota*) chips

Carrot (*Daucus carota*) was taken from Kea Farm, Cameron Highlands, and K.L Country Farm Organics Sdn Bhd supplies the whole grain flour. While, the production of whole grain and carrot chips will be done at Food Preparation Lab in Universiti Teknologi MARA, Puncak Alam campus.

According to Suslow and Cantwell (1998), generally, carrots that are firm, straight from "shoulder" to "tip," sweet with no harsh or bitter taste, smooth with little residual "hairiness," and show no signs of cracking or sprouting is considered as high quality²³. The carrots will be choosed based on above criteria.

The carrots were stored according to Produce Quality and Safety Laboratory USDA. The storage temperature at 0 to 1 °C (32 to 33.8 °F) is crucial to minimalize sprouting and decay during storage. High relative humidity (RH) is essential to prevent desiccation and loss of crispness. The suggested environments for commercial storage are 0 °C (32 °F) with 98 to 100% RH. Under this condition, the carrots can be kept for 7 to 9 months.

The main ingredients of this wholegrain and carrot chips are 60g shredded carrots, 100g whole wheat flour, 2 teaspoon of grated cheese, 2 tablespoon of canola oil, ¼ teaspoon of baking powder, salt (1/4) and garlic (1/4) to taste

The processes are

All ingredients are mixed into dough. After that, the dough is left to set aside for 15 minutes. Then, the dough was grind down to 2mm thick, and is cut 1 inch in length and width. Preheat the oven to 200 °C. Line 2 baking sheet at the tray and put the item carefully. The chips were baked for 15 to 20 minutes or until the chips are brown and crispy. After wholegrain and carrot chips is produced, it was stored in air tight container before undergo proximate analysis.

Proximate analysis

The proximate analysis was carried out in food analysis lab in Universiti Teknologi MARA. Analysis involved is protein determination, using Kjeldhal method and by multiplying the product with the conventional conversion factor of 6.25, the crude protein content is achieved. The crude fat determination was carried out by using Soxtherm system; the lipids are obtained out of the food by continuous extraction with petroleum ether. The ash content was determined according to James (1999). The determination of moisture was carried out and principle is known weight of food sample is dried to constant weight in an oven and the loss of weight is equated to the moisture content of the food. The crude fiber content was determine based on Weende method (AACC, Method 32-10)

Sensory evaluation

The sensory evaluation is conducted to 80 consumer panelist in UiTM Puncak Alam Campus. The 9-point hedonic scale was used in

this evaluation. It is a balanced bipolar measure around neutral at the center with four positive and four negative classes on each side. The categories are characterized with phrases representing various grades of affect and those labels are arranged consecutively to suggest a single range of likes and dislikes²⁴.

Statistical analysis

The data is analyzed by using SPSS 20.0 for Macintosh. The analysis involved is Analysis of Variance (ANOVA) and descriptive statistics.

RESULTS AND DISCUSSION

Proximate Analysis

Table 1.0 shows the results of proximal analysis of Wholegrain Carrot (*Daucus Carota*) Chips.

The results from this study found that average percentage of ash in 5.000 g of whole grain carrot (*Daucus carota*) chip sample is 17.573 ± 5.099 %. Ash is the inorganic deposit residual left behind the water and organic matter have been removed by heating in the presence of oxidizing agents, which provides a measure of the total amount of minerals within a food. The fat content of the chips was contributed by the usage of canola oil and also cheese as the ingredients. Canola oil was used as ingredients in this chip as it has high heat tolerance, and also contains many health benefits. The fat content also may come from the whole wheat flour itself. Average percentage of crude fiber in 1 g of whole grain carrot (*Daucus carota*) sample is 7.5 ± 0.141 %. Therefore, in 100 g of whole grain carrot (*Daucus carota*) chip contain about 7.359 g to 7.641 g of crude fiber. . It is higher than the recommended by Voe-dingscentrum (2006), the nutritional criteria for desired snack are the saturated fat must less than 4g per 100g and the fiber must contain more than 2 gram per 100g and also according to classification Codex Alimentarius on Dietary Fiber in 2009, source of dietary fiber must contain more than 3 g per 100g²⁵.

Sensory Evaluation

Table 2.0 shows the results of sensory evaluation. This sensory evaluation was conducted to 80 consumers panelist in Universiti Teknologi

MARA Puncak Alam, Malaysia. The consumers panelists are consist of students and the university staff itself. Blind testing was done, and panelists were given 2 samples of whole-grain based snack, which are, sample A is the whole grain (*Daucus Carota*) chips, and sample B is the commercialized whole-grains based snack. The panelist does not know the identity of the products and which one is the commercialized whole-grain based snack product. The criteria for the consumer panelist is

Table 1: Proximate analysis of Wholegrain Carrot (*Daucus Carota*) Chips

Component	Method	Unit (%)
Ash	James (1999)	17.573 ± 5.099
Fat	Soxtherm	10.55 ± 2.192
Crude Fiber	Weende (AACC Method 32-10)	7.5 ± 0.141
Crude protein	Kjeldhal	2.2178 ± 0.38863
Moisture		3.195 ± 0.233

Table 2: Results of sensory evaluation^a on 80 panelists

	Sample A ^c	Sample B ^d
Texture ^b	6.175 ± 1.675	7.088 ± 1.647
Acceptance ^b	6.363 ± 1.904	7.125 ± 1.694
Taste ^b	5.800 ± 1.746	7.188 ± 1.744
Aroma ^b	5.713 ± 1.891	7.238 ± 1.857
Overall ^b	6.088 ± 1.773	7.100 ± 1.818

^aThe test was scored on 9-point hedonic scale where 9 (like extremely), 8 (like very much), 7 (like moderately), 6 (like slightly), 5 (neither like nor dislike), 4 (dislike slightly), 3 (dislike slightly), 3 (dislike moderately), 2 (dislike very much) and 1 (dislike extremely)

^b The results from ANOVA shown that all five parameters (texture, acceptance, taste, aroma and overall) have significant difference between the two samples ($P=0.00$)

^cSample A = Whole grain (*Daucus Carota*) chips

^dSample B = Commercialized whole grain-based snack product.

they must have eaten whole grain based product at least once a month. The consumer panelists were given 2 pieces of the sample and have consumed the entire sample.

There are 5 characteristics that have been measured, which are appearance, taste, texture, aroma, and overall acceptability. The evaluation was marked on 9-point hedonic scale where the 9 (like extremely), 8 (like very much), 7 (like moderately), 6 (like slightly), 5 (neither like nor dislike), 4 (dislike slightly), 3 (dislike slightly), 3 (dislike moderately), 2 (dislike very much) and 1 (dislike extremely). Hedonic scale is affective test method, where it is to measure degree of liking or disliking one product to another. Affective method also applies to panelist that are untrained and for product use and testing (Murano, 2003).

For texture, sample a, average score for hedonic scale is 6.175 ± 1.675 compared to sample b, 7.088 ± 1.647 . Commercialized whole grain snack based product scored higher than whole grain carrot (*Daucus Carota*) chips. For the hedonic scale 6; like slightly, and 7, like moderately. Many factors contribute to sensory texture acceptance. It comprises several different kinds of sensation, geometrical, mechanical and "after feel". Besides, food fat and moisture content also play role in texture measurement. Sensory texture also comprises of structure, food molecules and composition of the food²⁶. The commercialized whole grain based snack products uses functional ingredients as texturizing agents, such as pectin. Pectin has functionality of stabilizing and thickening²⁶ and it is widely used in the industry. Pectin enhances the texture of the products. Compared to whole grain carrot (*Daucus Carota*) chips that do not have any added functional ingredients texturing agents.

For acceptance, sample b, the average score for hedonic scale is 7.125 ± 1.694 , compared to sample a, 6.363 ± 1.904 . The commercialized whole grain based snack scored more than whole grain carrot (*Daucus Carota*) chips, which 7, like moderately. The consumer panelists accept like moderately of the commercialized whole grain snack product compared to whole grain carrot (*Daucus Carota*) chips. One of the biggest trials in inventing a new food product is foreseeing how consumers

will acknowledge it. Numerous numbers of factors that contribute to consumer acceptance including packaging, price, and convenience but one key aspect that justifies significant evaluation is the sensory experience that person have with the food. (Reau, 2012)

For taste, sample a, whole grain carrot (*Daucus Carota*) chips scored average of 5.800 ± 1.746 , and sample b, commercialized whole grain based snack products scored 7.188 ± 1.744 . Sample b (commercialized whole grain based snack products) scored higher than sample a (whole grain carrot (*Daucus Carota*) chips). Flavors or taste are the results of chemical interaction between human tongue taste buds. Food flavor hence are the whole combination of mouth feel, odor, taste and trigeminal perception, which includes somatosensory perception (Murano, 2003). Compared to commercial product, whole grain carrot (*Daucus Carota*) chips, does not use any flavour enhancer. Therefore, this suggests that in the future, modification need to be done before commercialization.

For aroma, sample a, whole grain carrot (*Daucus Carota*) chips scored 5.713 ± 1.891 and sample b, commercialized whole grain based snack product scored 7.238 ± 1.857 . Sample b scored higher than sample a, indicates that the consumer panelist more prefer the aroma of sample b, which is commercialized whole grain based snack product. Aroma, in addition to taste, also plays role in the enjoyment of the food. Aroma can be described as the feeling derived from food as translated through the olfaction (sense of odor perception or smell)²⁶.

Overall, sample a, whole grain carrot (*Daucus Carota*) chips scored average of 6.088 ± 1.773 and sample b, commercialized whole grain based snack product score average of 7.100 ± 1.818 . This indicates in overall, consumer panelist like slightly the whole grain carrot (*Daucus Carota*) chips, compared to commercialised whole grain based snack product, which is like moderately, more positive hedonic score.

A whole grain carrot (*Daucus Carota*) chips finally have been produced from whole-wheat

flour and carrot (*Daucus Carota*) basis. This product has been undergone proximal analysis such as determination of ash, crude protein, crude fiber, crude fat, and moisture. Findings are the average percentage of ash in 5.000 g of whole grain carrot (*Daucus carota*) sample is 17.573 ± 5.099 %, while average percentage of fat in 2 g of whole grain carrot (*Daucus carota*) sample is 10.55 ± 2.192 %, average percentage of crude fiber in 1 g of whole grain carrot (*Daucus carota*) sample is 7.5 ± 0.141 %, which is 7.359 g to 7.641 g per 100g and its amount is more than targeted recommended fiber intake by Codex Alimentarius on Dietary Fiber in 2009, source of dietary fiber must contain more than 3 g per 100g²⁵. Besides, average percentage of crude protein in 0.3 g of whole grain carrot (*Daucus carota*) is chips 2.2178 ± 0.38863 and average percentage of moisture in 10 g of whole grain carrot (*Daucus carota*) chips sample is 3.195 ± 0.233 . The sensory analysis also was carried out to evaluate

the acceptance and quality of the food product. Statistical analysis ANOVA was completed to test the hypothesis, and the results is there is a significant difference between in all of the 5 parameters test, characteristic (aroma, texture, acceptance, taste and the overall) between the commercialized whole-grain based snack product and the whole grain carrot (*Daucus Carota*) chips (P -value = 0.000). Besides, commercialized whole-grain based snack product score more points in the hedonic scale, compared to the whole grain carrot (*Daucus Carota*) chips.

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