Development of the triple-c savory snack bar

Nigel Chimbetete, Martha Verghese*, Rajitha Sunkara, Shantrell Willis & Lloyd T. Walker

Department of Food and Animal Sciences, Alabama A&M University, 4900 Meridian Street North, Normal, Alabama 35762, USA

Abstract

The concept of functional foods was derived from the Japanese in the 1980s. Asian countries, such as China and Japan have been utilizing foods for health benefits for centuries. Functional foods are foods that can impact a person's health beyond basic nutrition and may help lower the risk of chronic diseases. Consumption of convenience foods and snacks with functional health benefits is increasing nationwide to accommodate the changing lifestyles and health awareness of the modern consumer. Spices are increasing in popularity and demand among consumers because of their flavor and purported health protecting properties. Spices that are becoming increasingly familiar to the Western palate include cinnamon, cardamom and cloves. The aim of this study was to develop a spicy, savory cereal bar using a combination of selected spices (cinnamon, cardamom, and cloves) at various concentrations. The blend of powdered spices was added at 2.5% and 5% (resulting in two varieties of the bar) of the formulation along with rolled oats, peanuts, honey, and corn syrup. The cereal bars were stored at ambient temperature and evaluated for nutrient content (nutritional label generator software), consumer acceptability (sensory testing) and shelf stability using physiochemical characteristics (texture, pH, color, Aw). The "Spice Bar" (Triple-C Savory Snack Bar) had a brown-colored appearance (top and bottom). For the bar with 2.5% spices, L*a*b* values were 37.57, 9.13 and 17.72. The spice bar with 5% spices was slightly darker with L*a*b* values of 38.65, 9.07 and 23.38. The specific textures of the two bars were very similar with the 2.5% spice bar having a specific texture of 98.6 (N/g) and the 5% bar with a specific texture of 97.9 (N/g). Water activity for the bars ranged from 0.48-0.51 over the 4-week testing period. Though results for sensory evaluation showed high consumer acceptance for both varieties of the spice bar, 90% of the panel preferred the 2.5% spice infused bar over the 5% spice infused bar. Developing a spicy granola or cereal bar may increase consumer options for savory snacks on-the-go with possible health benefits.

Keywords: Functional, Physiochemical, Cinnamon, Cardamom, Cloves, Sensory, Product development.

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Introduction

Functional foods are defined as foods, which not only deliver nutritional benefits to promote the well-being of an individual, but can lower the risk of developing chronic diseases [1-2]. Menrad identified that consumers are becoming more aware of the beneficial effects diet plays and their role in lowering the risk of developing diseases [3]. A study was conducted to develop functional foods in which red palm olein was added to bread and sugar pan cookies to deliver an antioxidative effect from Vitamin E [4]. The inclusion of compounds such as cinnamaldehyde from cinnamon to maintain shelf life, as well as customer acceptability has been studied [5]. Compounds such as tocopherols have been seen to not only serve as health benefitting ingredients, but also as ingredients capable of increasing the shelf life of bread by reducing oxidation [6]. The infusion of phytochemicals into food matrices and packaging material has shown to be vital in controlling the microbial growth. Spices are becoming a popular ingredient in teas, snacks, smoothies and grains [7]. Roussel et al. supported the efficacy of cinnamon in a diet by using human subjects [8]. The study suggested that the consumption of up to 500mg per day of the spice could lead to an enhanced protection against diseases associated with metabolic syndrome. According to Verma SK, et al. cardamom has been used for its medicinal properties including its ability to act as an antioxidant and lower blood pressure [9]. Zheng GQ, et al. described various phytochemicals present in cloves such as eugenol and humulenes and their anticarcinogenic potential [10]. Besides spices delivering a high level of antioxidants and other beneficial health effects, the incorporation of these spices in food products may provide avenues to increase their consumption in western diets. Therefore the objective of the research was to develop a functional food product with a blend of cinnamon, cardamom and cloves and to determine shelf life and consumer acceptability of the product.

Materials and Methods

Bar preparation

Bar preparation is shown in Figure 1.

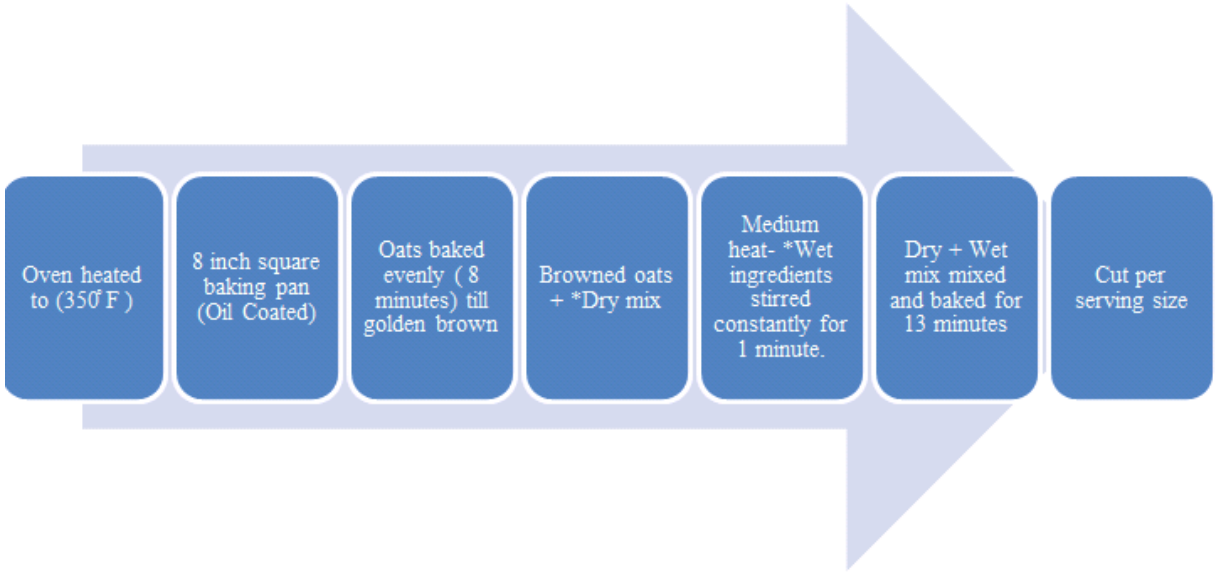


Figure 1: Preparation flow chart for 2.5% and 5% Spice bars

*Dry mix - cranberries, mixed nuts, coconut, flaxseed meal and chocolate, orange extract and orange peel; *Wet mix - peanut butter, honey, oil, spices (cinnamon, cardamom, & cloves) and salt

Table 1: Formulation of 2.5% and 5% Spice Bars

LEVEL 1 (2.5%)		**LEVEL 2 (5%)**	
Ingredients	%	Ingredients	%
Oats	27.70	Oats	24.57
Cranberries	17.12	Cranberries	15.19
Nuts	9.06	Nuts	8.04
Coconut	10.83	Coconut	9.60
Flaxseed	1.46	Flaxseed	1.29
Chocolate	2.77	Chocolate	2.45
Peanut butter	20.15	Peanut butter	17.87
Honey	5.07	Honey	4.46
Oil	1.25	Oil	1.11
Salt	0.25	Salt	0.22
Cinnamon	1.25	Cinnamon	2.23
Cardamom	0.78	Cardamom	1.83
Cloves	0.50	Cloves	1.67
Orange peel	1.78	Orange peel	1.58
Orange extract	1.56	Orange extract	1.11
Corn Syrup	6.20	Corn syrup	6.70
Total	100	**Total**	100

Sensory evaluation

To assess customer acceptability of the developed product, sensory evaluation was conducted, with a total of 35 panelists(13 males and 22 females); randomly selected from Alabama A&M University. Panelists were asked to describe the spice bar's attributes (taste, flavor, texture, overall acceptability), and likelihood to purchase the bar. Sensory evaluation was conducted based on a 5-point Hedonic scale (1= least acceptable; 2= more acceptable; 3= neutral; 4= much more acceptable and 5= most acceptable

Determination of moisture content

The moisture content was determined in triplicates from a composite sample of the bars by [11]. Three grams of the bar were weighed and placed into pre-weighed moisture dishes. The dish with sample was placed in a Fisher Scientific (Pittsburg, PA) Isotemp oven set at 130° C for 60 minutes. The dishes were removed from the oven and transferred quickly to a desiccator to cool to room temperature (25° C). The dishes with the samples were weighed and the moisture content was calculated as

% Moisture = (Loss in weight of sample/Original weight of sample)*100

Analysis was performed in triplicates.

Determination of water activity

A uniform sample of the granola bar was used to obtain the water activity of the bar. The samples were placed into individual dishes and placed into a Hygrolab water activity meter by Rototronic (Hauppauge, NY). Analysis was performed in triplicates.

Color analysis

Color analysis was examined for the top and bottom portions of the spice bar. Color was determined using the ColorFlex EZ colorimeter by Hunter Lab (Reston, VA). 000"L*" represents lightness or darkness, "a*" redness or greenness, and "b*" represents yellowness and blueness "L*" indicates a range of black to white.

Texture analysis

Specific texture of the bar was determined using the TMS-2000 Texture Analyzer by Food Technology Corporation (Sterling, VA). The results are expressed as force in Newton per gram. Analysis was performed in triplicates.

Determination of pH (Acidity of food)

To determine the acidity of the sample, 10grams of sample were placed into a dry Erlenmeyer flask along with100ml of distilled water. The sample was mixed for 30 minutes with frequent shaking. The supernatant was collected and pH name, city and state of the pH meter needed here was measured [11]. Analysis was performed in triplicates.

Statistical analysis

All experiments were conducted in triplicates. Data was analyzed using the SAS 9.1 (2011). Means were separated using Tukey's standardized range test. Level of significance was set at $p \leq 0.05$.

Results

Sensory results

Taste preferences: Results from the sensory evaluation for taste are illustrated in Figure 2. Forty-seven % of the panelists ranked the 2.5% bar to be more acceptable (4) and 44% ranked the taste as neutral (3). Over 30% ranked the 5% bar with a rating of 4 and above.

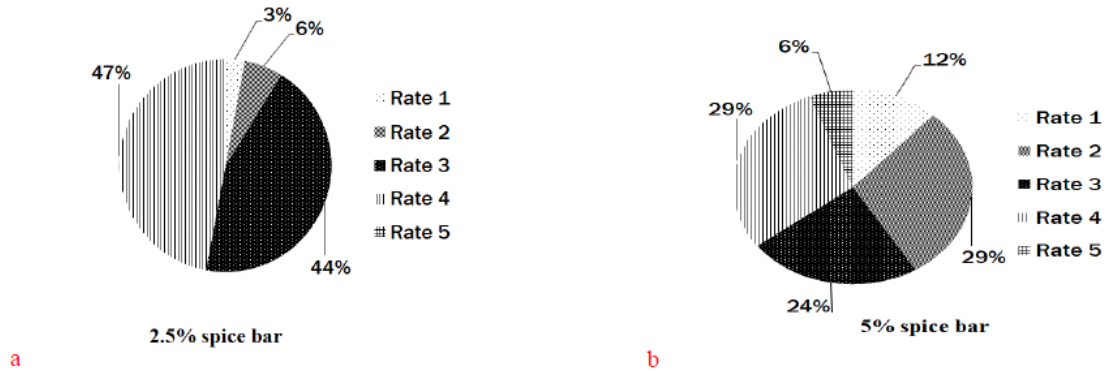


Figure 2(a) and (b): *Taste rating (1: Least acceptable, 2: More acceptable, 3: Neutral, 4: Much more acceptable, 5: Most acceptable) for Triple C Spice Bars (2.5% and 5%)*

Flavor description:

Sensory evaluation for flavor description of the spice bars (2.5% and 5%) is illustrated in Figure 3. The highest percent of panelists (45%) described the flavor as tangy for the 5% spice bar and 39% described the flavor as tangy for the 2.5% level bar. The lowest number of participants (about 10%) ranked the bars to be savory. After tangy, participants ranked the bars as sweet. There was a small (3%) difference in perception of sweetness between the 2 spice bars.

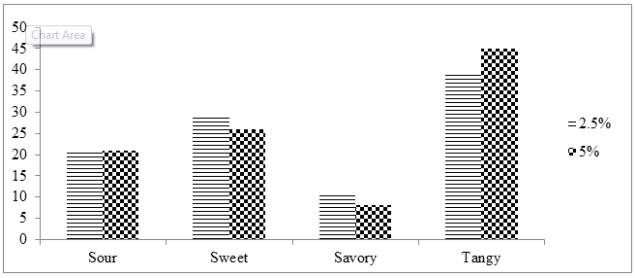


Figure 3: *Flavor acceptance of the Triple C Spice Bars (2.5% and 5%)*

Texture description

The results from the sensory evaluation on texture are shown in Figure 4. Most (72%) of the participants found the 5% spice bar to have a chewy texture compared to the 2.5% bar whereas, only 34% of the participants indicated that the low level spice bar (2.5%) was chewy. Few panelists (6%) described the 5% spice bar as crunchy, however, no participants ranked the 2.5% spice bar as having a crunchy texture. A small number (<10%) of panelists found both bars (2.5% and 5%) as hard.

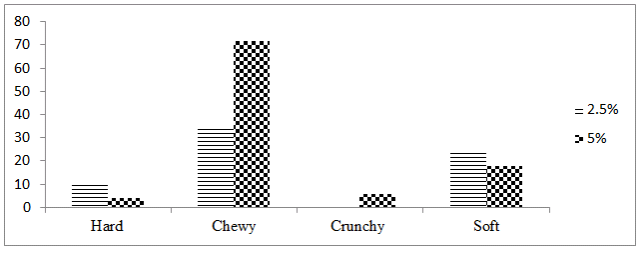


Figure 4: *Texture description for 2.5% and 5% Triple C Spice Bar*

Overall rating of triple C spice bar

The overall acceptability of the 2 spice bars (2.5 and 5%) is shown in Figure 5. The 2.5% spice bar received a ranking of 4 by 47% of the panelists. The 5% spice bar had a total of 41% of panelists rate it a 4 and above. About 41% (2.5%) and 32% (5%) of the panelists reported a neutral (3) rating to the overall acceptability of the bars.

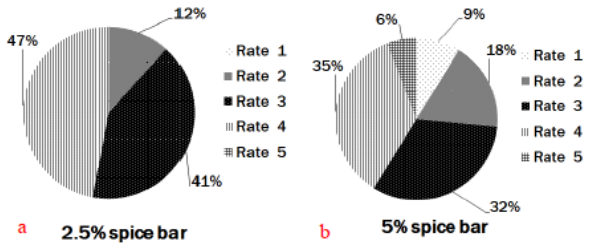


Figure 5 (a) and (b): *Overall acceptability rating (1: Least acceptable, 2: More acceptable, 3: Neutral, 4: Much more acceptable, 5: Most acceptable) of Triple C Spice Bar 2.5% and 5%*

Likelihood of purchasing triple C spice bar

The likelihood of purchasing the 2.5% and 5% spice bars is illustrated in Figure 6. About 25% of the panelists indicated that they would be more or most likely (4 and 5) to purchase the 2.5 and 5% spice bars. About 38% were neutral (3) regarding the purchase intent of the 2.5% spice bar. A higher percent (40) of the panelists indicated not being likely to purchase the 5% spice bar compared to the 2.5% bar (17%).

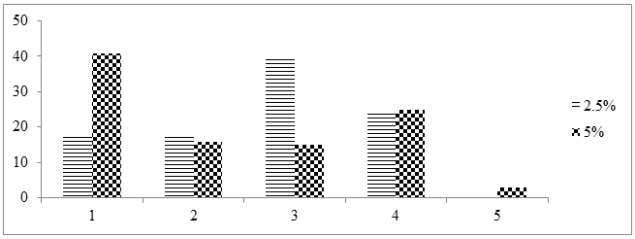


Figure 6: *Likelihood for purchasing Triple C Spice Bar (2.5% and 5%) (Rank 1-5) (1 being not likely, 3 being neutral, and 5 being most likely)*

Meal time and amount of triple spice bar

Sixty-nine percent of the total population of panelists selected the preference of having the bar as a snack. The second highest preference selected was opting to consume the bar as a breakfast item. Forty-six percent of the panelists preferred to buy a package of 4 bars at a $1.50 per pack, while 31% preferred to buy the pack of bars at $0.85.

Physiochemical results

Physiochemical analysis was conducted on the 2.5% and 5% spice bars over a 4-week period. Beginning of Week 1 was the start and lasted until Week 4, as end of the shelf life analysis. Data was collected in triplicates. The physiochemical data collected included specific texture (N/g), L*a* and b* values (both top and bottom of each bar), water activity, moisture content and pH.

Specific texture

Figure 7 shows the specific texture analysis of the spice bars (2% & 5%) over the 4-week shelf life period. Throughout the 4 weeks, the 2.5% spice bar consistently had lower force recordings as compared to the 5% bar. The highest force (228.9 N/g) was seen in the 5% bar in week 2. The lowest (146.5 N/g) was seen in week 1 (2.5% bar). The 5% bar had the highest (204.9 N/g) force peak in week 3. The lowest force required for the 5% bar was seen in week 1 (166.8N/g). The results showed that the hardness of both products increased from week 1 to week 2; however, hardness decreased from week 2-4.

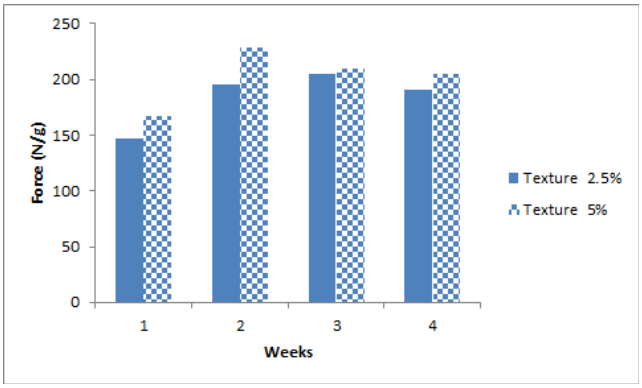


Figure 7: *Specific texture analysis of the spice bars (2% & 5%) over 4 week period*

Color determination of triple C spice bars

Figure 8 shows the L* values for the bottom of the spice bars. The L* value was seen to be highest for the 5% bar on week 2 (38.47) and the lowest L* value for the 5% bar was seen on week 4 (33.56). After week 2, the 5% bar became darker in color. The 2.5% bar consistently became lighter throughout the 4-week testing period. The highest L* value was seen in week 4 (37.86) and the lowest L* value was seen in week 1 (33.95) for the 2.5% spice bar. Figure 8 shows the a* values of the bottom of the spice bars. Throughout the 4-week period the a* values of the 2.5% bar increased marginally from 11.6-12.93. The highest a* value for the 5% bar was seen in week 3 (16.32) and the lowest a* value was seen in week 2 (10.67). The a* values of the 5% bar was very similar in weeks 1 and 2. Figure 8 shows the b* values for the bottom of the spice bars. Throughout the 4-week period, the yellowness of the 2.5% bars increased slightly. The highest b* value of the 2.5% bar was seen in week 1 (24.68). The lowest b* value for the 5% bar was seen in week 3 (20.03). The results show that the bottom of the 5% bar gradually became darker over 4 weeks. Figure 9 shows the L* values for the top of the spice bars. The highest L* value was seen in the 2.5% bar in week 2 (40.62) and the lowest (36.06) was seen in week 1. The results show that the 2.5% bar became lighter throughout the testing period. The 5% bar remained constant over the period tested (4 weeks). Figure 9 shows the a* values for the top of the spice bars. The highest value was seen in week 1 for the 2.5% bar (9.58) and the

lowest was seen in week 2 (8.98). The 5% bar had the highest a* value in week 2 (9.28) and the lowest was seen in week 4 (8.79). The results show that the redness decreased slightly for the 5% bar from week 2 to week 4, whereas, the redness of the 2.5% bar decreased from week 2 and did not change much until week 4. The a* (top) values ranged from a low of 9.58 in week 1 to a high of 8.98 in week 2. Figure 9 shows the b* values for the spice bars (top). The top of both bars did not change much over the period tested. Values for the 2.5% bar ranged from 20.26-22.34, whereas, the 5% bar ranged from 17.15-18.18 over the course of the 4-week period. The b* values (yellowness) stayed fairly constant over the period tested.

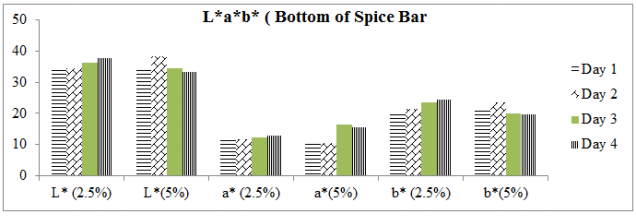


Figure 8: *L*a*b* values for the Top of Spice Bar (2.5% and 5%)*

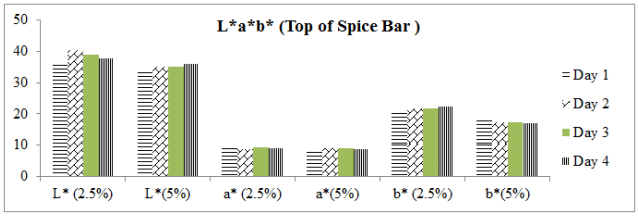


Figure 9: *L*a*b* values for the Top of Spice Bar (2.5% and 5%)*

pH (acidity) of triple C spice bar

Figure 10 shows the pH of the spice bars throughout the 4-week testing period. The pH was highest in week 1 for the 2.5% bar and ranged from a low of 5.54 to a high of 5.61. The pH for the 5% bar remained constant (5.56-5.57) throughout the test period (4 weeks).

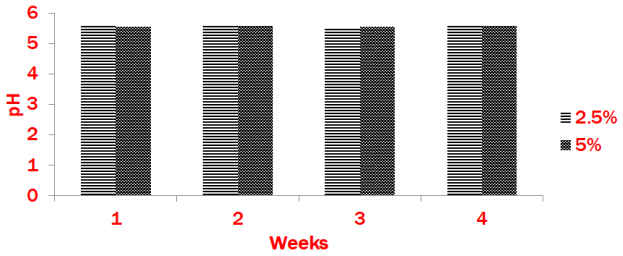


Figure 10: *pH (Acidity) of the Triple C Spice Bars (2.5% and 5%)*

Determination of moisture content for triple C spice bar

Figure 11 shows the changes in moisture content for the spice bars during the 4-week period. Moisture content in the 5% bars decreased throughout the 4 weeks, while the 2.5% bar showed a small increase from week 1 until week 2 and began to decrease over the remaining time. Moisture content stayed the same throughout the week 3 to week 4.

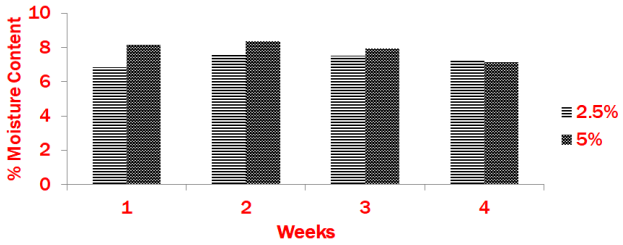


Figure 11: *Moisture Content of the Triple C Spice Bars (2.5% and 5%)*

Determination of water activity for triple C spice bar

Figure 12 shows the water activity (aw) of the spice bars during the 4-week period of shelf life testing. The aw consistently increased for both bars throughout the period. For the 2.5 (0.442) and 5% bar (0.468), the highest was seen in week 4. The lowest aw for the 2.5% bar (0.417) and 5% bar (0.402) was seen in week 1. The arranged from 0.417 to 0.442 (2.5%) and 0.402 to 0.468 (5%) over the 4-week period of testing.

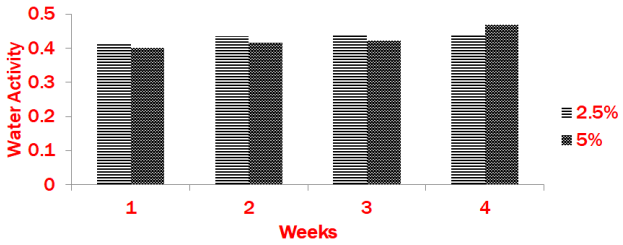
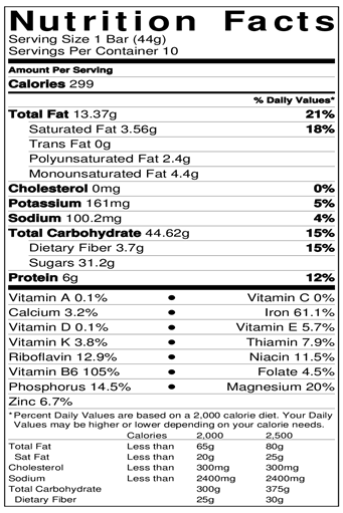


Figure 12: *Water activity of the Triple C Spice Bars (2.5% and 5%)*



Nutrition Facts

Serving Size 1 Bar (44g)
Servings Per Container 10

Amount Per Serving

Calories 299

	% Daily Values*
Total Fat 13.37g	**21%**
Saturated Fat 3.56g	**18%**
Trans Fat 0g	
Polyunsaturated Fat 2.4g	
Monounsaturated Fat 4.4g	
Cholesterol 0mg	**0%**
Potassium 161mg	**5%**
Sodium 100.2mg	**4%**
Total Carbohydrate 44.62g	**15%**
Dietary Fiber 3.7g	**15%**
Sugars 31.2g	
Protein 6g	**12%**

Vitamin A 0.1%	•	Vitamin C 0%
Calcium 3.2%	•	Iron 61.1%
Vitamin D 0.1%	•	Vitamin E 5.7%
Vitamin K 3.8%	•	Thiamin 7.9%
Riboflavin 12.9%	•	Niacin 11.5%
Vitamin B6 105%	•	Folate 4.5%
Phosphorus 14.5%	•	Magnesium 20%
Zinc 6.7%		

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Figure 13: *Triple C Spice Bar Nutritional Label for 5% level Triple C Spice Bar*

Discussion

For taste evaluation of the spice bars, results from the present study suggested that both (2.5% and 5%) spice bars were acceptable by panelists. This may have been attributed to the age group of young adults - 69% (15 to 25) years willing to try new/different foods. The new food trends are leaning towards satisfying younger generations, eager to experience new flavors. Improving the overall taste of the spice bars may further motivate individuals to consume functional foods.

The changes in the color of the bar may have been attributed to the baking process and evidence also supports that ingredients and formulation factors influence the browning intensity [12]. The participants in this study were given the opportunity to describe the taste of the bars. The results showed that 45% of the participants described both bars to possess a tangy flavor and 26% of the individuals described the bar to have a sweet taste. A product development project involving sugar and coconut products was conducted by Satyanarayana Rao TS, et al. and their results showed that the sweetness of the product was attributed to the presence of cardamom; however, the tangy taste perceived maybe attributed by the presence of the orange peel which was used to minimize the pungency of cloves [13].

In the sensory evaluation, participants were asked to evaluate the texture of the product. About 50% of the participants described the texture as very acceptable. This result correlated with the description of the bar as chewy, which may have been due to the familiar chewy feel of a regular "already on the market bar" that contains fruits and peanut butter.

The results of the moisture determination of the products showed that the minimal changes in the bar may have been caused by the oven dried oats which may have absorbed and desorbed moisture during the shelf life period. The loss in moisture near the end of the shelf life testing could suggest that the bar can easily fracture. A loss in moisture according to research reported by Parn OJ, et al would affect the texture of the end product [14]. In the sensory evaluation, participants were asked to evaluate the likelihood to purchase the spice bar and 47% ranked it 3 (neutral). One of the major challenges that the food industry faces is the ability to offer functional foods, which contain unfamiliar tastes and finding ways to increase acceptance of the product. In many cases, individuals will prefer a better tasting food product than a healthy food product. Research conducted by Larson N, et al. on the increase of the demand of snack foods could explain similar results which are obtained from our survey for time of consumption of the bar [15]. The participants were asked to decide the time of consumption of the bar and most individuals (65%) preferred having the spice bar as a snack or breakfast. As indicated in Figure 13, the bar is a good source of Vitamin B, iron, carbohydrates and proteins making it a viable option as a breakfast food. This may have been influenced by the habitual consumption of cereals. None of the participants suggested consuming the bar as a meal replacement, as the size of the bar may not have been sufficient enough for supplementation of the diet.

Conclusion

In the efforts to continue making new flavors and blends, the levels of spices in foods should be carefully monitored and tested to be made acceptable by a large group of consumers. Implementing a granola bar that contains 5% total spices may have potential health benefits to individuals if consumed regularly. With the high acceptance of the Triple C spice bar, it is a step forward in the development of functional food products that offer health benefits, as well as an acceptable taste and aroma. Further studies will need to be conducted in order to identify the specific age groups, gender and health conditions for the inclusion of the spices in products to increase consumption in the western world.

Acknowledgements

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***Correspondence to:**

Martha Verghese

Department of Food and Animal Sciences

Alabama A&M University

USA

Tel: 2563724175

E-mail: martha.verghese@aamu.edu