PROXIMATE AND SENSORY EVALUATION OF SNACK BARS MADE FROM WATER YAM AND OAT SPICED WITH CINNAMON AND MUSTARD SEED

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ABSTRACT

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| **Aims:** To produce snack bars from water yam and oat spiced with cinnamon and mustard seed, to determine the proximate composition of the snack bars and to rate the sensory attributes of the snack bars.  **Study design:** Quantitative and laboratory experiment  **Place and Duration of Study:** Department of Food Science and Technology, Nnamdi Azikiwe University, Awka.  **Methodology:** We applied a mixture design matrix in completely randomized design (CRD) layout which yielded 8 samples and 2 controls. The formulations are: W100 (Water yam 100%), O100 (Oat 100%), WC90 (Water yam 90; Cinnamon 10), WC5 (Water yam 95: Cinnamon 5), OC10 (Oat 90: Cinnamon 10), OC5 (Oat 95: Cinnamon 5), WM10 (Water yam 90: Mustard seed 10), WM5 (Water yam 95: Mustard seed 5), OM10 (Oat 90: Mustard seed 10) and OM5 (Oat 95: Mustard seed 5). The proximate evaluation was determined using AOAC (2015). The sensory evaluation was carried out using 25 semi-trained panelists and rated for appearance, taste, flavour, texture, crispiness and overall acceptability on a 9-point hedonic scale.  **Results:** The proximate composition of the snack bars had moisture content of 2.83-7.33%, ash content of 1.80-4.00%, fat content of 0.30-1.50%, fibre content of 3.33-12.33%, protein content of 0.21-0.89% and carbohydrate content of 74.79-87.23%. The sensory evaluation of the snack bars showed that snack bars with oat formulations were more preferred in appearance, taste, flavour, texture, crispiness and overall acceptability when compared to their water yam counterparts on the 9-point hedonic scale. The controls W100 (Water yam 100%), O100 (Oat 100%) were the least preferred on all parameters evaluated for the sensory properties.  **Conclusion:** This study revealed that snack bars can be made from Water yam, Oat, Cinnamon and Mustard seed. Analytically, the proximate composition showed a low protein, low fat, high fibre composition. Sensory evaluation revealed that the oat sample blended with mustard seed of 5% was the generally accepted on appearance, texture, taste, crispiness and flavour. |

*Keywords: Snack bar, diabetes, proximate composition, sensory evaluation*

1. INTRODUCTION

Snack bars are ready-to-eat baked products made with a variety of ingredients such as granola, oats, [chocolate](https://bakerpedia.com/ingredients/chocolate/), dried fruits, nuts, [coconut oil](https://bakerpedia.com/ingredients/coconut-oil/), honey, peanut butter, or others. Portability and nutrition are the main characteristics of snack bars. Consumers view them as a great alternative to highly caloric baked products when looking for nutritious and fulfilling snacks.Snack bars can be classified into three main groups:health and wellness snack, organic snack bars, and energy and nutrition bars (Yadav, 2020). These are ready-to-eat confections that are compact, versatile and convenient sources of carbohydrates, proteins and fats (Ayad *et al*., 2020). Water yam (*Dioscorea alata*), also known as winged yam, is one of the most economically significant yam species, serving as a staple food crop in tropical and subtropical regions (Neina, 2021). Water yam has a low glycemic index due to its low sugar content, which is necessary for diabetic patients (Udensi *et al*., 2010). This yam species is widely grown because of its favorable agronomic qualities and quality attributes, including high yield, better tuber storability and tolerance to non-staking circumstances (Neina, 2021). Oats (*Avena sativa*) are a [nutrient](https://en.wikipedia.org/wiki/Nutrient)-rich food associated with lower blood [cholesterol](https://en.wikipedia.org/wiki/Cholesterol) and reduced risk of human [heart disease](https://en.wikipedia.org/wiki/Heart_disease) when consumed regularly (Whitehead *et al*., 2014). Oats are a nutrient-rich whole grain with a balanced composition of carbohydrates, protein, and fat, plus a good source of fiber, particularly beta-glucan. The beneficial effect of oat consumption on lowering blood lipids is attributed to [oat beta-glucan](https://en.wikipedia.org/wiki/Oat_beta-glucan). Oat consumption can help to reduce [body mass index](https://en.wikipedia.org/wiki/Body_mass_index) in [obese](https://en.wikipedia.org/wiki/Obesity) people (Llanaj *et al*., 2022).

Cinnamon has been used as a spice in several cultures for centuries (Teuscher, 2003). In addition to its culinary uses, cinnamon has been employed as a stomachic and carminative for gastrointestinal complaints as well as other ailments and is still used for these conditions in many countries. Cinnamon has a long-standing reputation as a healing agent. The spice has been credited with antibacterial, antimicrobial, antioxidant, and anti-inflammatory properties (Teuscher, 2003). Mustard seeds ([*Brassica nigra*](https://en.wikipedia.org/wiki/Brassica_nigra)) is used as a condiment in sandwiches and other dishes. Cinnamon is low in calories and carbohydrates but contains trace amounts of various vitamins and minerals. It's also a good source of fiber and antioxidants (USDA, 2024).  Mustard seeds are first ground into a powder and then mixed with other ingredients to create this condiment. These nutrients contribute to overall health, including boosting immunity, supporting bone health, and potentially reducing the risk of chronic diseases (Longvah *et al*., 2017). Mustard seeds are good source of oil and protein. Mustard seeds have a pungent aroma. It is normally used as condiments but its medicinal value also was recognized by Pythagoras as a remedy for scorpion bites and snake bites (Thomas *et al*., 2004).

This research aims to develop a diabetic-friendly snacks for diabetics. According to an article by World Health Organization (2019) titled Diabetes country profile: Nigeria, Nigeria has the highest incidence of diabetes in sub-Saharan Africa. The WHO estimated a 4.3% prevalence of diabetes in Nigeria in 2016. Due to the surging rate of diabetes, this research is focused on developing a diabetic-friendly snack bar from food materials. The production of diabetic food products from locally sourced ingredients such as water yam, oat, cinnamon, and mustard seed presents a promising solution to this problem.

This work was centered on evaluating the proximate composition and rating the sensory properties of the snack bars. This research was designed to compare the nutritional effect of each of the spices on the different flours used.

2. material and methods

Fresh and wholesome Water yam, cinnamon, oat and mustard seed were procured from local markets in Awka, Anambra state. The ingredients were cleaned, processed and blended in varying ratios to produce ten different formulations of snack bars. The formulations are: W100 (Water yam 100%), O100 (Oat 100%), WC90 (Water yam 90; Cinnamon 10), WC5 (Water yam 95: Cinnamon 5), OC10 (Oat 90: Cinnamon 10), OC5 (Oat 95: Cinnamon 5), WM10 (Water yam 90: Mustard seed 10), WM5 (Water yam 95: Mustard seed 5), OM10 (Oat 90: Mustard seed 10) and OM5 (Oat 95: Mustard seed 5).

Standard methods were employed to determine the proximate composition (AOAC, 2015).

A panel of 25 semi-trained panelists evaluated the samples for appearance, taste, flavour, crispiness, texture and overall acceptability using a 9-point hedonic scale (Mihaela, 2023).

3. results and discussion

3.1 proximate composition of snack bars

The proximate composition as shown in Table 1 had moisture content of the snack bars with range from 2.83-7.33 %. Sample OM5 (Oat 95: mustard seed 5) had the highest moisture while sample O100 (100 % Oat) had the least moisture content. Samples WM10 (Water yam 90; Mustard seed 10), WM5 (Water yam 95; Mustard seed 5) and OM10 (Oat 90; Mustard seed 10) differed significantly (*p*˂.05) from the rest of the samples but not from each other. Also, samples WC5 (Water yam 95; Cinnamon 5) and OC5 (Oat 95; Cinnamon 5) differed significantly (*p*˂.05) from the rest of the samples but not from each other. According to Masooma *et al*. (2018) on the addition of oat enhanced the physico-chemical, nutritional and sensory qualities of date fruit based snack bars complemented with oats, the moisture content ranged from 8.3-28.1% showing a higher percentage of moisture of the snack bar as compared to that of this research. As shown inTable 1, the ash content of the snack bar ranged between 1.80-4.00 %. Sample W100 (100 % Water yam) had the least ash content while sample OC5 (Oat 95: Cinnamon 5) had the highest ash content value. Sample OC5 (Oat 95; Cinnamon 5) differed significantly (*p*˂.05) from the rest of the samples. This result was similar to that gotten from Masooma *et al*. (2018) on the addition of oat enhanced the physico-chemical, nutritional and sensory qualities of date fruit based snack bars complemented with oats with ash content ranging from 1.4-4.5%. The fat content of the snack bar ranged from 0.30-1.50 % as shown in Table 1 which was lower when compared to 0.5-8.6 % fat content value of Ujong *et al*. (2023) on formulation of fiber enriched crackers biscuits: effect on nutritional composition, physical and sensory properties had fat content of range 12.28-13.72 %. Given that this research is focused on developing a diabetic friendly snack, materials that were high in fat were completely avoided in the formulation of this snack. Samples O100 (100 % Oat) had the least fat content and was significantly (*p*˂.05) different when compared to the rest of the samples while samples WM10 (Water yam 90: Mustard seed 10) and WM5 (Water yam 90: mustard seed 5) had the highest fat content and were not significantly (*p*˃.05) different from each other. The very low fat content observed in this research makes it an ideal snack for diabetes.

The fibre content of the snack bar ranged from 3.33-12.33 % as shown in Table 1. Samples W100 (100 % Water yam) which was the control for this study had the least fibre content when compared to the rest of the samples and was significantly (*p*˂.05) different from the rest of the samples. All the samples differed significantly (*p*˂.05) from each other. The report according to Ahmed *et al.* (2022) in his study on the impact of addition of oats (*Avena sativa*) and cinnamon on cookies and their biological effects on rats treated with cirrhosis by CCL4, reported the fiber content of the different snacks ranged from 0.74-3.24 % respectively which were lower compared to the result of this research. The high fibre content of this snack bar was as a result of the oat used in this formulation as it is fibrous in nature (Sterna *et al*., 2016) because as the quantity of oat increased, the fibre content increased as well.

**Table 1: Proximate composition (%) of the snack bar samples**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sample | Moisture | Ash | Fat | Fibre | Protein | Carbohydrate |
| W100 | 3.67de±0.58 | 1.80d±0.20 | 0.35de±0.05 | 3.33i±0.28 | 0.21e±0.01 | 90.64a±0.39 |
| O100 | 2.83e±0.29 | 2.67cd±0.23 | 0.30e±0.00 | 8.87e±0.12 | 0.72b±0.03 | 84.61cd±0.10 |
| WC10 | 5.33bc±0.58 | 2.00d±0.00 | 1.00b±0.00 | 4.00h±0.00 | 0.44cd±0.00 | 87.23b±0.58 |
| WC5 | 4.33cd±0.58 | 3.00bc±0.00 | 0.67c±0.29 | 5.67g±0.12 | 0.46c±0.00 | 85.87bc±0.40 |
| OC10 | 4.00cde±1.00 | 2.33cd±0.58 | 0.50d±0.00 | 10.87d±0.12 | 0.89a±0.01 | 81.41e±0.52 |
| OC5 | 4.67cd±0.58 | 4.00a±0.00 | 0.50d±0.00 | 11.67c±0.12 | 0.45c±0.01 | 78.71f±0.46 |
| WM10 | 6.33ab±0.58 | 2.67cd±0.58 | 1.50a±0.00 | 6.00f±0.00 | 0.43d±0.01 | 83.07d±0.99 |
| WM5 | 6.67ab±0.58 | 2.33cd±0.58 | 1.50a±0.00 | 4.00h±0.00 | 0.44cd±0.00 | 85.06c±1.00 |
| OM10 | 6.67ab±1.53 | 2.00d±1.00 | 1.00b±0.00 | 11.93b±0.12 | 0.89a±0.01 | 77.51f±2.24 |
| OM5 | 7.33a±0.58 | 3.67ab±0.58 | 1.00b±0.00 | 12.33a±0.12 | 0.88a±0.00 | 74.79g±1.10 |

Values are mean ± standard deviation of triplicate determinations. Values in the same column bearing different superscript differed significantly (*p*˂.05).

As shown in Table 1, the protein content of the snack bar ranged from 0.21-0.89 % which presents a very low protein snack bar. The materials used for this study had very little or no protein, hence the result of this research. Samples W100 (100 % Water yam) had the least protein content when compared to the rest of the samples and differed significantly (*p*˂.05) from the rest of the samples whereas samples OC10 (Oat 90: Cinnamon 10) and OM10 (Oat 90: Mustard seed 10) had the highest protein content and did not differ significantly (*p*˃.05) from each other. The report by Ubbor *et al*. (2021) on quality evaluation of shortbread biscuits produced from water yam-wheat flour blends recorded 11.02-12.04% protein content which is higher than that of this research, this could be as a result of the added ingredients used in the production of the various baked snacks.

From the proximate composition of the snack bar shown in Table 1, the carbohydrate content ranged from 74.79-87.23% which was similar to the study by Masooma *et al*. (2018) on the addition of oat enhanced the physico-chemical, nutritional and sensory qualities of date fruit based snack bars complemented with oats with carbohydrate range of 67.5-92.7%. The high carbohydrate value could be attributed to the materials used in the formulation of these snack bars, hence it can be called energy-giving snack bars.

**3.2: Sensory evaluation of snack bars**

The appearance of the snack bar as shown in Table 2 ranged from 1.00-7.20. Sample OC10 (Oat 90: Cinnamon 10) was the most preferred in appearance compared to the rest of the samples. Sample W100 (100% Water yam) had the lowest preference in appearance and was significantly (*p*˂.05) different from the rest of the samples. The taste of the snack bar ranged from 1.00-6.44 as shown in Table 2 with sample OM5 (Oat 95: Mustard seed 5) having the best taste as it was liked slightly. The two controls samples W100 (100% Water yam) and O100 (100% Oat) were disliked extremely and disliked very much respectively on the 9-point hedonic scale. The flavour of the snack bar as represented in Table 2 showed that the score ranged from 1.92-7.20. The result showed that sample OM5 (Oat 95: Mustard seed 5) had the best flavour and was significantly different (*p*˂.05) from the rest of the samples. For texture, the snack bar samples ranged from 2.76-6.68. Samples WM10 (Water yam 90: Mustard seed 10), WC10 (Water yam 90: Cinnamon 10) and WC5 (Water yam 95: Cinnamon 5) were disliked moderately and differed significantly (*p*˂.05) from the rest of the samples as shown in Table 2.

**Table 2: Sensory evaluation of snack bars**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Samples | Appearance | Taste | Flavour | Texture | Crispiness | Overall Acceptability |
| W100  O100  WC10 | 1.00d±0.00  3.00c±0.00  4.32b±2.14 | 1.00d±0.00  2.00c±0.00  3.16b±1.82 | 1.92e±0.57  1.84f±0.37  4.88cd±2.55 | 2.76f±0.44  3.00ef±0.00  3.72d±1.70 | 1.96f±1.74  3.00e±0.00  3.68de±1.49 | 1.76e±0.44  1.00e±0.00  3.96d±2.15 |
| WC5 | 4.16b±1.68 | 3.80b±1.78 | 4.12de±1.88 | 3.56d±1.45 | 3.48e±1.61 | 4.52cd±1.56 |
| OC10 | 7.20a±0.96 | 5.72a±1.67 | 5.52bc±2.63 | 5.36bc±1.47 | 4.88bc±1.62 | 6.24b±1.64 |
| OC5 | 6.96a±1.27 | 5.64a±1.75 | 5.88bc±2.20 | 5.52b±1.29 | 5.00b±1.76 | 6.44b±1.29 |
| WM10 | 4.00b±1.63 | 3.36b±1.70 | 3. 40e±2.18 | 3.52d±1.56 | 3.96cde±1.67 | 4.16cd±2.06 |
| WM5 | 4.52b±1.76 | 3.92b±1.91 | 3.84de±1.91 | 4.60c±1.61 | 4.56bcd±1.47 | 5.00c±1.44 |
| OM10 | 7.00a±1.38 | 6.08a±1.73 | 6.52ab±1.45 | 6.16ab±1.52 | 6.72a±1.65 | 7.12ab±1.64 |
| OM5 | 7.12a±1.48 | 6.44a±1.87 | 7.20a±1.63 | 6.68a±1.46 | 7.36a±1.75 | 7.56a±1.45 |

Values are mean ± standard deviation of triplicate determinations. Values in the same column bearing different superscript differed significantly (*p*˂.05)

Sample OM5 (Oat 95: Mustard seed 5) was the most preferred and was significantly different (*p*˂.05) from the rest of the samples. The crispiness of the snack bar samples as shown in Table 2 ranged from 1.96-7.36 on the 9-point hedonic scale. Samples OM5 (Oat 95: Mustard seed 5) was the most preferred for crispiness and liked moderately when compared with the rest of the samples. Sample W100 (100 % Water yam) was the least preferred and disliked extremely compared to the rest of the samples differing significantly (*p*˂.05). On overall acceptability, the snack bar samples ranged from 1.00-7.56 as shown in Table 2. Samples OM5 (Oat 95: Mustard seed 5) had the best acceptability, liked moderately and was significantly (*p*˂.05) different from the rest of the samples followed by sample OM10 (Oat 90: Mustard seed 10) which was also liked moderately and significantly (*p*˂.05) different from the rest of the samples. Samples OC10 (Oat 90: Cinnamon 10) and OC5 (Oat 95: Cinnamon 5) were significantly (*p*˂.05) different from the rest of the samples but not significantly (*p*˂.05) different from each other and they were liked slightly. Sample WM5 (Water yam 95: Mustard seed 5) was significantly (*p*˂.05) different from the rest of the samples and was neither liked nor disliked. The controls W100 (100% Water yam) and O100 (100% Oat) were the least preferred on all the parameters evaluated for the sensory properties. The formulations with oat were more preferred when compared to the rest of the samples.

4. Conclusion

This study revealed that snack bars can be made from Water yam, Oat, Cinnamon and Mustard seed. Analytically, the proximate composition showed a low protein, low fat, high fibre composition. Sensory evaluation revealed that the oat sample blended with mustard seed of 5% was the generally accepted on appearance, texture, taste, crispiness and flavour.

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