



PRODUCTION AND QUALITY ASSESSMENT OF SUSTAINABLE PROTEIN RICH AND HIGH-ENERGY VEGAN COOKIES MADE UP OF WHOLE WHEAT, CORN COB FLOUR, BEETROOT POWDER AND SPIRULINA POWDER

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ABSTRACT

In this study the main objective was to produce sustainable protein rich and high energy vegan cookies. These enriched cookies were produced using whole wheat flour, corn cob flour, beetroot powder, spirulina blend in the ratios 100:0:0:0, 70:10:10:10, 55:15:15:15, 40:20:20:20 and were labelled as A, B, C and D respectively. Sample A served as control sample. The nutritional compositions, and sensory quality of the enriched cookies were evaluated. On dry weight basis, protein, fiber and ash increased from 8.75 to 24.65, 3.29 to 5.73 and 2.15 to 2.95 respectively, whereas carbohydrate decreased from 70.45 to 23.71% with increased substitution of con cob flour, beet root powder and spirulina powder. There were significant differences ($p < 0.05$) in sensory attributes analysed. Samples B with 10% substitution of each corn cob flour, beet root powder and spirulina powder with 70% whole wheat had the best overall acceptability ratings of 8.60. In conclusion, enriched cookies are superior in nutrition. Thus, the enriched vegan cookies can conveniently be regarded as a balanced whole meal.

KEYWORDS: Cookies, corn cob, beet root, spirulina, nutritional compositions and sensory quality.

INTRODUCTION

A cookie is an ignited or cooked snack or goody that's usually small, flat, and sweet. It generally contains flour, sugar, egg, and some type of oil, fat, or butter. Cookies, known in the United Kingdom as a type of biscuits but more generally appertained to as. "cookies" in USA is regarded as sweet- food with low moisture content (Albert, 2019). Cookies are nutritional snacks attained from single or compound dough which has been converted into digestible and more luscious products through the action of heat in the roaster (Singh et al, 2020). Cookies are classified grounded on the component composition and processing ways (Albert, 2019).

Wheat is one of the most important staple foods for humans (Akhtar et al., 2018). Whole wheat flour (WWF) is the powder obtained from the milling of wheat other than durum. It contains the natural kernel proportions of bran, endosperm, and germ (Mannay and Shadaksharaswany, 2019). Generally, the whole grain is milled to leave just the endosperm for white flour, while the by- products of bran and origin are discarded. It has been shown that the whole grain is a concentrated source of essential nutritive factors similar as vitamins, minerals, protein, fat, and fiber while the refined grain is substantially starch (Potter and Hotchkiss, .2016; Bakke and Vickers, 2017). Wheat thus, is maybe the most popular energy grain. for the product of confectionary products, because of the unique parcels of its protein (gluten) which combines strength and pliantness needed to produce chuck, cookies, galettes and similar as spaghetti, fop and polls of desirable texture and flavour (Potter and Hotchkiss, 2016; Akhtar et al., 2018).

The need for strategic development in the use of affordable original resources in the product of chief foods has been promoted by associations similar as the Food and Agricultural Organization (FAO) and the United Nations exile feeding programs (FAO/ WHO, 1994; Awogbenja and Ndife, 2019). This led to the initiation of the compound flour program, the ideal of which was to seek ways of substituting flours, and protein concentrates from indigenous crops, for as much wheat as possible in baked products (FAO/ WHO, 1994). This is because combining with SCP (Spirulina) is anticipated to mainly ameliorate the protein efficiency rate (PER).

Corn cob is the center or core part which is woody elongated in which corn grains are embedded, and it's also called corn pipe. Usually, this is considered as an agriculture waste. It contains dietary fiber, carbohydrate, starch, and protein. *Spirulina platensis* is one sort of spiral cyanobacteria microalgae which is found in Indonesian saline waters and fresh waters. It is rich in protein, vitamins, minerals, carotenoids, and antioxidants which will help protect cells from damage. It contains nutrients, including B-complex vitamin vitamins, beta-carotene, vitamin E, manganese, zinc, copper, iron, selenium, and gamma omega-6 fatty acid (an essential fatty acid). Test tube and animal studies suggest spirulina may boost the system, help protect against allergies, and have antiviral and anticancer properties.

A beetroot is the taproot part of a beet plant, and known as the table beet, garden beet, red beet, regale beet or golden beet. A Raw beetroot content 88% water, 10% carbohydrate, 2% protein, and lower than 1% fat. In a 100-gram (3 1/2-ounce) amount supplying 180 kilojoules (43 kilocalories) of food energy, raw beetroot is a rich source (27 of the Daily Value-DV) of folate and a moderate source (16 DV) of manganese, with other nutrients content.

Veganism is a way of living in which people exclude all forms of animal exploitation and cruelty and they choose not to consume dairy, eggs, or any animal products. So, a vegan diet contains only plants (such as vegetables, grains, nuts, and fruits) and foods made from plants.

The simplicity and ease of production makes cookies the best choice as excellent carriers of a mix of different and promiscuous functional constituents, without egregious denigration from the sensitive quality and shelf stability of the attendant products, therefore, cookies can be formulated into food a product that contains all the nutrients demanded by the body (Albert, 2019). Thus, this reverie intends to produce whole meal enhanced cookies of high energy, protein and fiber contents from flours attained from whole wheat flour, beetroot, corn cob, and spirulina (SCP) and to estimate the nutritive, microbial quality and sensory acceptance.

MATERIAL AND METHODS

The whole wheat flour, corns used for this study were purchased from local market of Phagwara and the beetroot powder, vegan butter and spirulina were purchased from online website.

Preparation of corncob flour

The corn kernels were removed from the corn cob and the cobs were cut into uniform pieces using the cutter and were later dried in the tray drier at 60°C. The dried cobs were grinded using grinder and sieved into fine flour.

Preparation of Cookies

The whole wheat flour and other raw materials was mixed in several ratios and labeled as A, B, C and D. Sample A served as control. The composite flours were blended with other baking ingredients (Table 1) in a mixer, kneaded for 12 min manually with hands into consistent dough. The resulting dough was cut into uniform sizes and passed through a series of moulding, shaping and stamping. The stamped dough was baked in the oven for 45 min at 260 °C, the products were allowed to cool and were subsequently packaged with a cellophane wrapper. All the enriched cookies were stored at room temperature, during the period of analytical investigation.

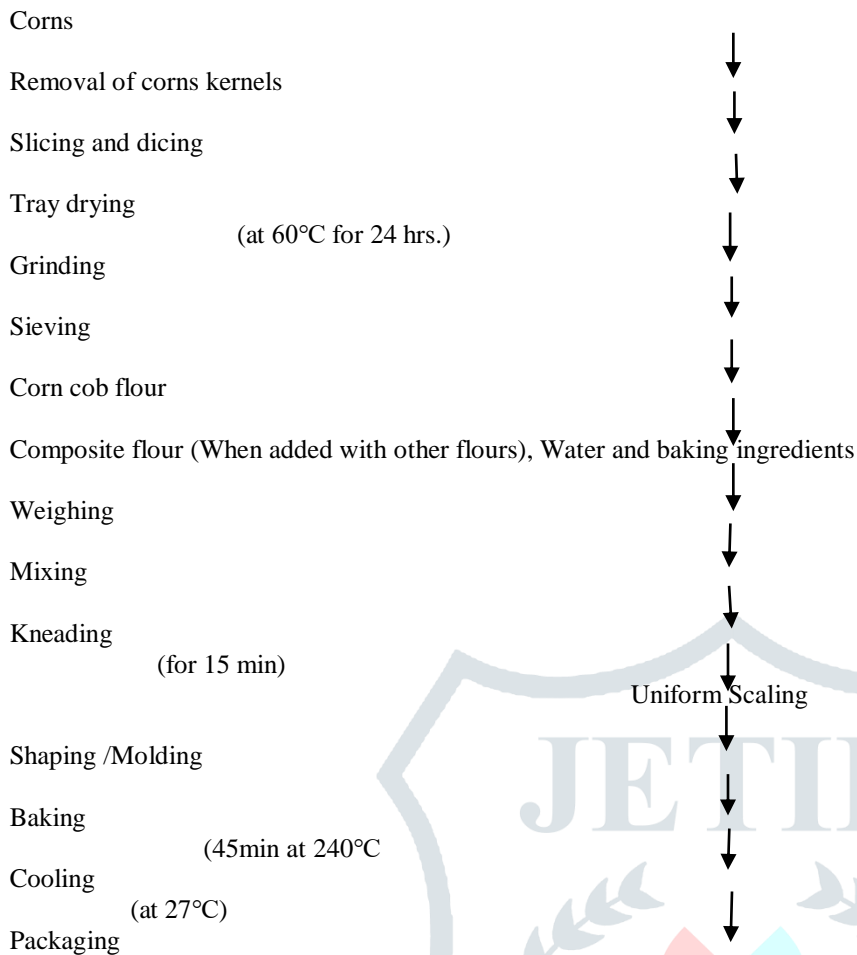


Figure 1. Flow chart of the production of enriched cookies

Table 1. Formulation for preparation of enrich cookies.

| | Cookie samples | | | |
|------------------------|----------------|-----|-----|-----|
| | A | B | C | D |
| Whole-wheat flour (g) | 100 | 70 | 55 | 40 |
| Corn cob flour (g) | 0 | 10 | 15 | 20 |
| Beetroot powder (g) | 0 | 10 | 15 | 20 |
| Spirulina (g) | 0 | 10 | 15 | 20 |
| Butter(g) | 60 | 60 | 60 | 60 |
| Sugar (g) | 60 | 60 | 60 | 60 |
| Total dough weight (g) | 210 | 210 | 210 | 210 |

Physico-chemical analysis

The physical characteristics of cookies, such as: height, width, thickness and the spread factor was measured with digital vernier calipers with 0.01mm precision. The determination of the chemical composition of the cookie samples viz: moisture content, fat, protein, dietary fiber and total carbohydrate contents were determined using methods described by AOAC 2019.

Sensory analysis

Sensory evaluation of the cookies prepared from composite mix was carried out by 10 semi trained panelists on the basis of 9-point hedonic scale for different sensory attributes such as colour and appearance, taste, flavor, texture, mouthfeel and overall acceptability as described by Iwe (2010).

RESULTS AND DISCUSSION

Physical characteristics

The result of the physical analysis of the cookies produced from composite flour blend shows that the width of the cookies samples A, B, C and D increased as a result of the level of substitution. The reverse was observed for the thickness of the cookies. Sample A (whole wheat cookies) had the highest value of 4.80mm. Sample D recorded the highest for

spread factor (87.22). The increased spread ratio observed in substituted cookie samples was due to the difference in the particle sizes and characteristics of the constituent flours (Agu et al, 2019). The spread factor is an indicator of biscuit and cookie quality.

Table 2: Result of physical evaluation of the enriched cookies.

| Parameters | Cookie samples | | | |
|----------------|----------------|------------|------------|------------|
| | A | B | C | D |
| Width (mm) | 22.83±1.10 | 26.13±1.32 | 28.40±1.52 | 30.40±1.45 |
| Thickness (mm) | 4.80±0.50 | 4.40±0.65 | 4.50±0.55 | 3.60±0.60 |
| Spread factor | 49.28±2.21 | 61.66±2.50 | 65.33±2.32 | 87.22±2.20 |

*Data are mean values of triplicate determination ± standard deviation.

Chemical analysis

Table 3 shows the results of the chemical composition of the enriched cookies. Cookies with increased substitutions were found to be nutritionally superior (have higher proximate value, protein, fat, crude fiber content and mineral contents) to whole-wheat cookies (sample A). The moisture contents of the cookies decreased with substitution by a range of 9.85% to 7.24%. High moisture content has been associated with short shelf life of baked products, as they encourage microbial proliferation that leads to spoilage (Ezeama, 2017; Akhtar et al., 2018; Elleuch et al., 2018).

There was also an increase in the protein content of the cookies with corn cob flour, beetroot powder and spirulina substitution in the range of 8.75% to 24.65%. This increase is as a result of substitution of whole-wheat flour (12.85% protein) with corn cob, beet root, spirulina bean flour of 38.50% protein content. Other studies have reported a similar increase of protein content in composite flours. Protein is needed as building blocks for the body, necessary for growth and for the repair of damaged tissues.

The ash content also increased from 2.15% to 2.95% in the cookies produced from flour substitution. Ash is an indication of mineral contents of foods. The crude fiber content of the cookies showed a percentage increase in the range of 3.29% to 5.73% as the whole-wheat flour was substituted with corn cob, beet root and spirulina blend flour.

Table 3: Result of chemical analysis of the enriched cookies

| Parameters | Cookie samples | | | |
|------------------|----------------|------------|------------|------------|
| | A | B | C | D |
| Moisture (%) | 9.85±1.52 | 8.30±1.55 | 7.56±1.48 | 7.24±1.56 |
| Protein (%) | 8.75±2.23 | 7.53±2.30 | 21.08±2.18 | 24.65±2.00 |
| Fat (%) | 4.50±0.30 | 4.37±0.32 | 4.20±0.33 | 4.33±0.30 |
| Crude fiber (%) | 3.29±1.35 | 4.55±1.40 | 5.05±1.43 | 5.73±1.38 |
| Carbohydrate (%) | 70.45±3.15 | 37.35±3.40 | 29.62±3.81 | 23.71±3.62 |
| Ash (%) | 2.15±0.85 | 2.47±0.70 | 2.75±0.90 | 2.95±0.86 |

*Data are mean values of triplicate determination ± standard deviation.

The increased fiber and the lower carbohydrate content of cookies have several health benefits, as it will aid digestion in the colon and reduce constipation often associated with products from refined grain flours. The crude fiber contents of the cookies, was within the recommended range of not more than 6 g dietary fiber and other nonabsorbable carbohydrates per 100 g dry matter (FAO/WHO, 2018). Sample A (whole wheat cookies) had the highest carbohydrate content (70.45%), while sample D had the lowest carbohydrates.

Sensory analysis

Table 4 summarizes the results for the sensory evaluation and overall acceptability of the different cookie samples. The statistical analysis revealed that there were significant differences ($p < 0.05$) among the cookie samples in the sensory attributes observed. Sample A (whole wheat) had the highest score (8.56), while sample D had the lowest score (5.90) for appearance. The appearance was based on the colour-appeal, the panelists showed preference for the lighter colour of sample A (whole wheat). Browning in the cookie samples could have been due to Maillard-type reactions resulting from the presence of reducing sugars, proteins and amino acids and caramelization due to the effect of severe heating during processing (Mannan and Shadaksharaswamy, 2018).

Table 4: Results of sensory evaluation of the enriched cookies

| Parameters | Cookie samples | | | |
|------------|----------------|-----------|-----------|-----------|
| | A | B | C | D |
| Appearance | 8.56±0.11 | 8.50±0.23 | 6.80±0.61 | 5.90±0.44 |
| Taste | 8.90±0.21 | 8.65±0.16 | 7.20±0.41 | 6.00±0.40 |

| | | | | |
|-----------------------|-----------|-----------|-----------|-----------|
| Flavor | 8.60±0.11 | 8.65±0.20 | 6.80±0.37 | 5.50±0.40 |
| Texture | 8.45±0.25 | 8.50±0.23 | 7.10±0.44 | 6.60±1.07 |
| Mouth feel | 8.60±0.29 | 8.70±0.29 | 6.50±0.23 | 5.10±0.49 |
| Overall acceptability | 8.70±0.14 | 8.60±0.18 | 6.50±0.40 | 5.85±0.75 |

*Data are mean values of triplicate determination ± standard deviation.

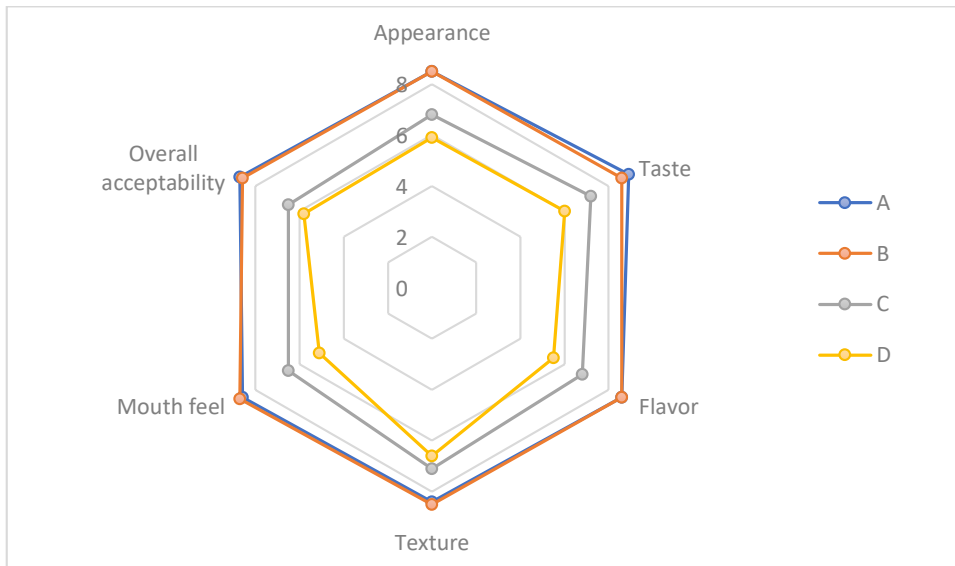


Fig. 1 Graphical representation of sensory evaluation enriched cookies

Incorporation of corn cob, beetroot and spirulina blend flour into whole-wheat cookies resulted in better taste and flavor. Sample A which is a control sample had the highest values of 8.90 and 8.60 for both taste and flavor respectively, while sample B had the second highest scores of 8.65 and 8.65 for taste and flavor respectively. Most of the panelist appreciated the sample B which is 10% mixture of each corn cob flour, beet root powder and spirulina with 70% whole wheat to be the most acceptable sample among other 3 samples, except the control sample A.

The scores for texture and mouth feel of the cookie samples were affected by the substitution. The cookie with 10% substitution (sample B), had the best score 8.50 and 8.70 for texture and mouth feel respectively, while the whole wheat cookie (sample D), had the lowest score 6.60 and 5.10 for the same. Hard crumb that is associated with increased fiber was probably mellowed by the contents. Cookie samples A and B had the best overall acceptability ratings of 8.70 and 8.60 respectively. The baking conditions (temperature and time variables); the state of the cookie constituents, such as fiber, starch, protein (gluten) whether damaged or undamaged and the amounts of absorbed water during dough mixing, will all contribute to the final outcome of the overall acceptability (Bakke and Vickers, 2019; Akhtar et al., 2018; Serrem et al., 2019).

CONCLUSION

In conclusion, enriched cookies with corn cob flour, beet root powder and spirulina substitutions were found to be nutritionally superior (have higher protein, fat, fiber energy and mineral content) to whole-wheat cookies. Thus, the enriched vegan cookies can conveniently be regarded as a balanced whole meal. However, there is the need to improve on the appearance (colour) and texture of the enriched cookies in order to increase the overall organoleptic acceptance. The results also show that the cookies are safe for human consumption. However, further research work should be focused on the shelf stability of the enriched cookies, considering that high lipid content would make the cookies to be prone to rancidity.

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