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Physicochemical Analysis of Cookies Enriched With Sugar Cane Bagasse Fibre

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ABSTRACT

Sugar cane bagasse, a discarded plant fibre remaining subsequent to the extraction of sugar cane juice, holds significant value as an abundant source of insoluble dietary fibres. These fibres offer a wide range of applications in various industries, including both the food and non-food sectors. Despite its potential, the comprehensive analysis of the physicochemical properties of sugar cane bagasse fibre for its role in cookie production is currently lacking or disregarded in evaluation processes. This study focused on utilizing sugar cane bagasse, a by-product of sugar extraction, for enhancing cookies. The bagasse was processed into powder after steam treatment, and cookies were made with different levels of bagasse powder (2%, 4%, and 6%). The study assessed the cookies' moisture content, crude fibre, and textural properties. The findings revealed that the cookies with bagasse (F1 6%) had higher moisture content (3.67±0.1274%), and the crude fibre content (2.02±0.871%) increased with the bagasse level. While there were no significant differences in hardness, cohesiveness, and springiness between the samples, cookies with bagasse had lower hardness (14047.33±21048.66) and springiness (0.366±0.152) but higher cohesiveness (0.0733±0.01155) than control cookies. The study highlights the potential of using sugar cane bagasse fibre in cookies, contributing to waste reduction in the food industry.

1.0 Introduction

Cookies are a popular choice among consumers due to their variety of taste, texture and digestibility (Ismail et al., 2024). However, most cookies are made with refined wheat flour, which is deficient in essential nutrients. To enhance cookies' nutritional value, they can be fortified with proteins or fibre-rich products.

Sugarcane, a vital crop globally, yields large quantities of bagasse as a by-product during juice extraction. Bagasse, a fibrous residue, is predominantly composed of cellulose, hemicellulose, and lignin. Even though it has potential uses as a dietary supplement and in the creation of biofuel, disposing of it presents environmental issues. A significant portion of sugarcane production results in bagasse, which is underutilized (Fito, Tefera & Hulke, 2019). Additionally, there is lack of comprehensive analysis regarding the physicochemical properties of sugar cane bagasse fibre for its utilization in cookies production.

This research focuses on creating fibre-enriched cookies from sugar cane fibre to provide health benefits and reduce waste. The bagasse was processed into powder after steam treatment, and cookies were made with different amount of bagasse powder (2%, 4% and 6%). First, the effects of adding varying amounts of sugar cane bagasse powder (2%, 4%, and 6%) on the moisture content of cookies were evaluated in this study. Additionally, the effect of adding sugar cane bagasse powder on the amount of crude fibre in cookies, considering the powder's potential as a source of dietary fibre was explored. Previous research by Llanes Gil-López et al. (2019) showed that the addition of fibres as ingredients during the elaboration of bread and pasta improved the nutritional value of human food. Furthermore, the textural properties, including hardness, cohesiveness, and springiness, of cookies containing varying levels of sugar cane bagasse powder was analysed. Every analysis, including the levels of moisture, crude fibre, and textural characteristics, was compared with conventional cookies used as the standard. By addressing these, this study hopes to contribute to the food industry to reduce waste by offering insights into the possible advantages and difficulties of using sugar cane bagasse powder in cookie production.

2.0 Literature review

2.1 Sugar Cane

Sugar cane (Saccharum officinarum L.), a perennial grass from the family Gramineae, is the major sugar crop globally (Wada et al., 2017). The primary product of sugarcane is refined sugar. In the process, various by-products such as brown sugar, bagasse, and molasses are also obtained. Molasses can be utilized in the production of ethanol and biogas, whereas sugarcane wax rich in sterols and policosanols, are widely used in cosmetic and medical products (Ali et al., 2019). Biogases, the residue left over after sugar extraction is regarded by many as waste. Nevertheless ss, it presents a rich source of bioactive phytochemicals including flavonoids, polyphenols, and phytosterols.

2.2 Sugar Cane Fibre or Bagasse

Bagasse contains 45% cellulose, 26% hemicellulose, and 19% lignin (Sangnark & Noomhorm, 2004). Most of the sugar cane bagasse are discarded after processing, however, it has garnered increasing attention. Sugarcane bagasse has emerged as valuable source of bioenergy by using novel high-pressure boilers (Rabelo et al., 2020). Moreover, advancements in processing techniques, including steam treatment and mechanical refining, have enhanced the extractability of fibres from bagasse, paving the way for novel applications in the food industry (Motaung and Anandjiwala, 2015).

2.3 Moisture Content Analysis

The moisture content of a food is important as will affect its shelf-life stability and quality (Moore, 2020). Bread shall have 35 – 45% moisture, cake, 15 – 30%, and biscuits or cookies has shall be 1 – 5% moisture. This low moisture content ensures that cookies are generally free from microbiological spoilage and have a long shelf life if they are protected from absorbing moisture from damp surroundings or atmosphere. Moisture content can be determined using traditional methods, such as gravimetric analysis. Moisture content is one of the important parameters which influences shelf life or storage stability of cookies. This method remains prevalent for moisture determination, although advancements in spectroscopic techniques offer rapid and non-destructive alternatives.

2.4 Crude Fibre Analysis

The moisture content of a food is important as will affect its shelf-life stability and quality (Moore, 2020). Bread shall have 35 – 45% moisture, cake, 15 – 30%, and biscuits or cookies has shall be 1 – 5% moisture. This low moisture content ensures that cookies are generally free from microbiological spoilage and have a long shelf life if they are protected from absorbing moisture from damp surroundings or atmosphere. Moisture content can be determined using traditional methods, such as gravimetric analysis. Moisture content is one of the important parameters which influences shelf life or storage stability of cookies. This method remains prevalent for moisture determination, although advancements in spectroscopic techniques offer rapid and non-destructive alternatives.

2.5 Texture Profile Analysis (TPA)

Texture profile analysis is important in assessing the sensory attributes and rheological properties of food products, including cookies derived from sugar cane bagasse. Parameters such as hardness, cohesiveness, and springiness can be evaluated through sensory evaluation and instrumental methods like the Brookfield Texture Analyzer (Guiné, 2022).

3.0 Methodology

3.1 Preparation of cookies

Cookies were prepared using the modified recipe for cookies as described by Gail (1996). The ingredients were sifted, kneaded and made into dough. The dough was shaped and baked at 150ºC for 30 minutes in convection oven. Cookies were prepared from blends containing sugarcane fibre at different levels (2%, 4% and 6%). After baking, cookies were cooled to room temperature, packed in Low Density Polyethylene (LDPE) bags and sealed. The cookies were then used for moisture content, crude fibre and textural analysis. All experiments were conducted in triplicate.

3.2 Treatment combination

Table 3.1: Treatment combination used for the preparation of cookies

Ingredients	Control (%)	F1 (%)	F2 (%)	F3 (%)
Sugar cane fibre powder	0	6	4	2

3.3 Moisture content analysis

Moisture content of samples was determined using air oven method as per AOAC 930.15 (AOAC, 1990). Experiments were conducted in triplicates and averaged.

3.4 Crude fibre analysis

Crude fibre of samples was determined according to AOAC 978.10 (AOAC, 1990). Experiments were conducted in triplicates and averaged.

3.5 Textural analysis

The textural properties of samples such as hardness, cohesiveness, springiness and chewiness were determined using CT3 Brookfield Texture Analyzer. Samples prepared in 5g each. The test settings as follow: Test speed-0.5 mm/s, Trigger force- 5g, Deformation- 1.0 mm and Distance- 0.9mm with adaptation on method in Brookfield Engineering (2024).

3.6 Statistical analysis of data

All experiment was done triplicate, and the data were presented in terms of means ± standard deviation. The differences between mean were at 95% confidence interval. Data was analysed by using One Way Analysis of Variance (ANOVA) using SPSS.

4.0 Discussion of analysis and findings

4.1 Moisture content analysis

Table 4.1: Result for moisture content

Treatment level (% fibre)	Control (0%)	F1 (6%)	F2 (4%)	F3 (2%)
Moisture content (%)	1.70 ± 0.726^{a}	3.67 ± 0.127^{b}	3.76 ± 0.127^{b}	3.71 ± 0.193^{b}

Mean ± standard deviation within the same row bearing different superscripts differ significantly ($P < 0.05$)

The percentage of moisture content obtained are tabulated in Table 4.1. Based on the results, the moisture content in samples enriched with sugarcane bagasse is higher than control. There were significant differences in moisture contents of sample between the three formulations and control cookies. Among the formulations, F1 (6% sugarcane bagasse) had the highest moisture content (3.67±0.1274%). The increase in moisture content in the cookies may be due to increase in bagasse. According to Alkarkhi et al (2011), the high-water holding capacity of product could be attributed to the fibre and protein of the product.

4.2 Crude fibre analysis

Table 4.2: Result for crude fibre

Treatment level (% fibre)	Control (0%)	F1 (6%)	F2 (4%)	F3 (2%)
Crude fibre (%)	0.00±0.00	2.02±0.871[b]	1.43±0.143[a]	0.29±0.146[a]

Mean ± standard deviation within the same row bearing different superscripts differ significantly (P < 0.05)

The results of crude fibre analysis of biscuits incorporated with sugar cane bagasse is stated in Table 4.2. As shown by results, the crude fibre content of cookies increased with the bagasse level, with F1 (6% bagasse) had the highest crude fibre content (2.02±0.871%). Bagasse contains 45% cellulose, 26% hemicellulose, and 19% lignin (Sangnark & Noomhorm, 2004). The fibre content in bagasse contributed to the results obtained.

4.3 Textural analysis

Table 4.3: Result for textural analysis

Treatment level (% fibre)	Control (0%)	F1 (6%)	F2 (4%)	F3 (2%)
Hardness	17368.33±7761.67[a]	14047.33±21048.66[b]	5856.33±6125.89[a]	8332.00±11401.82[a]
Cohesiveness	0.07±0.02[a]	0.07±0.01[a]	0.08±0.04[a]	0.05±0.01[a]
Springiness	1.17±1.33[a]	0.37±0.15[a]	0.33±0.12[a]	0.33±0.58[a]

Mean ± standard deviation within the same row bearing different superscripts differ significantly (P < 0.05)

Table 4.3 shows the result of textural analysis which include hardness, cohesiveness and springiness characteristics of cookies incorporated with bagasse at different level and control cookies. Cookies with bagasse had lower hardness (14047.33±21048.66) and springiness (0.366±0.152) but higher cohesiveness (0.0733±0.01155) than control cookies. The increase in moisture content of cookies incorporated with bagasse may possibly cause the reduce in hardness and increase of cohesiveness in cookies. In term of springiness, according to study done by Sharma et al. (2013), the incorporation of dried guduchi (*Tinospora cordifolia*) leaf powder decreased the springiness of cookies when compared to control cookie dough owing to dilution of gluten.

5.0 Conclusion and Future Research

The study was conducted to on the physicochemical properties of cookies enriched with sugar cane bagasse to utilize sugar cane bagasse in food products. The moisture content analysis showed that cookies enriched with bagasse (F1 6%) had the highest moisture content (3.67±0.1274%). While the crude fibre content (2.02±0.871%) increased with the bagasse level (F1 6%). Thus, it was proved that incorporation of sugar cane fibre into cookies will increase the crude fibre content of the cookies. Cookies with bagasse had lower hardness (14047.33±21048.66) and springiness (0.366±0.152) but higher cohesiveness (0.0733±0.01155) than control cookies. The incorporation of sugar cane fibre into cookies will result in dilution of gluten in the dough, thereby, hardness, cohesiveness and springiness of cookies will be affected. The limitation in this study is that the ways of obtaining sugar cane bagasse will influence the results. Subsequently, it is recommended for future researchers to continue the study by conducting the optimization on treatment imposed on sugar cane bagasse to obtained optimized fibre to incorporate into food products. In addition, future researchers also can continue the research by conducting more analysis on the incorporation of sugar cane fibre into other food products.

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Author Contributions

Yong S. H.: Conceptualization, writing review and editing, conducted experiments and collected and analysed the result data; **Moohyiddin D. I.**: Conceptualization, writing review and editing; **Baharuddin N. H.**: Conceptualization, writing review and editing; **Nasution Z.:** Writing review on methodology, discussion of analysis and findings

Conflicts of Interest

The manuscript has not been published elsewhere and is not being considered by other journals. All authors have approved the review, agree with its Submission and declare no conflict of interest in the manuscript.

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