Physico-chemical, textural and consumers’ acceptability of biscuits made from composite flour of wheat, fermented soybean-hull and date-pulp

R.M.O. Kayode, O.R. Egwumah*, B.I, Kayode and V.A. Joshua

Highlights

- Biscuits prepared from composite flour of wheat, Soybean-Hull and Date-pulp could help in combating protein-energy malnutrition.
- According to the proximate analysis of composite Biscuit, there was an increase in protein, fiber, fat and ash content and decrease in moisture and carbohydrate.
- Sample E was highly acceptable by panelists as it was the most preferred at 16% effect of Bacillus subtilis at 72hrs soybean hulls flour supplementation.
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Abstract: Soybean hull consist of complex polysaccharides that cannot be digested by human's alimentary canal and is usually discarded during processing. These complexes can be broken down by fermentation into simpler and more available forms. This research used solid state fermentation process with some microbes to ferment soybean hull for flour production and investigated the proximate, textural, physical and sensory properties of biscuits produced from composite flour of wheat and fermented soybean hull with date-pulp flour as a sugar replacement in the biscuit production. The proximate composition of the biscuit showed increasing protein (10.15 to 12.25 %), lipids (20.14 to 22.95 %), ash (2.07 to 2.16 %), fibre (1.23 to 1.38 %) and moisture contents (4.65 to 6.03 %) while the carbohydrate content (60.1 to 56.1%) decreased with increasing soybean hull flour. The weight (12.03 to 15.30 g), thickness (6.24 to 7.38 mm), density (5.08 to 5.18 g/cm³), and spread ratio (7.32 to 8.76) of the biscuit increased while its diameter (54.11 to 54.94 mm), decreased, and its volume (5.08 to 5.18 cm³) exhibited no particular trend. No significant difference (p<0.05) was observed in the textural properties of the biscuit but those produced from 16% soybean hull flour fermented with B. subtilis for 72hrs, and 4% soybean hull flour, fermented with A. oryzae for 72hrs were the most preferred. Therefore, supplementing wheat flour with soybean hull flour fermented with A. oryzae at 72hrs and B. subtilis at 72hrs significantly improved the nutritional quality of biscuit without adverse effects on its physical, textural and sensory properties.

Keywords: Wheat flour; Biscuit; Fermentation; Soybean-hull; Date-pulp.

INTRODUCTION

The light, quick, and ready-to-eat foods known as snacks are in high demand, particularly in urban areas where people eat them as quick meals or refreshments, to satisfy their hunger, or occasionally as a replacement for a full meal (Pikuda & Ilelaboye, 2009). Snack goods have recently gained more acceptability on a global scale as a result of nutritional preferences, convenience-driven lives, and employment needs (Okafor & Ugwu, 2014). In much of the world, biscuits are a key component of human snacks. It is an unleavened crisp, sweet pastry made with wheat flour, shortening (hydrogenated fat), and sugar. Baking powder, which is a combination of sodium carbonate, sodium biphosphate, and cereal flour, is typically added to make it lighter (O’Brien et al., 2003). Because they have a lengthy shelf life, biscuits can be found anywhere and at any time (Nakov et al., 2016). Due to the high content of dietary fiber and other phytonutrients in soybean hulls, fortified biscuits made with this flour have the potential to aid Africans in the prevention and treatment of constipation, cardiovascular diseases, and hypertension (Ayo & Kajo, 2016) as well as reduce the level of current food insecurity (Jideani & Jideani, 2011). When used as a composite flour in the production of biscuits, soybean hull flour can aid to enhance the biscuits’ characteristics without affecting their flavor or quality. To ensure an adequate quantity of amino acids for lean mass (i.e., muscle) maintenance or growth, and to improve the quality of your diet overall, it is advised that a healthy eating pattern include consuming a range of high quality protein meals (Phillips et al., 2015). Numerous studies have been conducted on the enrichment of these meals with sources of protein from legumes that are high in dietary protein (McWatters et al., 2004). Food produced and consumed in less developed areas does not offer balanced meals to meet the population’s nutritional demands, especially those of vulnerable populations like mothers, children, and youth. More over 70% of people in sub-Saharan Africa depend on agriculture as their main source of income, food, and nutrition security (Abass et al., 2014).

According to Seibel (2006) composite flour has been the focus of a great deal of research because it is well known that no other crop can achieve the pastry qualities of wheat. As a result, it is now necessary to develop a plan to replace wheat flour for use in the food industry using less expensive local resources that could still combine optimal nutritional value with good processing attributes. Yam, cassava, and other starchy tubers, as well as cowpea, soybean, and plantain flours, along with or without wheat flour, are all examples of composite flour (Seibel, 2006). A greater supply of proteins for human nutrition, the encouragement of local species with high yields, the improvement of domestic agriculture, the generation of rural revenue, and assistance for rural development are a few of the recognized benefits of composite flour (Berghofer, 2000; Bugusu et
were

According to the method described in Olaoye, (2006). The hull flour was sealed in a plastic bag and kept at room temperature (27 ± 2 ºC) until required for use before being oven dried at 60°C for 15 hours (Olaoye, 2003). By looking into the possibility of using soybean-hull as composite flour to improve the nutritional quality of biscuits, this study aimed to introduce an alternative way to utilize soybean hulls, thereby reducing its food wastage and to improve the quality of date pulp sweetened biscuit. In general, a biscuit made with this mix of wheat flour, soybean hull, and date pulp would not only be an excellent snack or food for diabetics but also a good functional food to replace wheat flour with any of the locally available alternate local sources of flour, such as cassava, soybean-hull, sorghum, etc., is necessary given the enormous demand for wheat flour and Nigeria’s inability to provide it. Since wheat flour is considered to be poor in essential protein, fermented soybean-hull flour should be added for fortification and value enhancement. Therefore, any attempt to replace wheat flour with any of the locally available cereal flours will significantly lower the cost of baking products in Nigeria, so assisting in reducing the country’s ongoing food insecurity (Jideani & Jideani, 2011).

Fermentation is a food processes been explored over the years and has improved the nutritional qualities of soybean-hull. Additionally, dates pulp has a great nutritional value as a natural sweetener since it includes sugars, minerals, protein, and fiber. This improves mental health and offers protection from aging-related diseases due to its high level of antioxidant components (Al-Shahib & Marshall, 2003). By looking into the possibility of using soybean-hull as composite flour to improve the nutritional quality of biscuits, this study aimed to introduce an alternative way to utilize soybean hulls, thereby reducing its food wastage and to improve the quality of date pulp sweetened biscuit. In general, a biscuit made with this mix of wheat flour, soybean hull, and date pulp would not only be an excellent snack or food for diabetics but also a good functional food with significant nutritional value

MATERIAL AND METHODS

Soybean-hulls from soybeans seeds (Glycine max) were obtained as a waste during the processing of beske, soy sauce and soymilk while date palm fruit (Phoenix dactylifera L.), wheat flour (golden penny brand), sugar, margarine (fat), egg, condensed milk powder, salt and baking powder were purchased from a local market (Oja-Oba) in Ilorin, Kwara State, Nigeria.

Preparation of Raw Materials

Soybean-hull: To produce soybean hull flour, the fermented hulls were milled in a laboratory blender and sieved through a 60 mm mesh sieve (British Standard) before being oven dried at 60°C for 15 hours (Olaoye, 2006). The hull flour was sealed in a plastic bag and kept at room temperature (27 ± 2 ºC) until required for use. Date pulp flour: According to the method described in Peter et al. (2017), date pulp flour was produced. Date palm fruits were hand-deseeded and given a thorough wash in distilled water to get rid of any clinging dirt. The pulps were then weighted, sliced into small, uniform-sized pieces, and oven dried for 6 to 8 hours at 75 ºC to create fine, homogenized particles, the dried pulps were next processed using a hand milling machine and sieved using a 0.35mm mesh sieve (date pulp flour). Finally, a cellophane bag with an airtight closure was used to store the flour at room temperature.

Formulation of Composite Flour Blends

Before being batched into various mixes, wheat, (Golden Penny brand), and soybean-hull flour were sieved through a metal sieve with a 160µm pore size. The control samples were made entirely of wheat flour. In order to produce the composite flours, the experimental flour blends were produced by combining wheat flour and soybean hull flour in the following ratios: 100:0, 96:4, 92:8, 88:12, and 84:16 percent, respectively. The mixtures were well combined before being stored in plastic containers until needed.

The best result, according to Ikechukwu et al. (2017), came from incorporating 30% date pulp flour to biscuits. On the other hand, boosting the mineral content, particularly potassium, calcium, phosphorus, and iron, resulted in improvements in overall appearance, flavor, texture, and crust color. The recipe for making biscuits using the combination of flours in the table is shown below (wheat, soybean-hull and date pulp flour).

Production of Composite Biscuit

Biscuits were prepared according to the method of Ayo & Nkama (2006) with some modifications in the recipe. Hand mixing for 3 minutes in a bowl of dry ingredients (wheat flour, date pulp flour, salt, and baking powder). The mixture was then added, then milk, water, and egg were added. On a sheeting board, the batter was rolled out into a thin, light sheet that was about 0.6 cm thick. A biscuit cutter with a diameter of about 2.5 cm was then used to cut out the shapes. The cut dough was placed on oil-greased baking trays with 25mm of space between each piece, and baked for 30 minutes at 180°C. After baking, the biscuits were allowed to cool at room temperature before being sealed in a container and stored at a temperature that was near ambient temperature (27±2 ºC) for later analysis and sensory evaluation. Flour (200g), sugar (118g), eggs (50ml), baking powder (3g), salt (3g), water (30ml), and margarine were the ingredients needed to make biscuits (100g).

Proximate Analysis of Biscuit Produced from Composite Flours of Wheat and Fermented Soybean-hull

Moisture, fat and ash contents were determined using AOAC (2000) methods. Protein contents was determined by the kjeldahl method (6.25 x N) and total carbohydrate was calculated by the difference. Fibre content was determined by standard laboratory procedure

Determination of Physical properties of the Biscuit

With a slight modification, the procedure outlined by

Determination of Physical properties of the Biscuit

Flours of Wheat and Fermented Soybean-hull

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Determination of Physical properties of the Biscuit

With a slight modification, the procedure outlined by

Determination of Physical properties of the Biscuit
Table 1: Recipe for the formulation of wheat-soybean hull composite flour for biscuit production/making.

<table>
<thead>
<tr>
<th>Constituents</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat flour (g)</td>
<td>200</td>
<td>192</td>
<td>184</td>
<td>176</td>
<td>168</td>
</tr>
<tr>
<td>Soybean hulls flour (g)</td>
<td>0</td>
<td>8</td>
<td>16</td>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>Date pulp flour (g)</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Margarine (g)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Fresh eggs (ml)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Water (ml)</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Salt (g)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Baking powder (g)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

A = 100% Wheat flour and date pulp flour (Control sample).
B = 96%: 4% Ratio of wheat and soybean-hull flour in the biscuits.
C = 92%: 8% Ratio of wheat and soybean-hull flour in the biscuits.
D = 88%: 12% Ratio of wheat and soybean-hull flour in the biscuits.
E = 84%: 16% Ratio of wheat and soybean-hull flour in the biscuits.

Bala et al. (2015) was applied to assess the biscuit for the following characteristics: A Vernier caliper was used to measure the thickness and diameter of biscuits made from each blend in two perpendicular directions, and the average results were reported. Using an analytical weighing balance, the weight of the biscuits was calculated as the average of the weights of six different biscuits. The weight’s average value was given in grams. In order to calculate the spread ratio, diameter and thickness were divided.

By using seed displacement to measure the volume of the biscuit, a measuring cylinder was filled with some rice grains. A sample of a biscuit was placed inside the cylinder after the grains were removed. The biscuit in the cylinder was now covered with the grains, which had been leveled. The leftover grains were then added to a measuring cylinder to acquire the volume, and the density of the biscuit was determined by dividing the weight (g) by the volume (cm$^3$) and expressed as (g/cm$^3$).
Determination of Textural Properties of Biscuit Samples

The TA-XT Plus texture analyzer (Stable Micro Systems Serial No. 5014 England) was used to measure the biscuit samples’ hardness, springiness, adhesiveness, cohesiveness, chewiness, gumminess, stinginess, and energy to peak analysis (Ahmed & Hussein, 2014). The analyzer was configured to conduct single-cycle measurements, which were utilized to calculate the product’s initial biting force. A measurement distance of 5 mm and a speed of 2 mm/s were used. The hardness or breaking force (g), springiness, adhesiveness, cohesiveness, chewiness, gumminess, energy to peak, and stinginess to reach the peak were all examined in the force-time plots. Six different samples were used to measure various textural characteristics.

Sensory Evaluation of the Biscuit

The sensory evaluation of the samples Were carried for consumer acceptance and preference using 50 panelists, (students and staff of the Department of Home Economics and Food Science, University of Ilorin, Kwara State, Nigeria), that were regular consumers of biscuits. A nine-point Hedonic scale one (1) and nine (9) indicating ‘extremely dislike’ and ‘extremely like’, respectively, were used (Iwe, 2002). The qualities assessed include taste, flavour, colour, texture, crispiness and general acceptability. Judges were given coded samples that were the same size and temperature (29 ± 3 °C) on white plates under fluorescent lighting. One sensory attribute could only be examined at a time, and sachets of water were offered to rinse the mouth between evaluations (Ihekoronye & Ngoddy, 1985).

Statistical Analysis

The mean values of data obtained were subjected to multiple analyses of variance (ANOVA) at 5% significance level (p ≤ 0.05), using statistical package for social sciences (SPSS) version 21.0 as described by Akingbala et al. (2005). The mean values were separated using Duncan’s multiple range tests.

RESULTS AND DISCUSSION

Effect of Bacillus subtilis at 72hours Fermentation on the Proximate Composition of Biscuit from Composite Flour Soybean-Hull and Date Pulp Flour

The effect of the soybean-hull flour on the proximate composition of date pulp sweetened biscuit is shown in Table 2. The protein, lipids, ash, fibre and moisture contents of the soybean-hull based biscuit increased from 10.15 to 12.25, 20.14 to 22.95, 2.07 to 2.16, 1.23 to 1.38 and 4.65 to 6.03% respectively while the carbohydrate content decreased from 60.12 to 56.10% with increase in the percentage soybean hulls flour supplementation. All the samples are significantly (P≤0.05) different from one another.

Due to the addition of soybean hull flour, which is high in protein, fat, and minerals (iron and zinc), the protein level increased. The protein content increased by 53.8% when the 30% malted soybean acceptance level was reached; the equivalent protein level was 8.09%. The product may be a suitable source of reasonably priced protein given the rise in the protein content. Furthermore, because proteins are vital biomolecules, they give the body energy when they are ingested and processed. The addition of soybean-hull flour dramatically raised the protein level of the biscuits.

The increased fat content might serve as a reliable source of energy. When metabolized by the body, one gram of fat or oil will provide around 368 kJ/gkcal of energy Okaka & Okaka, (2001). Because it provides vital fatty acids that support excellent health, fat is a necessary component of a healthy diet.

According to similar works, the product’s increased ash content might make it a valuable source of minerals (Ayo et al., 2018). It helps with the metabolism of other compounds like protein, fat, and carbohydrates. The product’s high ash content may be a source of minerals and vitamins (such as vitamins A, D, and E), which, in addition to their nutritional value, are helpful for bones, skin, and eye sight.

With an increase in the percentage of soybean-hull flour, the biscuit’s crude fiber significantly improves. It has a varied percentage of dietary fiber, which is thought to have some positive effects on the muscles of the large and small intestine. It is well-known that soluble fibers typically lengthen the time food takes to pass through the gut, delay stomach emptying, and inhibit the body’s ability to absorb glucose (Lattimer & Mark, 2010). Due to their high dietary fiber content, soybean hulls have the potential to significantly reduce blood glucose levels.

The biscuit’s moisture content increased when soybean hull was added; this could be because soybean hull has a strong affinity for moisture (Ayo & Nkama, 2006). The product’s relatively high moisture content necessitates suitable packing to prevent spoiling.

Because more soybean hull flour was added, the product’s carbohydrate composition dropped from 60.12 to 56.10% indicating that there were decreasing carbs present (Elleuch et al., 2011). The impact of additional soybean-hull flour on the carbohydrate, however, was significantly different (P<0.05). Because soybean-hull flour has a low carbohydrate content, the amount of carbohydrates may have decreased. Cookies with less sugar have less health risks since they will help the colon with digestion and reduce the constipation that is frequently linked to foods made with refined flour (Elleuch et al., 2011).

Effect of Aspergillus oryzae at 72hours Fermentation on the Proximate Composition of Biscuit from Composite Flour Soybean-Hull and Date Pulp Flour

In Table 3, the impact of the soybean-hull flour on the approximate composition of date pulp sweetened biscuit is shown. With an increase in the percentage of soybean hulls flour supplementation, the soybean-hull-based biscuit’s protein, lipids, ash, and fiber contents increased from 12.06 to 14.14, 22.06 to 25.75, 1.88 to 2.23, and 1.23 to 1.42%, respectively, while the carbohydrate and moisture contents decreased from 57.45 to 52.22%, 6.03 to 4.65, and from 1.23 to 1.42%, respectively. Significant differences between each sample and the others exist (P<0.05). The rise might possibly be the result of the inclusion of soybean

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hull flour because it has considerable amounts of fiber, protein, fat, and minerals (iron and zinc).

The fermentation of the hull led to a greater protein content in biscuits produced from fortified soybean-hull flour. According to Gandhi et al. (2001), increasing the protein level of sweet biscuits by substituting soy flour for 40% of the wheat flour boosted the protein content of the biscuit to 14.8%. This rise could aid in the prevention of several nutrient deficiency conditions such as phenylketonuria, marasmus, and kwashiorkor, which are prevalent in underdeveloped nations (Okaka et al., 2002). By increasing the quantity and quality of the food product’s protein content, soybean hull flour shows great potential in the combat against protein energy insufficiency.

The fat content gradually increased when more soybean hull flour was added, resulting in a higher fat percentage because the broken soybeans that were added to the hull caused the fat content to rise.

The inclusion of soybean coat, which has been found to be very rich in minerals, especially iron, phosphorus, salt, and potassium, could be to blame for the increase in the proportion of ash (mineral) contents (Iwe, 2002).

The amount of crude fiber in the biscuit increased along with supplementation. The rise in the amount of blended flour, which contains primarily lignin, cellulose, and hemicellulose components and represents a variable percentage of dietary fiber, may be to blame for the rise in fiber intake (Kris, 2018). Of all the important dietary fiber sources examined, soybean hulls were found to have the greatest impact on lowering blood cholesterol and alleviating constipation (Ayo et al., 2008).

The low carbohydrate content of the soybean hull flour supplement and Aspergillus oryzae’s utilization of the sugar during fermentation as a source of energy could both be to account for the decline in carbohydrate content. The soybean-hull biscuits’ carbohydrate content reduced as soybean-hull flour replaced other flour in the composite biscuits on a larger scale.

Because it may help retain quality and reduce post-handling costs, such as packaging and transportation costs, the relatively low moisture level is advantageous (Elleuch et al., 2011; Ayo et al., 2003).

**Table 2:** Effect of Bacillus subtilis at 72 hours fermentation on the proximate composition of biscuit from composite flour of soybean-hull and date pulp flour.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Crude protein (%)</th>
<th>Crude lipid (%)</th>
<th>Moisture content (%)</th>
<th>Total ash (%)</th>
<th>Crude fibre (%)</th>
<th>Carbohydrate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12.14± ± 0.01</td>
<td>23.42± ± 0.01</td>
<td>4.65± ± 0.00</td>
<td>2.07± ± 0.02</td>
<td>1.23± ± 0.01</td>
<td>56.25± ± 0.02</td>
</tr>
<tr>
<td>B</td>
<td>10.15± ± 0.01</td>
<td>20.14± ± 0.03</td>
<td>4.60± ± 0.00</td>
<td>2.12± ± 0.14</td>
<td>1.25± ± 0.00</td>
<td>60.12± ± 0.01</td>
</tr>
<tr>
<td>C</td>
<td>10.57± ± 0.02</td>
<td>22.65± ± 0.00</td>
<td>5.15± ± 0.00</td>
<td>2.13± ± 0.01</td>
<td>1.29± ± 0.00</td>
<td>57.61± ± 0.03</td>
</tr>
<tr>
<td>D</td>
<td>12.25± ± 0.00</td>
<td>22.16± ± 0.01</td>
<td>5.57± ± 0.01</td>
<td>2.16± ± 0.01</td>
<td>1.36± ± 0.01</td>
<td>59.19± ± 0.11</td>
</tr>
<tr>
<td>E</td>
<td>11.67± ± 0.01</td>
<td>22.95± ± 0.01</td>
<td>5.25± ± 0.00</td>
<td>2.14± ± 0.01</td>
<td>1.38± ± 0.01</td>
<td>56.10± ± 0.03</td>
</tr>
</tbody>
</table>

Values are expressed as mean of two replicates ± S.D. Means with the different superscripts across a row are significantly (P≤0.05) different.

A = 100% Wheat flour and date pulp for biscuits (Control sample).
B = 96%: 4% Ratio of wheat flour and soybean-hull flour in the biscuits.
C = 92%: 8% Ratio of wheat flour and soybean-hull flour in the biscuits.
D = 88%: 12% Ratio of wheat flour and soybean-hull flour in the biscuits.
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**Table 3:** Effect of Aspergillus oryzae at 72 hours fermentation on the proximate composition of biscuit from composite flour soybean-hull and date pulp flour.

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<tr>
<th>Sample</th>
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</tr>
<tr>
<td>B</td>
<td>12.15± ± 0.01</td>
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<td>1.27± ± 0.01</td>
<td>57.45± ± 0.01</td>
</tr>
<tr>
<td>C</td>
<td>12.06± ± 0.01</td>
<td>22.16± ± 0.00</td>
<td>5.57± ± 0.00</td>
<td>2.04± ± 0.01</td>
<td>1.26± ± 0.00</td>
<td>56.15± ± 0.04</td>
</tr>
<tr>
<td>D</td>
<td>12.23± ± 0.01</td>
<td>24.16± ± 0.00</td>
<td>5.16± ± 0.00</td>
<td>2.22± ± 0.01</td>
<td>1.33± ± 0.00</td>
<td>53.41± ± 0.01</td>
</tr>
<tr>
<td>E</td>
<td>14.14± ± 0.01</td>
<td>25.75± ± 0.04</td>
<td>5.15± ± 0.00</td>
<td>2.23± ± 0.01</td>
<td>1.42± ± 0.01</td>
<td>52.22± ± 0.03</td>
</tr>
</tbody>
</table>

Values are expressed as mean of two replicates ± S.D. Means with the different superscripts across a row are significantly (P≤0.05) different.

A = 100% Wheat flour and date pulp for biscuits (Control sample).
B = 96%: 4% Ratio of wheat flour and soybean-hull flour in the biscuits.
C = 92%: 8% Ratio of wheat flour and soybean-hull flour in the biscuits.
D = 88%: 12% Ratio of wheat flour and soybean-hull flour in the biscuits.
E = 84%: 16% Ratio of wheat and soybean-Hull flour in the biscuits.
Effect of Bacillus subtilis at 72 hours Fermentation on the Textural Properties of Biscuit from Composite Flour Soybean-Hull and Date Pulp Flour

Table 4 represents the textural profile of biscuit from fermented soybean hull and wheat flour sweetened with date fruit flour. The composition varied for hardness (302.83-1614.50N), adhesiveness (0.01 – 0.03N.s), cohesiveness (0.36 - 0.46 N), chewiness (26.10 – 109.72N) and springiness (0.34 - 0.45N), gumminess (7.58 – 289.95 N). The sample E had the highest mean value for hardness while sample B had the lowest value compare to the control. This could be due to partial substitution of wheat flour with Bacillus subtilis fermented soybean hull flour. Starting at 8% inclusion, it was shown that hardness increased as soybean hull flour inclusion increased. This suggests that the tougher the biscuits will be the higher the percentage of soybean hull flour. This recommends that soybean hull flour should be added in moderate order in order to produce soft, crispy biscuits. According to the report of Sahagn & Gomez (2018), the interaction of protein and starch by hydrogen bonding results in the hardness of the biscuit. The samples E that contained 16% fermented soybean hull had the maximum adhesiveness value, whereas samples B and C had the lowest values that were not significantly (p > 0.05) different from the control, as was the case with Aspergillus oryzae. These values are lower than those found in biscuits made from finger millet seed coat-based composite flour, as reported by Krishnan et al. (2011). Samples B and C had more cohesion than the control sample. Given that the functional behavior of the mixed batter determines the texture of snacks, the enhanced cohesiveness with increasing soybean flour may have been due to higher specific gravity and apparent viscosity, as well as its decreased batter volume with the addition of soybean hull flour. Yet, given that Bacillus subtilis has a significant impact on the functional qualities of fermented soybean hull flour, this may be the case (Table 4). When compared to the control sample, sample B had the lowest chewiness value, while sample E had the highest value. Given that sample B had the least amount of force to shear, chewiness can be correlated with the energy needed to shear-compress sample B. Also, sample E had the highest mean springiness value (0.45N), while sample B had the lowest mean value (0.03N). Aspergillus oryzae produced biscuits with a different level of gumminess than Bacillus subtilis fermented soybean hull. Bacillus subtilis E had the greatest value, while sample C Aspergillus oryzae had the highest value. This suggests that for reduced gumminess in biscuits, a little amount of soybean hull flour fermented with Bacillus subtilis is necessary.

Effect of Aspergillus Oryzae at 72 hours Fermentation on the Textural Properties of Biscuit from Composite Flour Soybean-Hull and Date Pulp Flour

The textural profile of biscuit produced from soybean hull flour fermented by Aspergillus oryzae at 72 hours added to wheat flour at carrying proportion showed significant (p > 0.05) difference. Wheat and soybean hull flour hardness levels differed significantly (p<0.05). Sample A had the highest value, ranging from 763.75 to 455.71 N, while sample E had the lowest value. As the amount of soybean hull flour inclusion increases, a decline in hardness value was seen. The addition of soybean hull may be accounts for the decline in harness value. This contradicts the findings of Kuchtová et al. (2016), who observed lower values for cookies made with wheat flour and grape flour. Decreased hardness implies mastication ease.

Table 4: Effect of Bacillus subtilis at 72 hours fermentation on the textural properties of biscuit from composite flour soybean-hull and date pulp flour

<table>
<thead>
<tr>
<th>Sample</th>
<th>Hardness (N)</th>
<th>Springiness</th>
<th>Adhesiveness (N.s)</th>
<th>Cohesiveness</th>
<th>Chewiness (N)</th>
<th>Gumminess (N)</th>
<th>Energy to Peak (N.m)</th>
<th>Stringiness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>763.75(a) ± 7.35</td>
<td>0.44(a) ± 0.02</td>
<td>0.02(a) ± 0.01</td>
<td>0.36(a) ± 0.02</td>
<td>79.86(a) ± 16.30</td>
<td>277.76(a) ± 18.88</td>
<td>0.55(a) ± 0.01</td>
<td>1.61(a) ± 0.02</td>
</tr>
<tr>
<td>B</td>
<td>302.83(a) ± 43.51</td>
<td>0.34(a) ± 0.01</td>
<td>0.01(a) ± 0.00</td>
<td>0.37(a) ± 0.04</td>
<td>26.10(a) ± 2.06</td>
<td>76.58(a) ± 8.11</td>
<td>0.19(a) ± 0.04</td>
<td>1.66(a) ± 0.02</td>
</tr>
<tr>
<td>C</td>
<td>658.90(a) ± 11.80</td>
<td>0.38(a) ± 0.00</td>
<td>0.01(a) ± 0.00</td>
<td>0.43(a) ± 0.02</td>
<td>107.33(a) ± 3.09</td>
<td>280.96(a) ± 8.38</td>
<td>0.36(a) ± 0.01</td>
<td>1.42(a) ± 0.02</td>
</tr>
<tr>
<td>D</td>
<td>1024.45(a) ± 97.55</td>
<td>0.44(a) ± 0.04</td>
<td>0.03(a) ± 0.02</td>
<td>0.36(a) ± 0.02</td>
<td>69.31(a) ± 15.06</td>
<td>206.41(a) ± 73.72</td>
<td>0.43(a) ± 0.07</td>
<td>1.60(a) ± 0.00</td>
</tr>
<tr>
<td>E</td>
<td>1614.50(a) ± 47.60</td>
<td>0.45(a) ± 0.01</td>
<td>0.034(a) ± 0.021</td>
<td>0.36(a) ± 0.01</td>
<td>109.72(a) ± 18.92</td>
<td>289.95(a) ± 81.27</td>
<td>0.44(a) ± 0.17</td>
<td>1.35(a) ± 0.00</td>
</tr>
</tbody>
</table>

Values are expressed as mean of two replicates ± S.D. Means with the different superscripts across a row are significantly (P≤0.05) different. A = 100% Wheat flour and date pulp for biscuits (Control sample), B = 96%: 4% Ratio of wheat and soybean-hull flour in the biscuits, C = 92%: 8% Ratio of wheat and soybean-hull flour in the biscuits, D = 88%: 12% Ratio of wheat and soybean-hull flour in the biscuits, E = 84%: 16% Ratio of wheat, and soybean-hull flour in the biscuits.
Hardness, as defined by Grasso et al. (2019), is the characteristic of a biscuit that represents its maximal resistance to impact at the time the sample started to break. The results of this study’s hardness tests may reflect the impact of solid state fermentation on the protein level of soybean hull flour, which may affect hardness.

The springiness value of biscuits made with wheat-and-soy flour ranged from 0.37 to 0.49. The lowest value was recorded for sample B while sample E had the highest value. Springiness value did not increase or decrease in any particular order, however, sample C and E recorded a higher springiness compared to the control. In comparison to the value reported by Ben-Jeddou et al. (2017) for cookies made from soybean residue, the springiness value achieved in this investigation is, on average and lower.

These authors correlated the results with gluten-free biscuits having denser cell structures. It is evident that soybean hull inclusion becomes stickier. This could explain an increase in the adhesive force between flour particles during mixing, which was probably made stronger by the addition of fermented soybean hull. Except for sample C, which exhibited a significant difference when compared to the control and other samples, there was no difference in the chewiness of biscuit samples made by adding varying levels of fermented soybean hull flour in wheat flour and the control (p > 0.05).

This may be explained by the mixture’s balanced fiber level, which increased the chewiness (Table 4). This supports the research of Gómez et al. (2007), which revealed an increase in biscuit chewiness and suggested a positive relationship between chewiness and dietary fiber. All samples, with the exception of sample C, had gumminess values higher than the control, with values ranging from 172.03 to 514.47 N. Gumminess was seen to rise as soybean hull flour was added, but to fall at greater levels. This is in line with the findings of Martnez-Cervera et al. (2012) for non-gluten flour cookies and muffins.

According to these authors, increased gumminess is likely to be attributed to gel formation by fibers included in composite flour. Samples with minimal gumminess characteristics might be suitable for making crispy biscuits. When compared to the control, reduced values were recorded for all samples after the presence of soybean hull flour for the energy to peak. Their values ranged between 0.29 and 0.55 N.m., and they differed considerably (p< 0.05). Reduced energy to peak is a sign of low hardness and easy mastication.

The stringiness was between 1.61 and 2.07 mm. According to Table 5, sample E, which contained 16% fermented soybean hull, had the greatest values, whereas sample C had the lowest values and did not differ from the control substantially (p > 0.05). These authors reported that the high fibre content of the flour alternative, which had a significant impact on the springiness textural qualities of cookies, was the cause of the rise in stringiness. This suggests that fermented soybean hull can be beneficial for improving the springiness of baked food samples like biscuits.

**Effect of Bacillus subtilis at 72hours Fermentation on the Physical Properties of Biscuit from Composite Flour Soybean-Hull and Date Pulp Flour**

The physical characteristics of date pulp-sweetened biscuit were affected by soybean hull fermentation with *Bacillus subtilis* at 72 hours, as shown in Table 6. The weight of the samples of cookies varied from 12.03 2.13 to 15.30 1.03. The sample of wheat flour that had

---

<table>
<thead>
<tr>
<th>Sample</th>
<th>Hardness (N)</th>
<th>Springiness (N.m)</th>
<th>Adhesiveness (N.s)</th>
<th>Cohesiveness (N)</th>
<th>Chewiness (N)</th>
<th>Gumminess (N)</th>
<th>Energy to Peak (N.m)</th>
<th>Stringiness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>763.75±7.35</td>
<td>0.44±0.01</td>
<td>0.02±0.01</td>
<td>0.36±0.02</td>
<td>79.86±16.30</td>
<td>277.76±18.88</td>
<td>0.55±0.01</td>
<td>1.61±0.02</td>
</tr>
<tr>
<td>B</td>
<td>581.67±8.43</td>
<td>0.37±0.00</td>
<td>0.01±0.00</td>
<td>0.39±0.04</td>
<td>64.37±29.45</td>
<td>271.02±17.55</td>
<td>0.47±0.02</td>
<td>1.73±0.00</td>
</tr>
<tr>
<td>C</td>
<td>536.90±32.10</td>
<td>0.47±0.01</td>
<td>0.01±0.00</td>
<td>0.50±0.00</td>
<td>240.57±15.65</td>
<td>514.47±39.94</td>
<td>0.53±0.06</td>
<td>1.64±0.00</td>
</tr>
<tr>
<td>D</td>
<td>477.85±4.08</td>
<td>0.43±0.00</td>
<td>0.05±0.03</td>
<td>0.33±0.01</td>
<td>70.47±2.56</td>
<td>174.57±4.47</td>
<td>0.29±0.00</td>
<td>1.71±0.02</td>
</tr>
<tr>
<td>E</td>
<td>455.71±85.89</td>
<td>0.49±0.00</td>
<td>0.12±0.00</td>
<td>0.47±0.01</td>
<td>75.33±13.44</td>
<td>172.03±7.62</td>
<td>0.35±0.09</td>
<td>2.07±0.00</td>
</tr>
</tbody>
</table>

Values are expressed as mean of two replicates ± S.D. Means with the different superscripts across a row are significantly (P≤0.05) different.

A = 100%; Wheat flour and date pulp for biscuits (Control sample).
B = 96%; 4% Ratio of wheat and soybean-hull flour in the biscuits.
C = 92%; 8% Ratio of wheat and soybean-hull flour in the biscuits.
D = 88%; 12% Ratio of wheat and soybean-hull flour in the biscuits.
E=84%; 16% Ratio of wheat and soybean-hull flour in the biscuits.

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Table 5: Effect of *Aspergillus oryzae* at 72hours fermentation on the textural properties of biscuit from composite flour soybean-hull and date pulp flour
been completely refined (W) was the heaviest and bulkiest. This might be as a result of more gluten being present in the 100% wheat flour, which is in charge of better dough development and elasticity (Badifu et al., 2005). Weights were lower for the wheat and combination flours. With the exception of samples C and D, which are similar, all of the samples had significant (P<0.05) weight differences, while the weight of the biscuit increased as level of soybean-hull flour in the formulation increased. This might be as a result of the increased protein content brought on by the addition of soybean-hull flour. The thickness ranged from 6.24 ± 0.69 to 7.38 ± 0.47, with sample D having the highest thickness and sample C having the lowest thickness. The biscuit’s capacity to withstand stress decreases with decreasing thickness. Hence, date pulp influences thickness and diameter (sugar dissolution) (inhibiting gluten development). There was no statistically significant (P≥0.05) variation in the volume of any of the biscuit samples, which varied from 5.08 ± 0.08 to 5.18 ± 0.08. The diameter of the biscuit varied from 54.11 ± 0.72 to 54.94 ± 0.67, indicating that the addition of soybean-hull flour had no effect on the diameter. The control biscuits had a much higher diameter than those made with a high proportion of soybean hull, Increases in the diameter were seen after adding soy flour to wheat cassava biscuits (cookies) (Olowamukomi et al., 2011). The diameter of the biscuits significantly increased as the amount of soybean-hull flour in the supplementation increased. The blended biscuit’s larger diameter is an added benefit as a result of the potential for higher market prices. This suggests that baking industries will likely enhance their profitability if they start using non-wheat flours, including soybean hull flour, in their biscuit recipes while simultaneously enhancing the local population’s nutrition. The density of the biscuit samples varied from 5.08 ± 0.08 to 5.18 ± 0.08; there was a significant difference in all the samples’ densities (P<0.05), and the densities of the samples increased with the addition of soybean-hull flour. As a result of the addition of soybean hull, the density of the biscuits increased, which may influence the packaging material selection. The spread ratio of the biscuit samples varied from 7.32 ± 0.49 to 8.76 ± 0.86. All of the samples had a significant (P<0.05) difference in spread ratio. According to Agu et al. (2007), the difference in the particle sizes and properties of the constituent flours of soy and wheat is what caused the greater spread ratio seen in cookie samples made with soyflour substitutes.

**Effect of Aspergillus oryzae at 72 hours Fermentation on the Physical Properties of Biscuit from Composite Flour Soybean-Hull and Date Pulp Flour**

The physical properties of date pulp-sweetened biscuits after 72 hours of fermentation with *Aspergillus oryzae* are summarized in Table 7. The weight of each sample of cookies varied from 11.03 ± 0.63 to 17.59 ± 1.58. All of the samples’ weights differed significantly (P<0.05), with the exception of samples C and D, which are similar. The weight of the biscuit increased as the amount of soybean hull in the formulation increased. This might be because adding soybean-hull flour has increased the protein content. The weight of the composite biscuit is an added benefit because it might attract a higher price on the market. The thickness ranged from 6.19 ± 0.56 to 8.86 ± 0.23, with sample D having the highest thickness and sample B having the lowest thickness. The volume of the biscuit samples ranged from 5.14 ± 0.10 to 5.26 ± 0.08; there was no significant (P≥0.05) difference in volume between any of the samples. The diameter of the biscuit varied from 54.18 ± 1.00 to 54.94 ± 0.67, indicating that the integration of soybean-hull flour had no effect on the diameter. The diameter of the control biscuits was noticeably larger than the biscuits made with different amounts of soybean hull. The diameter of the biscuits significantly decreased as the quantity of soybean-hull flour in the supplementation increased. The density of the biscuit samples ranged from 2.14 ± 0.12 to 3.34 ± 0.31; all samples, with the exception of samples D, it differed significantly (P<0.05), and the density of the samples increased with the addition of soybean-hull flour. The spread ratio of the biscuit samples ranged from 6.12 ± 0.21 to 8.81 ± 1.17, and there was a significant difference (P<0.05) between the spread ratios of all the samples. The decrease in the spread ratio may have been brought on by the addition of more soybean hull, which may have increased the paste’s viscosity and hindered its ability to spread. The spread ratio is used to

<table>
<thead>
<tr>
<th>Sample</th>
<th>Weight (g)</th>
<th>Thickness (mm)</th>
<th>Volume (cm³)</th>
<th>Diameter (mm)</th>
<th>Density (g/cm³)</th>
<th>Spread ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15.30±1.03</td>
<td>6.44±0.40</td>
<td>5.16±0.10</td>
<td>54.94±0.67</td>
<td>2.51bc±0.19</td>
<td>8.55±0.53</td>
</tr>
<tr>
<td>B</td>
<td>12.03±2.13</td>
<td>6.85±0.26</td>
<td>5.08±0.08</td>
<td>54.11bc±0.72</td>
<td>2.32±0.41</td>
<td>7.46bc±0.36</td>
</tr>
<tr>
<td>C</td>
<td>12.70±0.09</td>
<td>7.38±0.47</td>
<td>5.16±0.08</td>
<td>53.54±0.79</td>
<td>2.49bc±0.13</td>
<td>7.32±0.49</td>
</tr>
<tr>
<td>D</td>
<td>12.94bc±1.06</td>
<td>6.24±0.69</td>
<td>5.18±0.08</td>
<td>53.32bc±1.20</td>
<td>3.01±0.22</td>
<td>8.24bc±0.41</td>
</tr>
<tr>
<td>E</td>
<td>14.08bc±1.54</td>
<td>6.51bc±0.33</td>
<td>5.12±0.07</td>
<td>53.85bc±0.66</td>
<td>2.75bc±0.28</td>
<td>8.76±0.86</td>
</tr>
</tbody>
</table>

Values are expressed as mean of two replicates ± S.D. Means with the different superscripts across a row are significantly (P<0.05) different.

A = 100% Wheat flour and date pulp for biscuits (Control sample).
B = 96%: 4% Ratio of wheat and soybean-hull flour in the biscuits.
C = 92%: 8% Ratio of wheat and soybean-hull flour in the biscuits.
D = 88%: 12% Ratio of wheat and soybean-hull flour in the biscuits.
E = 84%: 16% Ratio of wheat and soybean-hull flour in the biscuits.
assess the quality of the flour used to make biscuits and the biscuits’ capacity to rise (Bala et al., 2015). The more desirable a biscuit is, the bigger the spread ratio (Chauhan et al., 2016).

Effect of Bacillus subtilis at 72hours Fermentation on the Sensory Properties of Biscuit from Composite Flour Soybean-Hull and Date Pulp Flour

Results for the sensory evaluation of the composite biscuit from wheat flour, soybean-hull fermented with Bacillus subtilis at 72hrs and date pulp are represented in Table 8. Samples were scored for taste, flavour, colour, texture, crispiness and general acceptability. Samples A and E had the lowest and highest taste ratings, respectively, scoring between 5 ± 2.89 and 7 ± 2.27. Only samples A and E differ from each other significantly (P≤ 0.05). Samples D and B had the lowest and highest flavour scores, respectively, ranging from 5 ± 2.14 to 7 ± 1.70. Score differences are statistically significant (P≤0.05). Color ratings ranged from 5 ± 1.89 to 7 ± 0.81, with samples A and D having the lowest and highest ratings, respectively; all values are significantly different (P≤0.05) with the exception of samples C and E. Samples A and D had the lowest and highest texture scores, respectively, with scores ranging from 5 ± 1.90 to 6 ± 0.81; values are significantly different (P≤0.05). Samples E and A had the lowest and highest crispiness scores, respectively, ranging from 5±1.92 to 7±1.21. All values are significantly different (P≤0.05) with the exception of samples A and B. Samples B and D had the lowest and highest overall acceptability scores, respectively, ranging from 5 ± 1.99 to 7 ± 2.29. Except for samples B and C, scores differ significantly (P≤0.05). While there was no significant (P>0.05) difference in the taste scores from the control, the findings of the taste test showed that the addition of date powder at a 30% replacement ratio to the biscuits improved the organoleptic quality of the product. The obtained findings correspond with those of Mohamed et al. (2016), who stated that 30% date powder may be added to a formula to produce highly acceptable biscuits. There was a significant (P≤0.05) difference between the aroma of the composite samples and the control. According to the Hedonic Scale, the aroma value for the composite samples revealed that consumers liked nor disliked the fermented soy bean hull-based biscuit. This is perhaps because the biscuit is a new product that the customers are not accustomed to Iwe (2002). The color of the biscuits produced was darker and more favoured by the panelists because there was an increase in the addition of soybean husks flour and date pulp (score approximately 7.0). Due to the high fiber and carbohydrate content of the date pulp and soybean hull, respectively, and how they reacted to the heat during baking, the darker the color of this biscuit may be, making it more palatable. Due to its impact on food acceptance, color is a crucial sensory component as millard reaction’s brown color is associated to baked goods. (Ubbor & Akobundu, 2009). Ryu & Surh (2021) revealed that during the fermentation process, Bacillus subtilis is known to produce a number of enzymes, including amylase and protease, which give traditional Doenjang its distinctive flavor and aroma. Yet, with the addition of more soybean hull flour, the average mean scores for the texture increased from 5.40 to 6.92. With regard to the product’s crunchiness, a decline in crunchiness was seen as the amount of fermented soybean hull inclusion increased. This could, however, be explained by the hull’s lower gluten concentration.

The panelists rated Sample E as their highest approval because it was their top choice for supplementing with 16% soybeans hull flour.

Effect of Aspergillus oryzae at 72hours Fermentation on the Sensory Properties of Biscuit from Composite Flour Soybean-Hull and Date Pulp Flour

The effect of soybean hulls flour supplementation of microbial species Aspergillus oryzae on the sensory quality of the date pulp sweetened biscuit is summarized in Table 9. Samples were scored for taste, flavour, colour, texture, crispiness and general acceptability. Samples E and A had the lowest and highest taste ratings 5 ± 1.70 and 7 ± 1.38, respectively. The samples differ significantly (P≤ 0.05). Samples B and E had the lowest and highest flavour scores 5 ± 1.18 and 7 ± 1.67, respectively. Scores differ significantly (P≤ 0.05). Samples A and E had the lowest and highest color scores, respectively, ranging from 5 ± 1.70 to 7 ± 1.48. All sample values are significantly different (P≤0.05), with the

Table 7: Effect of Aspergillus oryzae at 72hours fermentation on the physical properties of biscuit from composite flour soybean-hull and date pulp flour

<table>
<thead>
<tr>
<th>Sample</th>
<th>Weight (g)</th>
<th>Thickness (mm)</th>
<th>Volume (cm³)</th>
<th>Diameter (mm)</th>
<th>Density (g/cm³)</th>
<th>Spread ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12.94± 1.06</td>
<td>6.44± 0.40</td>
<td>5.14± 0.10</td>
<td>54.94± 0.67</td>
<td>2.51± 0.19</td>
<td>8.55± 0.53</td>
</tr>
<tr>
<td>B</td>
<td>11.03± 0.63</td>
<td>6.19± 0.56</td>
<td>5.15± 0.14</td>
<td>53.61± 3.17</td>
<td>2.14± 0.12</td>
<td>8.81± 1.17</td>
</tr>
<tr>
<td>C</td>
<td>12.06± 0.87</td>
<td>7.73± 0.55</td>
<td>5.16± 0.10</td>
<td>53.36± 1.23</td>
<td>2.35± 0.16</td>
<td>6.93± 0.48</td>
</tr>
<tr>
<td>D</td>
<td>16.39± 1.40</td>
<td>8.45± 0.55</td>
<td>5.22± 0.08</td>
<td>54.18± 1.00</td>
<td>3.13± 0.44</td>
<td>6.44± 0.46</td>
</tr>
<tr>
<td>E</td>
<td>17.59± 1.58</td>
<td>8.86± 0.23</td>
<td>5.26± 0.08</td>
<td>54.22± 1.28</td>
<td>3.34± 0.31</td>
<td>6.12± 0.21</td>
</tr>
</tbody>
</table>

Values are expressed as mean of two replicates ± S.D. Means with the different superscripts across a row are significantly (P≤0.05) different.

A = 100% Wheat flour and date pulp for biscuits (Control sample). B = 96%; 4% Ratio of wheat and soybean-hull flour in the biscuits. C = 92%; 8% Ratio of wheat and soybean-hull flour in the biscuits. D = 88%; 12% Ratio of wheat and soybean-hull flour in the biscuits. E = 84%; 16% Ratio of wheat and soybean-hull flour in the biscuits.
Table 8: Effect of Bacillus subtilis at 72 hours fermentation on the sensory properties of biscuit from composite flour soybean-hull and date pulp flour

<table>
<thead>
<tr>
<th>Sample</th>
<th>Taste</th>
<th>Flavour</th>
<th>Colour</th>
<th>Texture</th>
<th>Crispiness</th>
<th>General acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.06±2.89</td>
<td>6.64±2.53</td>
<td>5.60±1.89</td>
<td>5.40±1.90</td>
<td>7.64±1.21</td>
<td>6.10±1.00</td>
</tr>
<tr>
<td>B</td>
<td>6.84±2.06</td>
<td>7.28±1.70</td>
<td>5.72±2.05</td>
<td>5.72±2.05</td>
<td>7.16±1.89</td>
<td>5.76±1.99</td>
</tr>
<tr>
<td>C</td>
<td>5.88±2.30</td>
<td>5.40±2.14</td>
<td>5.96±2.30</td>
<td>5.96±2.30</td>
<td>6.16±1.37</td>
<td>5.80±1.29</td>
</tr>
<tr>
<td>D</td>
<td>5.40±2.29</td>
<td>5.30±2.24</td>
<td>7.92±0.81</td>
<td>6.92±0.81</td>
<td>5.76±1.30</td>
<td>6.60±1.71</td>
</tr>
<tr>
<td>E</td>
<td>7.08±2.47</td>
<td>6.00±1.58</td>
<td>6.28±1.82</td>
<td>6.16±2.67</td>
<td>5.12±1.92</td>
<td>7.32±2.29</td>
</tr>
</tbody>
</table>

Values are expressed as mean of two replicates ± S.D. Means with the different superscripts across a row are significantly (P≤0.05) different.

A = 100% Wheat flour and date pulp flour (Control sample).
B = 96%: 4% Ratio of wheat and soybean-hull flour in the biscuits.
C = 92%: 8% Ratio of wheat and soybean-hull flour in the biscuits.
D = 88%: 12% Ratio of wheat and soybean-hull flour in the biscuits.
E = 84%: 16% Ratio of wheat and soybean-hull flour in the biscuits.

except of B and C. The samples D and A had the lowest and highest texture scores, respectively, ranging from 5 to 1.67 to 7 to 1.68; the differences in the results are significant (P≤0.05). Samples E and A had the lowest and greatest crispness ratings, respectively, ranging from 5±1.69 to 7±1.29; results are significantly different (P≤0.05). Samples C and B had the lowest and highest overall acceptability scores, respectively, ranging from 6±1.04 to 7±1.48. Except for samples C and D, scores are significantly (P≤0.05) different. As there was no significant (p>0.05) difference in the taste scores for the control, the taste results showed that the addition of date powder at a 30% replacement ratio to the biscuits as a sugar substitution improved the organoleptic quality of the product. It was reported that the taste parameter usually determines the acceptability of the product (Banureka & Mahendran, 2009). Participants commented on how the soybean-hull fungus biscuit tasted just a little bit salty. According to the results, A. oryzae-based dishes require extremely little salt to be produced; this is probably because the fungus naturally has the umami taste. Based dishes require extremely little salt to be produced; just a little bit salty. According to the results, the soybean-hull fungus biscuit tasted somewhat acceptable by the panel.

Table 9: Effect of Aspergillus oryzae at 72 hours fermentation on the sensory properties of biscuit from composite flour soybean-hull and date pulp flour

<table>
<thead>
<tr>
<th>Sample</th>
<th>Taste</th>
<th>Flavour</th>
<th>Colour</th>
<th>Texture</th>
<th>Crispiness</th>
<th>General acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.78±1.38</td>
<td>5.44±1.39</td>
<td>5.06±1.70</td>
<td>7.08±1.68</td>
<td>7.80±1.29</td>
<td>7.01±1.11</td>
</tr>
<tr>
<td>B</td>
<td>6.36±2.16</td>
<td>5.36±1.18</td>
<td>6.20±1.08</td>
<td>5.64±1.47</td>
<td>6.44±1.39</td>
<td>7.36±1.48</td>
</tr>
<tr>
<td>C</td>
<td>5.64±1.68</td>
<td>6.55±1.13</td>
<td>6.24±1.05</td>
<td>6.36±1.35</td>
<td>6.32±1.49</td>
<td>6.20±1.04</td>
</tr>
<tr>
<td>D</td>
<td>5.60±1.70</td>
<td>6.68±1.29</td>
<td>6.00±1.79</td>
<td>5.24±1.67</td>
<td>5.80±1.08</td>
<td>6.24±1.63</td>
</tr>
<tr>
<td>E</td>
<td>5.16±1.73</td>
<td>7.28±1.67</td>
<td>7.24±1.48</td>
<td>6.12±1.13</td>
<td>5.72±1.69</td>
<td>6.90±1.50</td>
</tr>
</tbody>
</table>

Values are expressed as mean of two replicates ± S.D. Means with the different superscripts across a row are significantly (P<0.05) different.

A = 100% Wheat flour and date pulp flour (Control sample).
B = 96%: 4% Ratio of wheat and soybean-hull flour in the biscuits.
C = 92%: 8% Ratio of wheat and soybean-hull flour in the biscuits.
D = 88%: 12% Ratio of wheat and soybean-hull flour in the biscuits.
E = 84%: 16% Ratio of wheat and soybean-hull flour in the biscuits.
CONCLUSION

According to proximate analysis of the biscuit sample, there was an increase in protein, fiber, fat, and ash content and a decrease in moisture and carbohydrate content as with the increase of the proportion of soybean flour. The sample with the most impact on health sensory characteristics of the composite biscuit showed an improvement in the taste, appearance, and flavour and overall acceptability, sample E was highly regarded by the panel because it had the most preferred Bacillus subtilis effect of 16% after 72 hours of soybean hulls flour supplementation, while sample B had the most desired Aspergillus oryzae effect of 4% after 72 hours of soybean hulls flour supplementation. Such composite flour has the potential to be a functional diet, especially for celiac, diabetic, and obese patients, and biscuits made from it could aid in the fight against protein-energy malnutrition.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in this study.

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