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Original Research

Nutritional and Functional Evaluation of Winged Yam (*Dioscorea alata*) Composite Biscuits for Health-Promoting Diets

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ABSTRACT

Background: In order to ensure human health and raise the standard of living for people, plants and their crops have been extremely important. Yams are extremely important for both food security and medicine in poor nations. *Dioscorea alata*, a species of yam, provides an advantage for sustained production because of its relatively strong agronomic traits. This study's main goal was to generate composite food products, and the yam's relatively strong agronomic characteristics offer a sustained production advantage. **Methods:** The food items that were created, namely biscuits, had improved nutritional value. Composite biscuits were made by combining wheat flour with D. *alata* flour in three distinct formulas (5%, 10%, and 15%). **Results:** *D. alata* Yam's compositional analysis revealed that the samples with and without peels had the following contents: moisture (69.13±1.48%) and 66.85±1.47%); ash (2.11±0.03%) and (1.99±0.19%); fat (0.40±0.80%) and 1.07±0.12; crude fiber (2.06±0.12%) and (2.57±0.22%); protein (2.4±1.39) and (6.31±0.34) and carbohydrates (28.01±1.40%) and (28.24±1.52%), respectively. Overall, composite flour can be used as an unusual ingredient in baked goods. Based on the sensory evaluation, the results indicated that biscuits made with 5% composite flour were superior to those made with 10% and 15% composite flour. **Conclusion:** It was shown that food products manufactured with composite flour can nevertheless have properties that are comparable to those made with whole wheat flour. Overall, the test panelists found the created biscuits (5% DAYF integrated) to be satisfactory in terms of appearance, color, flavor, taste, and texture.

Keywords: Cheapest source; carbohydrate; fiber; water and oil absorption capacity; sensory attributes

1. INTRODUCTION

The world's tropical regions are where *D. alata* grows most commonly. It is widespread in our nation. Compared to other root and tuber crops, yams—specifically, *D. alata*—have received less research attention.(1) In West Africa, where food production cannot keep up with population expansion, *D. alata* has the potential to improve food security and generate wealth.[2] It is the most widely distributed species and plays a crucial role when other food crops are scarce because of its relatively superior agronomic traits, which include higher nutritive value, longer storage life, and ease of propagation and yields.[3] Farmers' choices of yam variety and quantity are influenced in part by what customers consider to be a suitable level of food quality.[4]

The primary acceptability parameters that consumers use to assess the quality of yam tubers are sensory/organoleptic characteristics like texture, appearance, and flavor/taste.[5] The chemical, physicochemical, and pasting properties of tuber starch—a major chemical component of yam—have the biggest effects on these sensory variables.[6] To support food quality improvement initiatives and its application in a variety of food products, a thorough understanding of *D. alata*'s qualities and their relationship to product organoleptic properties is required. As is already feasible for goods based on wheat, maize, and cassava, it will also improve value addition through processing.[7] Plants and their fruits have had a significant impact on human health and the enhancement of their quality of life. The leaves, roots, stems, flowers, and fruits of many plants are edible and therapeutic.[8]

People in Asia, the Caribbean, Africa, and America rely heavily on yams (*Dioscorea* spp.) for both food and revenue. The people who harvest and eat them enjoy a holy lifestyle, and they feel like they belong in the social and cultural spheres.[9] The yams are classified under the genus *Dioscorea* in the section Enantiophyllum. Because it promotes the use of locally grown crops as flour and decreases the importation of wheat flour, composite flour is seen as beneficial in developing nations.[10] The expanding markets for confections have led to a rise in the substitution of local raw materials for wheat flour. As a result, a number of developing nations have promoted the start of programs to assess the viability of using locally accessible flours in place of wheat flour.[11] Furthermore, the Food and Health Organization (FAO) introduced the idea of composite technology in 1964 with the goal of lowering the cost of assistance for temperate nations by promoting the use of native crops like cassava, yam, maize, and others in partial replacement of wheat flour.[12]

According to the FAO, using domestically grown products instead of wheat could meet demand for biscuit, bread, and pastry products, and the use of composite flour in a variety of food products would be economically advantageous if wheat imports could be decreased or even eliminated.[13] Although the texture and properties of the bakery products made with composite flour differed from those made with wheat flour, they were of good quality and had some qualities in common with wheat flour cakes. They also had a higher nutritional value and looked better. Wheat is regarded as nutritionally inadequate while being a rich source of calories and other nutrients because its cereal proteins lack important amino acids like lysine and threonine.[14]

Therefore, the growing number of studies on the impact of various types of materials used to create flour on the physiochemical and functional qualities has been prompted by the increasing number of applications of composite flour in various bread and pastry items.[15] The experience with composite flours has made it abundantly evident that wheat is a necessary ingredient in many of them for reasons of customer acceptance as well as product technology.[16] Additionally, they noted that the amount and quality of wheat gluten, as well as the types of ingredients used, greatly influence the %age of wheat flour needed to produce a certain impact in composite flours.[16] Biscuits are nutritious snacks made from unappetizing dough that is heated in an oven to create a tasty product. When baking biscuits, the main ingredients are flour, oil, and sugar; additional auxiliary ingredients include milk, salt, flouring agent, and aerating agent.[17] Biscuits are made from a mixture of flour and water, but they can also include oil, sugar, and other ingredients.[18]

The dough is then allowed to rest for a while before being rolled between rollers to create a sheet. In many nations, biscuits are a readily consumable, affordable, and practical food item that is enjoyed by people of all ages.[19] Due to a number of appealing characteristics, such as increased consumption, lower cost compared to other processed foods, a variety of tastes, easy availability, high eating quality, and a comparatively long shelf life, bakery food products—particularly biscuits—are currently gaining popularity in Bangladesh across all age groups in both rural and urban areas.[20] In order to produce biscuits, breadfruit was ground into flour and added to wheat flour in %ages of 0, 5, 10, 15, 20, and 25.[21] This study demonstrated that adding breadfruit flour might enhance the biscuits' quality in terms of ash and crude fiber. Additionally, it was observed that sweet potato flour enhanced biscuits' flavor and texture while also considerably raising the product's dietary fiber and mineral content.[22]

When making glucose-type biscuits, finger millet seed coat matter could replace up to 20% of the wheat flour. The cookies' thickness varied significantly, but their diameter did not vary greatly.[23] It is possible to add up to 10% fenugreek flour to biscuit recipes without compromising the biscuits' overall quality, texture, flavor, or nutritional value.[24] Since population nutrition in developing nations is a major public health concern, producers have already been urged to increase the nutritional value of staple and choice crops. Plants and their crops have been vital to maintaining human health and improving people's quality of life. In underdeveloped countries, yams are crucial for both food security and medicine. The yam species *Dioscorea alata* offers a sustained production advantage due to its comparatively robust agronomic features.

2. METHODS

2.1 Study Design

Dioscorea alata and other ingredients needed to make food products were bought from Swapna Super Shop in Tangail Sadar, Tangail, and Sakhipur Upazila. At MBSTU, Santosh-1902, Tangail, the Food Technology and Nutritional Science Department's FTNS laboratory performed compositional studies, and the food processing laboratory of the same department manufactured food products. In order to get successful results, our project employed a combination of purposive sampling. Initially, *D. alata* yams were gathered at random from Sakhipur upazila in Tangail. The sample was then chosen for examination.

2.2 Compositional Analysis of D. alata

2.2.1 Determination of moisture

The empty crucible was first dried for three hours at 105 °C in the oven before being moved to the desiccators to cool. A computerized electronic balance was then used to weigh the empty crucible. After that, around 5 g of the material was weighed and distributed out to guarantee homogeneity inside the crucible. After that, the sample-filled crucible was put in an air oven set to 105 °C for three hours to dry. 13 Finally, the crucible and its dried sample were weighed after it had been moved to the desiccators to cool. To make sure the weight is stable, this was done thrice in a row.[25]

2.2.2 Determination of ash

Three decimal places were used to weigh the crucible. After that, roughly 5 g of the sample was weighed into the crucible and burned for three to four hours at 6000 degrees in a muffle furnace after first being heated over a low flame until all of the material was totally charred. To keep the fluffy ash from escaping during heating, the crucible was covered with a lid. These were then allowed to cool in the desiccators. The crucible was then used to weigh the ash.[26]

2.2.3 Determination of fat

To filter paper and wrap, approximately 5 g of the sample was weighed. After that, the sample was placed in an extraction thimble and moved into a Soxhlet, which was then filled with roughly 250 milliliters of petroleum ether and placed on the heating mantle. The heating mantle was turned on after the Soxhlet equipment was connected and the water was turned on to cool them. The sample was heated at a rate of 150 drops per minute for approximately three to four hours. The extracted oil and solvent were then added to the previously weighed beaker. The beaker was then kept in an incubator set between 80°C and 90°C until the solvent had evaporated and the beaker was fully dry. After drying, the beaker transferred to the desiccators to cool and reweighed the beaker and its dried content.[27]

2.2.4 Determination of crude fiber

200 ml of boiling 0.225 N (1.25% w/v) sulfuric acid was poured to a 500 ml beaker containing about 5 g of the moisture and fat-free sample after it had been weighed. After 30 minutes of boiling, water was added to the mixer to keep the volume steady. Following boiling, the mixture was filtered, and the residue was repeatedly cleaned with hot water to remove any remaining acid. Next, 200 milliliters of 0.313 N (1.25%) NaOH were added to the residue that was free of acid. After 30 minutes of boiling, it was filtered and rinsed with hot water to remove any remaining alkali. Once more, ether and alcohol were used to wash the combination, and the residue was then prepared for the measurement of crude fiber. After that, the porcelain crucible was weighed, the residue was retained, and it was baked for three hours at 105 degrees Celsius. The sample was then allowed to cool in desiccators. After weighing the sample, it was heated to 600ºC for three to four hours in a muffle furnace. After cooling in desiccators, the residue was finally weighed as ash.[28]

2.2.5 Determination of carbohydrate

The Anthrone technique was used to determine the carbohydrate content. The Anthrone method was used to determine the amount of carbohydrates. Concentrated sulfuric acid is used to hydrolyze carbohydrates into simple sugars. Glucose is dehydrated to hydroxymethyl furfural in a hot, acidic media. This chemical has a maximal absorption at 620 nm and generates a green product with anthrone.[29]

2.2.6 Preparation of composite *D. alata* yam flour (DAYF) with wheat flour

Initially, organically grown *D. alata* yams were gathered and cleaned with water to get rid of any debris. Following a size grading process, the fruits were sliced into tiny pieces. The little fruit fragments were freeze-dried. *D. alata* yam flour was then made by mixing the dried fruits. The composite flour was created by combining wheat flour with *D. alata* yam flour.[30] All of the freeze-dried fruit flour was kept at room temperature in a sterile, airtight plastic container.

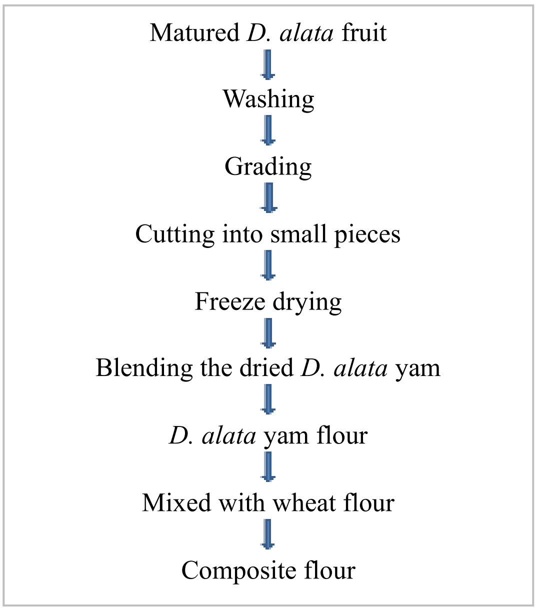

Figure 1. Flow sheet for the preparation of composite *Dioscorea alata* yam flour with wheat flour

2.3 Food Product Development from D. Alata Yam Flour with Wheat Flour

The local market does not carry food goods derived from a mixture of *D. alata* yam flour and wheat flour. We are motivated to create food products as a result. In many nations, biscuits are a readily consumable, affordable, and nutritious food item that is enjoyed by people of all ages. Biscuits are a common flour product. Depending on personal desire, it can be either unsweetened or sweetened. It is flat crisp. Hard dough, hard sweet dough, short dough, or soft dough can all be used to make biscuits. It is made by combining several ingredients, such as water, fat sweetener, and wheat flour, to create dough. In contrast to bread, the dough is baked in an oven without being allowed to ferment. In order to make the biscuits, *D. alata* yam flour is combined with wheat flour and combined with butter, oil, salt, sugar, egg, milk powder, and baking powder.[30] Table 1 below lists the food ingredients used in the creation of composite biscuits.

2.4 Procedure of Biscuit Making

After precisely weighing the butter, oil, and sugar, they were put in a big basin. For five minutes, it was mixed. By hand, the mixing was completed. After that, more components like baking powder, salt, milk powder, and egg were added, and everything was combined quickly while being mashed for five more minutes. After combining the aforementioned ingredients, *D. alata* yam flour and wheat flour were added. After mixing, it was left for five minutes to form dough. After that, the dough was left on the table to be kneaded and rolled into sheets.

Table 1. Amount of food ingredients for the development of composite biscuits

Food ingredients	Control	Sample 1 (5%)	Sample 2 (10%)	Sample 3 (15%)
Wheat flour (g)	100	95	90	85
DAYF (g)	0	5	10	15
Butter (g)	45	45	45	45
Sugar (g)	35	35	35	35
Milk (g)	5	5	5	5
Egg (g)	60	60	60	60
Baking powder (g)	0.8	0.8	0.8	0.8
Salt (g)	1	1	1	1

DAYF = *D. alata* yam flour

Raw biscuits were sheeted and then cut to the desired size. After that, it was placed on a baking tray. After that,raw biscuits were baked in a deck oven for eighteen minutes at 160 degrees Celsius. Before baking, the oven was preheated. The biscuits were let to cool for eight to ten minutes at room temperature.[31] The biscuits were cooled and then sealed and packed. Ultimately, biscuits were kept at room temperature.

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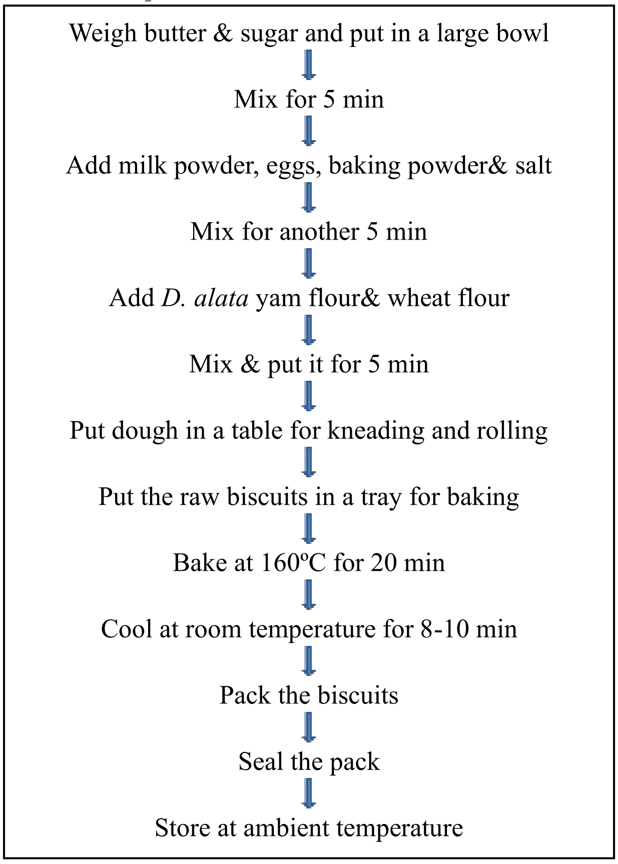

Figure 2. Flow sheet of developing biscuits from composite flour

2.5 Determination of Physical Characteristics of the Developed Biscuits

2.5.1 Weight

The biscuits' weight was calculated using the method mentioned by Laguna et al. (2013).[32] As soon as the biscuits cooled, their weights were measured using a weighting balance (model).

2.5.2 Diameter

The biscuits' diameter (D) was calculated using the AACC (2000) method. Using a ruler, the total diameter of four biscuits was measured after they were positioned edge-to-edge. For duplicate reading, the biscuits were rotated at 90-degree angles. The overage diameter was measured in millimeters after the experiment was conducted twice.[32]

2.5.3 Thickness

The thickness of the biscuits was determined according to the method mentioned by Laguna et al. (2013).[32] The biscuits thickness was measured with the aid of a digital vernier caliper with 0.01 mm precision.

2.5.4 Water and oil absorption capacity

The 1.0 g sample was combined with 10 ml of either refined soybean oil or distilled water, allowed to sit at room temperature for 30 minutes, and then centrifuged at 2000×g for 10 minutes. The %age of water or oil bound per gram of the sample was used to express the water or oil absorption capability.[32]

2.5.5 Color analysis

A Hunter Lab color analyzer was used to measure the developed biscuits' color. The three dimensions—L*, a*, and b*—in the Hunter's lab colorimeter indicate a sample's color. The a* value is the red-green coordinates (negative is green, positive is red), the b* value is the blue-to-yellow coordinates (negative is blue, positive is yellow), and the L* value is a measurement of brightness (100 for flawless white, and 0 for black, as the eye would judge it). The biscuits' L*, a*, and b* values were taken straight from the device.[33]

2.5.6 Texture analysis

A Texture Analyzer was used to measure the developed biscuits' texture at room temperature. The test speed was set to 1 mm/s while the instrument was in break mode. Tensile strength (highest force; N) and breaking length (distance at maximum force) were the two textural metrics that were acquired.[34]

2.5.7 Sensory evaluation of developed biscuits

Food preferences have been measured using a variety of techniques. The most popular approach uses a hedonic scale and a questionnaire of produced foods or food groups. An organoleptic quality evaluation measure called the Hedonic scale (Appendix B) allows the judge to describe how much a person likes something. Organoleptic evaluations of biscuits often rely on the samples' initial look, color, flavor, texture, and general acceptability. Twenty panelists from the Food Technology and Nutritional Science department at MBSTU, Santosh, Tangail, Bangladesh, who were teachers and students, evaluated the sensory qualities of the biscuits made with 5%, 10%, and 15% *D. alata* yam flour and control biscuits using a nine-point hedonic scale.[35]

2.6 Statistical Analysis

To determine if the observed differences were significant, $P < 0.05$ was employed. Each experiment underwent standard and mean analysis and was duplicated. To ascertain significance, a one-way ANOVA in SPSS and deviation using Microsoft Excel 2020 were employed.

2.7 Ethical Practices

The purpose of this study was to regulate compositional analysis of winged yam (*Dioscorea alata*) and its composite food product development. The study involving human subjects was reviewed and approved by the Ethics Committee of Mawlana Bhashani Science and Technology University ethical review committee (ERC) with approval number: 2023e02. Additionally, we received ethical permission from the departmental ethical review committee (ERC) after obtaining informed consent from each member of the sensory panel (permission no.: mbstu/ftns/2025/42(4)). This study was conducted in the department of Food Technology and Nutritional Science. Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh.

3. RESULTS

Below are the physical attributes of the created biscuits and a compositional analysis of *D. alata* yam.

3.1 Compositional Analysis of D. alata

Mature yams were used to measure the moisture content on a wet basis. We collected the sample both with and without the peel. The ash, lipid, crude fiber, carbohydrate, and protein content of the freeze-dried *D. alata* yam were then examined. Measurements were recorded in duplicate for every test for this reason. The findings are shown in Table 2.

Moisture content of *D. alata* yams was 69.13±1.482% and 66.85±1.466%; ash content was 2.11±0.035% and 1.99±0.192%; fat content was 0.40±0.08% and 1.07±0.116%; crude fiber content was 2.067±0.119% and 2.57±0.22%; protein was 2.4±1.39% and 6.31±0.34% and total carbohydrate content was 28.01±1.40% and 28.24±1.52% for yams without and with peels, respectively.

Table 2. Compositional analysis of *D. alata* yam

Parameters	Without peel	With peel
Moisture (%)	69.13±1.48^{a}	66.85±1.47^{b}
Ash (%)	2.11±0.03^{a}	1.99±0.19^{a}
Fat (%)	0.40±0.08^{a}	1.07±0.12^{b}
Protein	2.4±1.39^{a}	6.31±0.34^{b}
Crude fiber (%)	2.06±0.12^{a}	2.57±0.22^{a}
Carbohydrate (%)	28.01±1.40^{a}	28.24±1.52^{a}

*Values are mean ± S.D. of triplicate analyses and expressed as % dry matter. Means within a row with different superscripts are significantly different at $p < 0.05$ by Duncan Multiple range test.

3.2 Physical Analysis of Biscuits

The result revealed that incorporation of yam significantly affected all of the physical properties of biscuit samples was observed in the above Table 3. There was significant difference ($p > 0.05$) in the weight (8.25-9.69g), thickness (8.22-12.44mm), diameter (10.38-12.44mm), water absorption capacity (105.59-146.20%) and oil absorption capacity (65.43-79.48%) of the biscuit samples.

Table 3. Physical analysis of biscuits

Parameters	Control	Sample 1 (5%)	Sample 2 (10%)	Sample 3 (15%)
Weight(g)	8.25±0.09^{a}	9.51±0.22^{a}	8.73±0.25^{a}	9.69±0.33^{a}
Thickness(mm)	8.22±1.15^{b}	10.11±0.58^{a}	10.77±0.58^{a}	12.44±0.58^{a}
Diameter(mm)	10.38±1.91^{c}	10.19±0.96^{a}	10.75±1.15^{b}	12.44±0.96^{a}
Water absorption capacity (%)	105.59±5.65^{d}	125.32±7.25^{b}	138.30±4.53^{d}	146.20±3.92^{d}
Oil absorption capacity (%)	65.43±0.74^{a}	69.08±2.70^{d}	72.68±1.84^{d}	79.48±0.94^{a}

Values are means ± standard deviation of 3 replications. Means within a row with different superscripts are significantly different at $p < 0.05$ by Duncan Multiple range test.

3.3 Color Test of Developed Biscuits

By measuring the L*, a*, and b* values—which denote bright brown and yellowness of the biscuits, respectively—the color was ascertained. The control biscuits had the highest L* values, which progressively decreased as the amount of *D. alata* yam flour increased (Table 4). As more *D. alata* is added to the wheat flour, the a* value rises while the b* value falls, suggesting more blackness and less yellowness. The brightness of the biscuits gradually decreased as the *D. alata* levels rose. The increase in fiber content, which causes dark coloring, may be the cause of the decrease in whiteness. When making biscuits with yellow kenaf seeds, a parallel tendency in color pattern was observed.

3.4 Texture of developed biscuits

One of the most crucial factors in assessing the quality of biscuits is their texture. Texture and appearance are the main factors that determine the biscuits' quality.

The table 5 above displays the textile characteristics of the biscuits made with the composite flour. A texture analyzer was used to determine the developed biscuits' texture. The biscuits became harder when *D. alata* yam flour was added. The hardness value of the control biscuits was 50.07, but in samples 1 and 2, it rose to 69.93, 70.60, and 73.37, respectively.

Table 4. Color test of developed biscuits

Parameters	Control	Sample 1 (5%)	Sample 2 (10%)	Sample 3 (15%)
L*	59.43±0.11[b]	35.94±0.07[a]	38.51±0.02[a]	29.097±0.03[c]
a*	7.20±0.02[a]	7.40±0.12[a]	9.16±0.03[c]	11.80±0.07[b]
b*	26.72±0.08[c]	15.92±0.03[a]	15.59±0.01[a]	11.21±0.02[b]

Values are means ± standard deviation of 3 replications. Means within a column with different superscripts are significantly different at $p < 0.05$ by Duncan Multiple range test.

3.5 Sensory Evaluation of Developed Biscuits

The biscuit samples displayed varying degrees of acceptance in terms of appearance, color, flavor, taste, texture, and overall acceptability because each of these sensory characteristics varied greatly from one another. Results of several organoleptic quality parameters of control and composite (5%, 10%, and 15%) cookies were determined using Hedonic scales. Table 6 displayed the detailed data.

Table 5. Texture of developed biscuits

Biscuits types	Hardness (N)
Control	50.07±0.950[a]
Sample 1 (5%)	69.93±0.702[a]
Sample 2 (10%)	70.60±1.558[b]
Sample 3 (15%)	73.37±1.102[c]

4. DISCUSSION

In this investigation, the moisture content of *D. alata* yam was 69.13 ± 1.482%, as shown in Table 3. The moisture contents reported by Baah et al.[1] and Mulualem et al.[33] were 65–78.6% and 22.03 ± 2.4%, respectively. Our findings were very similar to those reported by Baah et al.[1] The current study found that the ash content of *D. alata* yam was 2.11 ± 0.03%. Mulualem et al.[33] reported an ash content of 2.61 ± 0.63%, which is comparable to our findings. According to the current study, the fat content of *D. alata* yam was 0.40 ± 0.08%. Mulualem et al.[33] reported a fat content of 0.32 ± 0.14%, which was also comparable to our findings.

The current study found that the fiber content of *D. alata* yam was 2.06 ± 0.12%. Baah et al.[1] reported that the fiber content of yams ranged from 1.4% to 3.8%, which is comparable to our findings. Dietary fiber is known to help prevent constipation. Total carbohydrate is an essential nutrient because it serves as one of the primary sources of energy in yams. The carbohydrate content of *D. alata* yam was 28.01 ± 1.40% in the present study. Our findings were in good agreement with those of Baah et al.,[1] who reported carbohydrate contents ranging from 22% to 31%. The observed differences in the reported values may be attributed to variations in soil conditions,

Table 6. Sensory evaluation of control and developed biscuits

Quality parameters	control	Sample 1	Sample 2	Sample 3
Appearance	7.50±0.85[a]	7.50±0.95[a]	6.75±0.97[b]	6.00±0.85[c]
Colour	7.00±0.85[a]	7.50±0.95[a]	6.75±0.97[b]	6.00±0.85[c]
Flavour	6.50±1.17[b]	7.90±0.87[a]	6.75±0.75[b]	6.91±0.79[b]
Taste	7.58±1.08[a]	8.92±1.08[d]	7.25±0.87[b]	6.50±1.17[c]
Texture	6.25±1.03[b]	7.30±0.72[a]	6.50±0.90[b]	6.25±1.14[a]
Crispiness	6.50±0.52[b]	7.00±0.74[a]	6.42±0.51[b]	6.42±0.90[b]
Hardness	6.17±1.27[a]	6.58±0.67[a]	6.33±1.43[a]	6.08±0.79[a]
Mouth feel	6.83±1.03[b]	7.08±0.90[a]	6.75±0.87[b]	6.09±1.24[c]
Overall acceptability	7.67±0.78[a]	7.80±0.90[a]	6.70±0.80[b]	6.50±0.90[b]

Values are means ± standard deviation of 3 replications. Means within a row with different superscripts are significantly different at $p < 0.05$ by Duncan Multiple range test.

maturity stage, geographical location, or sample type.

Overall, *D. alata* yam is a valuable food source with a favorable nutritional composition that supports a wide range of culinary applications. The results revealed that the incorporation of *D. alata* yam flour significantly altered the physical properties of the biscuit samples, as shown in Table 4. Significant differences ($p < 0.05$) were observed in the weight (8.25–9.69 g), thickness (8.22–12.44 mm), diameter (10.38–12.44 mm), water absorption capacity (105.59–146.20%), and oil absorption capacity (65.43–79.48%) of the biscuit samples. Similar observations have been reported for cookies prepared from wheat, walnut, and carrot flour.[38]

The color characteristics of the biscuits were evaluated using the L*, a*, and b* color values, representing lightness, redness, and yellowness, respectively, as presented in Table 5. The L* values of the control biscuits were the highest and gradually decreased as the proportion of *D. alata* yam flour increased. The a* values increased, whereas the b* values decreased with increasing levels of *D. alata* yam flour, indicating darker biscuits with reduced yellowness. As the level of *D. alata* yam flour increased, the brightness of the biscuits gradually declined. This reduction in lightness may be attributed to the increased fiber content, which contributes to darker coloration. A similar color trend was reported in biscuits prepared using yellow kenaf seeds.[33]

Texture is one of the most important quality attributes of biscuits. Along with appearance, it is a primary determinant of overall biscuit quality. The texture properties of biscuits prepared from the composite flour are presented in Table 6. The texture was evaluated using a texture analyzer. The addition of *D. alata* yam flour increased the hardness of the biscuits. Samples 1 and 2 had hardness values of 69.93, 70.60, and 73.37, respectively, which were comparable to those reported in a previous study.[35] In contrast, the control biscuits had a hardness value of 50.07.

As shown in Table 7, the control and biscuits containing 5% DAYF received the highest sensory scores. Biscuits containing 10% and 15% DAYF received scores of 6.75 and 6.00, respectively, whereas the control and 5% DAYF-incorporated biscuits received scores of 7.50. Based on the color evaluation, biscuits containing 5% DAYF were rated significantly higher than the other formulations. The control, 10%, and 15% DAYF-incorporated biscuits received color scores of 7.00, 6.75, and 6.00, respectively, while the 5% DAYF-incorporated biscuits received a score of 7.50.

The biscuits containing 5% DAYF also exhibited the highest flavor acceptability, with a score of 7.90. In comparison, biscuits containing 0%, 10%, and 15% DAYF received flavor scores of 6.50, 6.75, and 6.91, respectively. Similarly, biscuits containing 5% DAYF achieved the highest taste acceptability score (8.92), compared with the control (7.58), 10% DAYF (7.25), and 15% DAYF (6.50) biscuits. The 5% DAYF-incorporated biscuits also recorded the highest texture acceptability score (7.30), whereas the control, 10% DAYF, and 15% DAYF biscuits received scores of 6.25, 6.50, and 6.25, respectively. In terms of overall acceptability, biscuits containing 5% DAYF were rated superior to the other formulations. The control, 10% DAYF, and 15% DAYF biscuits received overall acceptability scores of 7.67, 6.70, and 6.50, respectively, while the 5% DAYF biscuits received the highest score (7.80), consistent with the findings of Yetunde et al.[34]

The sensory panel concluded that although all biscuit samples were generally acceptable, some specific sensory attributes differed among the formulations. Naturally grown *D. alata* yam has long been consumed and is traditionally believed to contribute to the management of various ailments. Incorporation of *D. alata* yam flour into biscuits enhances their nutritional value by increasing dietary fiber and fat content. Regular consumption of these biscuits may contribute to meeting daily nutritional requirements, particularly for fiber, fat, and carbohydrates. Due to financial limitations, limited laboratory facilities, and time constraints, some aspects of the study could not be completed.

5. CONCLUSION

The *D. alata* yam is a food that is suitable for human consumption and contains vital nutrients. It is accessible locally and is among the most affordable and essential sources of nutrition. The results showed that it was a good source of fiber, fat, and carbohydrates. The created biscuits were made using a blend of wheat flour and *D. alata* yam flour. Overall, the produced biscuits' sensory qualities (which included 5% DAYF) were satisfactory. It may offer a number of health advantages.

Consuming naturally grown *D. alata* yam is crucial and helps people recover from a number of illnesses. It has been consumed for a very long period. The usage of *D. alata* yam in diet is a relatively recent development. Different levels of *D. alata* yam-incorporated biscuits are very nutrient-dense and might offer additional fiber and fat. It can somewhat satisfy the needs for different nutrients, such as fiber, fat, and carbohydrates, if it is consistently consumed. Some tasks were not completed because of time constraints, a lack of laboratory space, and a lack of funding. To further investigate *D. alata*, the following recommendations are made.

Ethical Approval

The study involving human subjects was reviewed and approved by the Ethics Committee of Mawlana Bhashani Science and Technology University ethical review committee (ERC) with approval number: 2023e02. Additionally, we received ethical permission from the departmental ethical review committee (ERC) after obtaining informed consent from each member of the sensory panel (permission no.: mbstu/ftns/2025/42(4))

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Competing Interests

All the authors declare that there are no conflicts of interest.

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Underlying Data

Derived data supporting the findings of this study are available from the corresponding author on request.

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