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UTILIZATION OF CEREAL AND LEGUME BY-PRODUCTS FOR THE PREPARATION OF VALUE-ADDED COOKIES

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Abstract: *The study aimed to assess the quality parameters of cookies prepared from supplementation with wheat and cowpea by-products in the place of wheat flour. The physicochemical and sensory qualities of wheat and cowpea by-products supplemented cookies were studied and compared with control cookies from 100% wheat flour. The proximate composition for all cookies varied for moisture content between 2.21 to 2.40%; fat content ranged from 22.65 to 28.37%; ash content was found in ranges of 0.05 and 0.08%. The mean value for texture varied from 1935.67 to 2037.33 (gm/f). The physical properties of cookies were evaluated in terms of weight (gm), thickness (mm), diameter (mm), and spread ratio. Weight for all samples was in the range from 11.40 to 11.50 gm; thickness varied between 9.40 and 11.40mm; diameter possessed within ranges of 47.70 to 49.67mm, and spread ratio for all cookies was in the range from 4.36 to 5.20. As a part of sensory parameters, the taste and overall acceptability of cookies produced using 20% wheat and cowpea by-products were superior as compared to others. Overall, the formulation of 20% multigrain by-products had better results than the other formulation.*

Keywords: *Wheat By-Products, Cowpea By-Products, Cookies, Fat, Sensory Characteristics*

Introduction

Cookies are one of the most popular bakery products consumed by almost all levels of society due to their variety of taste, texture, digestibility, low cost, and extended shelf life[1]. The main ingredients used to formulate cookies are wheat flour, sugar, and fat (shortening)[2]. While other optional ingredients include milk, salt, flavoring, aerating, and other food additives. Cookies are a rich source of fat, protein, and carbohydrate; hence they provide energy and are also a good source of minerals[3].

Wheat *(Triticum aestivum L.)* is the most widely produced cereal and one of the world's most important staple food crops[4]. Wheat is a rich source of carbohydrates. It also contains protein, fat, ash, fiber, and vitamins and minerals such as sodium, potassium, calcium, magnesium, iron, phosphorus, copper, zinc, and manganese. Usually, wheat flour is produced by milling whole wheat kernel and has distinguished characteristics from other cereals due to its unique dough-forming properties[5]. Wheat flour is the main ingredient for cookie formulation. Generally, low-protein flour is used to produce bakery products such as cakes, biscuits, puffins and pie crusts, etc.[6]

Cowpea is a leguminous crop (called black-eyed peas) and has now been utilized as a part of the animal and human food due to its inexpensive protein source[7]. Fresh or dried seeds, pods, and leaves are commonly used in human food since they are precious as fodder. Cowpea by-products such as cowpea seed waste and cowpea hulls (which result from the dehulling of the seeds for food) have been used to replace conventional feedstuff in some developing countries[8].[1]

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By-products obtained after the process of cereal and legumes such as bran, husk, and hulls, etc. are now being exploited as animal feed or left in the field for reducing erosion[9].
Bakery products such as cookies and biscuits are produced from wheat flour, sometimes composite with other flour[10] but biscuits or cookies prepared with by-products from wheat, or cowpea is scarce.[2] Incorporating this by-product into baked goods may be given promising results. An attempt was taken to incorporate wheat and cowpea byproducts into the preparation of cookies, with the following aims: to standardize the formulation of cookies with by-products; to assess the physicochemical characteristics of cookies; and to evaluate consumer acceptance.

Materials and methods

Materials

Sample Collection and Preparation

All raw materials were purchased from the local markets, Dhaka Bangladesh. In a laboratory, raw materials were packed after weighing into a polyethylene bag until use.

Chemical reagents

Wheat Flour, Pea Powder, Corn Powder, Wheat bran, Sugar powder, Crystal Sugar, Palm Oil, Vegetable Fat, Salt (sodium chloride), Lecithin, SMP (skimmed milk powder, Flavor, Water, Sodium Bi Carbonate, Ammonium Bi-Carbonate, sodium acid pyrophosphate, Sodium metabisulfite, Tert-Butylhydroquinone, Food Grade Flavor.

Table 1 Formulation of Multi Grain cookies

Ingredients	Sample 1 (control)	Sample 2	Sample 3	Sample 4
WF: WBP: CBP	100:0:0	90:5:5	80:10:10	50:25:25
Sugar powder %	32.4	32.4	32.4	32.4
crystal sugar %	6.4	6.4	6.4	6.4
Palm oil %	19.5	19.5	19.5	19.5
Vegetable fat %	29.6	29.6	29.6	29.6
Salt %	0.64	0.64	0.64	0.64
SBC %	0.32	0.32	0.32	0.32
SAPP %	0.32	0.32	0.32	0.32
SMP %	1.34	1.34	1.34	1.34
Lecithin %	0.745	0.745	0.745	0.745
TBHQ %	0.0001	0.0001	0.0001	0.0001
IFF Butter %	0.0108	0.0108	0.0108	0.0108
Kerry Milk %	0.260	0.260	0.260	0.260
Saffron %	0.01	0.01	0.01	0.01
Symrise Butterdol %	0.152	0.152	0.152	0.152
Water %	4.0	4.0	4.0	4.0

WF=Wheat flour, WBP=Wheat by-products, CBP-Cowpea by Products

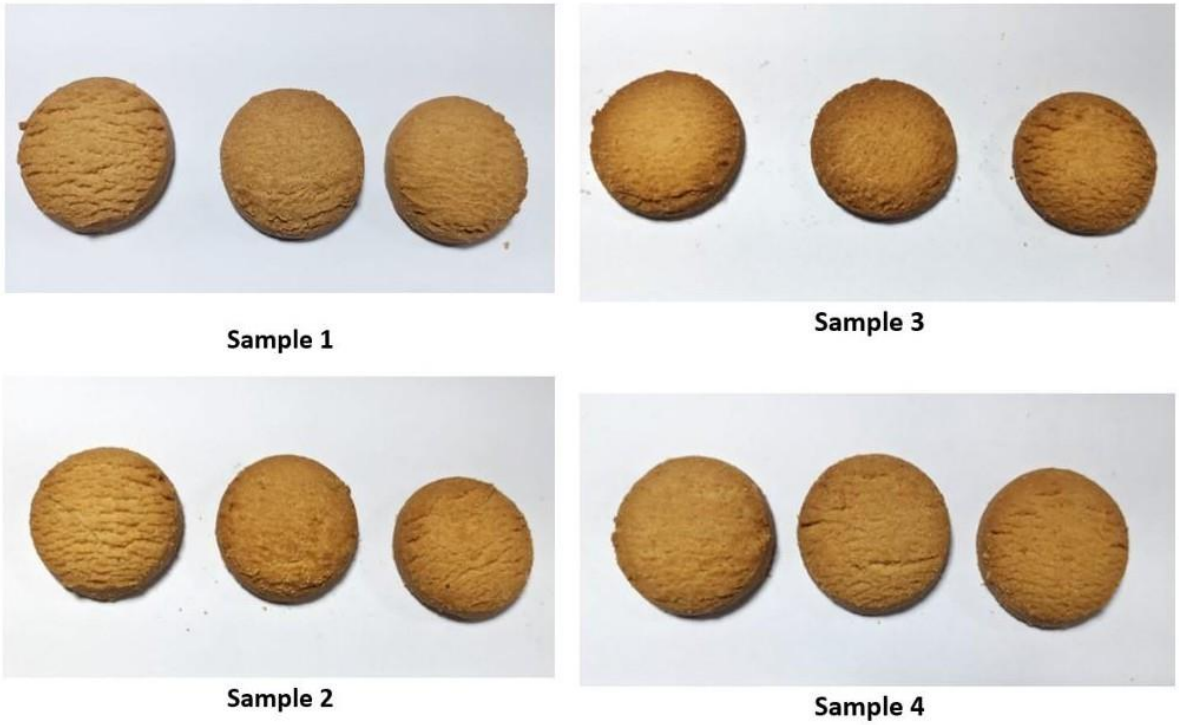

Figure 1 Samples of cookies formulated using wheat flour and by-products of wheat and cowpea

Production Procedure of Multi-Grain Cookies

The succeeding steps were followed for the cookie's formation (Figure 2)

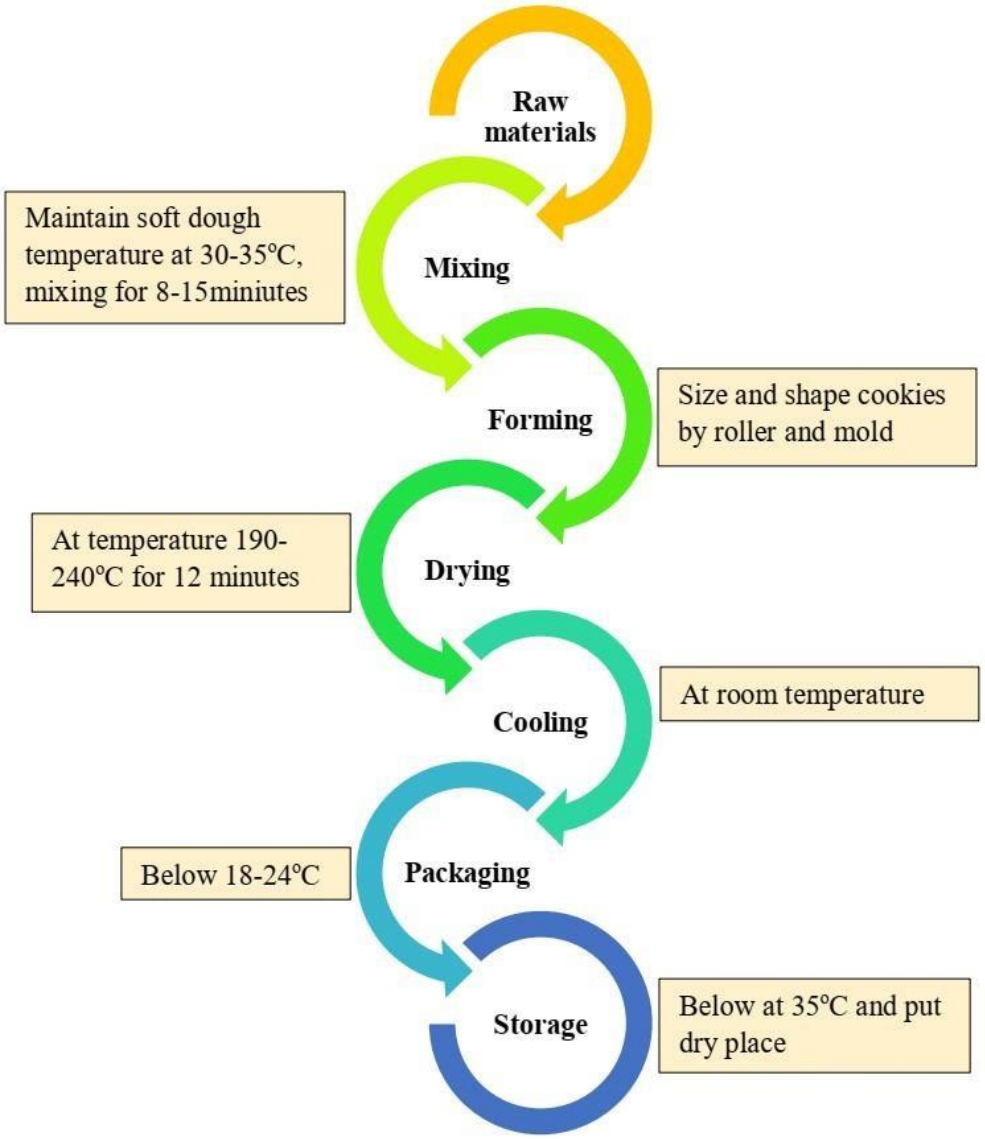

Fig. 2 Process flowcharts of cookies manufacturing.

Steps-1 The raw materials were collected and tested for required properties and their qualities.

Steps-2: Mixing
To begin with, clean the mixing hopper properly. Weighed all raw materials (Table 1) before mixing. In the first step, vegetable fat, sugar, lecithin, SMP, and all multi-grain flour/byproducts were mixed well for 3 minutes. Then add all chemical reagents mixed with water for 1 minute. After that palm oil and flavor were added to it and mixed for 1 minute. Next, creaming was done, wheat flour and crystal sugar were then added to it and mixed for 3 minutes more. Then the dough was prepared for cookie production.

Steps-3: Forming
Dough was automatically fed into the hopper of the Molding Roller through a feeding conveyer where dough mass was pressed inside the Molds/Die fitted in the rotary molder to form the Raw

cookies. These raw cookies were extracted onto the extraction conveyer and ultimately onto the Oven Band through the panner web for baking.

Steps-4: Baking
A tunnel oven was used where the oven Band runs along the length. The oven was heated by burning gas and air inside the oven. The temperature was controlled as per requirements. Raw cookies were carried by oven band into the oven maintained the temperature at 190-240^{o}C for 12 Minutes more or less.

Steps-5: Cooling
After that, baked cookies were passed through a cooling conveyor were cooled at ambient temperature.

Steps-7: Packing
Finally, cookies were fed into the packing machines where cookies were packed, printed laminated wrappers were used as packaging material, and then packed in corrugated cartons (Figure 1).

Methods

Determination of Moisture
The moisture content of prepared cookies was determined with a moisture analyzer.

Determination of ash content
The ash content of cookies was analyzed according to the method of Rana et al.[11]. Cookies powder (5 g) was weighed and transferred into a clean, dry, and pre-weighted crucible. Then the crucible was kept in a muffle furnace (Model: ACMAS ATI-118-A) at 550 °C for 6 hours. It was cooled at the desiccator and weighed. The ash content was calculated by the following equation:

$$\% \text{ Ash} = \frac{W_1 - W_2}{W} \times 100$$

Where,
W1=weight of ash with crucible
W2=weight of empty crucible
W=weight of sample

Determination of Total Fat
The total fat content of cookies was determined according to the methods reported by Rana et al.,[11]. A cookie sample of about 5 g was taken into the thimble. Then the thimble was attached to the Soxhlet apparatus (Model: SZF-06A/SZF-06C) which was attached with a round bottom flask containing 200 mL ether. The fat was extracted for 16 hours. After that ether was evaporated at 80°C until the flask completely dried. Lipid content was calculated by the following formula:

$$\% \text{ Fat(total)} = \frac{W_1 - W_2}{W} \times 100$$

Where,
W1=weight of the evaporated flask with the sample
W2=weight of empty flask
W=weight of sample

Determination of Texture
All cookies were subjected to a texture analyzer and measured the texture of each cookie.

Determination of Physical Properties
The diameter (cm), width (cm), and thickness (cm) of cookies were measured using a scale, weight (gm) using balance and the spread ratio was calculated as width divided by thickness[13].

Sensory Quality Analysis
The sensory quality of the cookies was analyzed using a Hedonic scale of 9-points for taste, flavor, texture, and overall acceptability according to the method reported by Saeid et al.,[12]. In this study, fifteen panelists were involved.

Statistical Analysis
All data were analyzed statistically using statistical software R (windows version 2.13.1). Each data was taken in triplicate and shown mean ± standard deviation (SD). Duncan Multiple Range Test (DMRT) was performed for a significant difference. The significant difference was evaluated for the mean value of each sample at 5% ($P \leq 0.05$)

Results and Discussion

Table 2 Physicochemical characteristics of prepared cookies

Sample	Moisture (%)	Fat (%)	Ash (%)
1	2.21 ± 0.10^{a}	22.65 ± 0.26^{b}	0.05 ± 0.03^{a}
2	2.33 ± 0.20^{a}	28.37 ± 0.50^{a}	0.08 ± 0.01^{a}
3	2.34 ± 0.26^{a}	25.13 ± 2.25^{ab}	0.07 ± 0.02^{a}
4	2.40 ± 0.04^{a}	25.77 ± 2.78^{ab}	0.05 ± 0.01^{a}

Mean±SD, different superscript letters (a-c) are significantly ($P \leq 0.05$) among the samples in column

Table 2 shows the proximate composition of cookies prepared with various wastes from wheat and cowpea. The moisture content for all prepared cookies was in the range of 2.21 to 2.40%. The highest moisture found in sample 4 was 2.40% and the lowest found in sample 1 (control) was 2.21%. This result was lower according to work of Adeyeye[13] who found cookies had 5.16 to 6.87% moisture content. According to Nanyen et al.,[14] reported the moisture content of cookies from different composite flour was 10.96 to 12.64%. The moisture content of cookies formulated using various composite flour was in the range of 12.10 to 12.52% this also higher than our work[15].

In addition, the fat content of different formulated cookies is shown in Table 2. The figure for fat content was in ranged from 22.65 to 28.37%. Sample 2 witnessed the highest fat content and lowest in the control sample. This result was higher than composite flour cookies, investigated by Sibian and Riar[16]. According to Racheal and Margaret[15] who reported the composite flour cookies contained 20.41 to 25.11% fat, this is comparable with our findings. It was clear that fat% has marginally raised accompanied by increasing other by-products for sample 2 and sample 3, except for sample 2 substantially raised which is significantly different ($P \leq 0.05$) from the control sample. Furthermore, the result from ash content in various cookies produced from multigrain by-products and wheat flour has presented in Table 2. The results for ash in different cookies were in ranged between 0.05 and 0.08%, while sample 2 found a higher amount of ash and lower found in sample 4. These values were tiny as compared with other composite flour cookies contained ash content in the ranges of 4.05 to 5.02% [15].

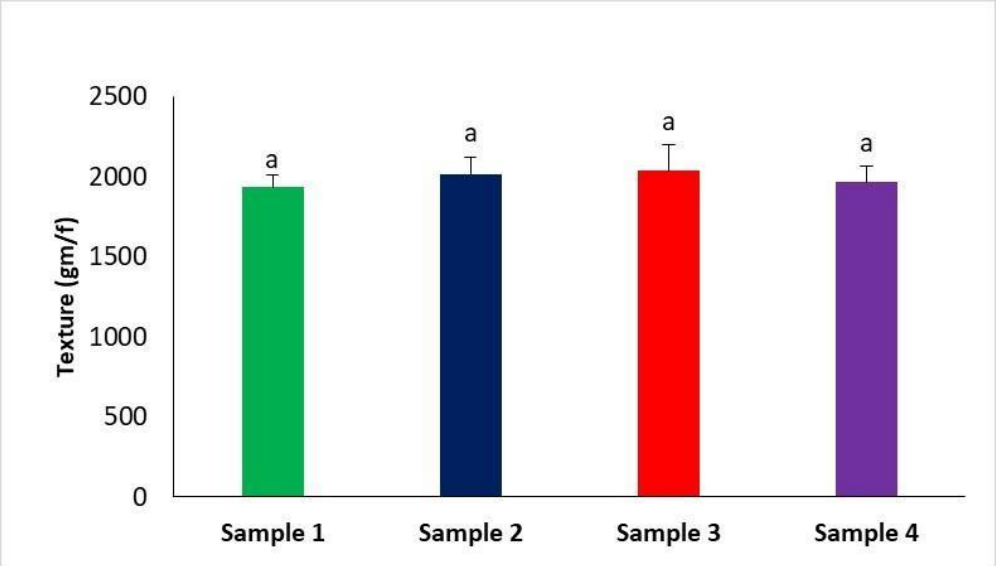

Figure 3 The texture value of cookies from wheat flour and multigrain by-products

The values for the texture of various cookies manufactured from wheat flour and other grain by-products are shown in Figure 3. The texture value for all samples was in the ranges of 1935.67 to 2037.33 (gm/f). The higher the texture harder the structure of the cookies, sample 3 prepared with 20% byproducts from wheat and cowpea with 80% wheat flour found higher texture values and sample 1 (control) found a soft texture with a low texture value. It has been clearly witnessed that, initially increasing by-product percentage results harder structure of cookies except in sample 4 but there was no significant difference ($P \leq 0.05$) found among the samples.

Table 3 Physical properties of cookies obtained from various multigrain blend flour and byproducts

Sample	Weight (gm)	Thickness (mm)	Diameter (mm)	Spread ratio
1	11.50 ± 0.20^{a}	10.5 ± 0.10^{b}	47.70 ± 1.25^{a}	4.54 ± 0.15^{b}
2	11.73 ± 0.15^{a}	9.40 ± 0.69^{c}	48.63 ± 1.40^{a}	5.20 ± 0.55^{a}
3	11.40 ± 0.56^{a}	10.33 ± 0.23^{b}	49.00 ± 2.33^{a}	4.74 ± 0.23^{ab}
4	11.70 ± 0.20^{a}	11.40 ± 0.20^{a}	49.67 ± 0.50^{a}	4.36 ± 0.03^{b}

Mean±SD, different superscript letters (a-c) are significantly ($P \leq 0.05$) among the samples in column

The results for the physical properties of prepared cookies are shown in Table 3. Mean values of weight for all samples were in the ranges from 11.40 to 11.50 grams, whereas the highest was found in sample 2, and the lowest found in sample 3. All cookie thicknesses varied between 9.40 and 11.40 mm with the highest found in sample 3. It was clearly observed that after increasing the by-products percentage, the thickness of cookies increased. In addition, the highest diameter values were found in sample 4, and the lowest was found in the control sample within ranges of 47.70 to 49.67mm. The diameters of cookies are reduced with various mechanisms while wheat flour is supplemented with non-wheat flour [17]. In this case, the diameters of cookies gradually increased while wheat flour was reduced with a by-product increment of wheat and cowpea. The spread ratio for all cookies was in ranged from 4.36 to 5.20. The highest mean value for the spread ratio was obtained from sample 2 whereas the lowest was found in sample 4. The Spread ratio of cookies depends on the thickness of the cookies. From this study, it was observed that gradual thickness

increment resulted declining the spread ratio. A similar trend was reported by Hussain et al.,[18]. The spread ratio increases with a reduction in sorghum flour supplementation in the cookies[13], but our observation found the opposite. Spread ratio were increased with the reduction of adding by-products. This trend was followed by our findings. A similar observation was found according to the report of Yadav et al.,[19] as the highest spread ratio of crackers was achieved by adding about 3% of the processed chickpea husk.

Table 4 Sensory characteristics of cookies

Sample	Color	Flavor	Taste	Overall acceptability
1	8.33 ± 0.72^{a}	8.53 ± 0.52^{a}	7.80 ± 0.56^{b}	8.20 ± 0.68^{a}
2	6.20 ± 1.01^{b}	6.87 ± 0.74^{c}	6.93 ± 0.59^{c}	6.20 ± 1.08^{c}
3	7.93 ± 0.70^{a}	8.13 ± 0.64^{a}	8.47 ± 0.64^{a}	8.30 ± 0.37^{a}
4	8.07 ± 0.70^{a}	7.40 ± 0.74^{b}	7.73 ± 0.59^{b}	7.13 ± 1.06^{b}

Mean±SD, different superscript letters (a-c) are significantly ($P\leq0.05$) among the samples in column

Table 4 shows the sensory characteristics of various cookies produced from multigrain by-products. Consumer acceptance was evaluated in terms of color, flavor, taste, and Overall acceptability. Color is one of the essential sensory parameters for consumer attraction. The score for color for all samples was in the range of 6.20 to 8.33. The higher score was found in the control sample, and the lower was found in sample 2. The color values for all samples except the control sample increased with the increment of by-products, and the highest color score retained sample 4, prepared with 50% wheat flour, 25% wheat by-products, and 25% cowpea by-products. In addition, the score for flavor found highest in sample 3 and lowest in sample 2 ranged from 6.87 to 8.13 except for the control sample. Next, the most elevated taste score was obtained from sample 3, formulated with 80% wheat flour, 10% wheat by-products, and 10% cowpea by-products.
Furthermore, the overall acceptability was highest for sample 3 and lowest in sample 2 among the ranges of 6.20 to 8.30. It has been observed that sample 3 had the superior sensory value for taste and overall acceptability, except the control sample, found highest in the case of color and flavor. And the sensory value increased up to 20% by-products combined with wheat and cowpea, and then it reduced while it reached 50% by-products addition of wheat and cowpea.

Conclusion

In this study, cookies were formulated using various by-products such as wheat and cowpea accompanied with wheat flour, and then quality parameters were investigated. The physicochemical characteristics of cookies were higher than in the control sample that produced only wheat flour. The formulation with by-product flour can be replaced with 20% wheat flour resulting in increased consumer acceptance in terms of taste and overall acceptability. This replacement level would significantly reduce wheat flour dependency if cookies were produced in countries that import wheat. A higher level of by-products, about 50% blended with wheat flour, was found lower sensory scores than others. Therefore, we recommend that the 20% by-product blend with wheat flour would be a better cookie formulation considering better physicochemical characteristics and sensory qualities. Future study is necessary to investigate other parameters in terms of protein, fibers, and starch, as well as energy values.

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