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DETERMINING SOME NUTRITIONAL INDICATORS AND COLOUR OF BANANA (*Artocarpus integer*) POWDER

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Abstract. In Vietnam, banana trees are grown in all localities throughout the country, especially Ha Giang, Lai Chau, Tuyen Quang, Phu Tho, Hung Yen, and Hai Duong provinces, with large areas and outputs. Therefore, the goal of this study is to determine some nutritional indicators and colour of banana powder, to serve as a scientific basis for the application of banana powder in food processing. The Hai Duong banana powder sample has the highest colour indicator of 2.89, followed by the Hung Yen banana powder sample with a colour indicator of 2.85. The Phu Tho banana powder sample has a colour indicator of 2.43, the Tuyen Quang banana powder is 2.35 and the lowest is the Ha Giang banana powder sample with a colour indicator of 2.27. Banana trees grown in Hai Duong and Hung Yen provinces on fertile alluvial soil in the Red River Delta have a higher soluble dry matter content, total sugar content, total protein content, and vitamin A content than banana trees grown on hillside land in Phu Tho, Tuyen Quang, and Ha Giang provinces.

Keywords: banana powder, colour indicators, determine, nutritional indicators.

1. Introduction

Bananas hold approximately 15% of the world's total fresh fruit production. Bananas are widely produced in tropical and subtropical regions. Banana plantation is a business with low investment, high efficiency, and rapid income. It plays a crucial role in becoming an essential industry in the rural economy. It has an important impact on the economy of developing countries [1]. Bananas are major food crops in the humid and subhumid parts of Vietnam and are a major source of energy for millions of people in these regions. In Vietnam, banana trees are grown in all localities throughout the country, especially Ha Giang, Lai Chau, Tuyen Quang, Phu Tho, Hung Yen, and Hai Duong provinces, with large areas and outputs. The annual world production of plantains and bananas is estimated at 75 million tonnes. The development and dissemination of disease resistant, high yielding varieties of plantains by various research institutes had evolved over the years, which has hitherto led to increase in production. Worldwide, vitamin A

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deficiency is the most common form of malnutrition after protein deficiency. In mountainous provinces, vitamin A deficiency occurs in millions of children and plantains could be an important source of provitamin A for the people of those regions. This therefore provides a strong stimulus to investigate the provitamin A component of the new plantain, in furtherance of the micronutrient initiative of banana fruit [2, 3]. Carotenoids are one of the most important classes of plant pigments and play a crucial role in defining the quality parameters of fruits and vegetables. The red capsanthin, capsorubin, and cryptocapsin pigments are valued mostly as natural colorants, whereas carotene and cryptoxanthin have provitamin A activity, with carotene having the highest. During ripening the colour of plantains and bananas changes from dark green to bright yellow, due to the degradation of chlorophyll structure. This process gradually unmasks the carotenoid pigments present in the fruit. Change in peel colour often reflects changes in pulp colour [2, 3]. The banana is a tropical fruit that easily rots. Fruit colour has changed rapidly under physical influences such as sunlight and cuts, and biological influence (fungus). Therefore, post-harvest handling of banana cultivation is essential to prolong the shelf, so it can be a value-added product [4]. To prolong shelf life, various processing and preservation methods such as drying, chemical treatments, and various packaging methods are used [5]. Bananas can be processed and preserved into various forms of processed products such as banana flour, banana sale, banana juice, banana wine, dodol banana, banana chips, banana sauce, banana jam, and others [4]. In Vietnam, consumers have developed distinct correlations between colour and the overall quality of specific products. Consumers of plantains associate the colour of the peel with specific tastes or uses and they will usually purchase plantains if the colour is suited to the required purpose or desire. Information on the total carotenoids, iron, zinc, and flour colour variability of plantains, especially the newly developed hybrids is very fragmentary. Bananas have been applied in nutritional and nutraceutical utilization by processing into flour to increase its functionality and prolong its shelf-life. It is a preferred item in the diet as it contains a considerable amount of fiber, carbohydrate, vitamins, and polyphenols with antioxidant capacity. Therefore, the goal of this study is to determine some nutritional indicators and colour of banana (*Artocarpus integer*) powder, to serve as a scientific basis for the application of banana powder in food processing, which is very necessary.

2. Content

2.1. Materials and methods

2.1.1. Material

Five Tieu Hong banana (*Artocarpus integer*) samples reached technical maturity (harvested 90 days after flowering) in Ha Giang, Tuyen Quang, Phu Tho, Hung Yen, and Hai Duong provinces. These bananas are grown according to Vietgap standards. Banana fruits are packed in perforated foam boxes and transported by car to the laboratory to perform research.

2.1.2. Methods

- Method of processing banana powder

From the results of exploratory research, the method for processing banana powder is proposed as follows: The raw bananas were washed using tap water. Bananas used in

the experiment must meet quality standards, be pest free, and undamaged, and ensure food safety and hygiene. The banana is peeled and sliced with a length of 5cm, a thickness of 0.5cm, and a width depending on the type of fruit. Then these banana slices are soaked in water mixed with vitamin C, 0.001% concentration, for 15 minutes, taken out, drained, and dried at 70^{o}C, in tray driers for 8 hours. After drying, bananas are crushed using a mill, with a sieve size of 0.01mm, then packaged in plastic packaging. The raw banana powder was stored at ambient temperature [5, 6].

- *Method to determine the colour*

Colouration was determined using a Colour-PenTM handy colour difference photometer, which recorded the spectrum of reflected light and converted it into a set of colour coordinates (L, a, and b values). Colour coordinates range from L = 0 (black) to L = 100 (white), -a (greenness) to +a (redness), and -b (blueness) to +b (yellowness). A Minolta standard white plate (X = 83.6, Y = 81.2, Z = 93.8) and a black plate were used to standardize the instruments [7].

- *Method for determining soluble dry matter content*

The soluble solids content was determined using a Japanese ATAGO N-1α refractometer, the measurement unit is ^{o}Bx at 20^{o}C. When light passes through a solution with different dissolved solids, the light is refracted with different refraction angles, from which the solid concentration of the analyte can be deduced [7].

- *Method for determining total sugar content*

The total sugar content of banana powder was determined according to the Vietnamese National standard TCVN 4594. This method was carried out according to the principle of extracting total sugar from the sample with hot water, using hydrochloric acid to hydrolyze it into glucose, the amount of glucose is determined through reactions with peeling solution, $Fe_2(SO_4)_3$, $KMnO_4$ [8].

- *Method for determining total protein content*

The protein content of banana powder was determined according to the Vietnamese National standard TCVN 9936. organic matter was decomposed with sulfuric acid, alkalinize reaction products, distill liberated ammonium, and boric acid solution was collected, then was titrated with standard sulfuric acid solution [9].

- *Method for determining vitamin A content*

The vitamin A content of banana powder was determined according to the Vietnamese National standard TCVN 8972-1. The method was carried out according to the principle that retinol was saponified with a solution of potassium hydroxide in ethanol or methanol and extracted with a suitable solvent. It was then determined by high performance liquid chromatography with a fluorescence detector or an ultraviolet detector. Substances were identified based on retention time and determined by the external standard method, using peak area or peak height [10].

- *Statistical analysis*

Analysis of variance (ANOVA) and Duncan multiple range test (DMRT) were used to determine the significance of differences between means ($p \leq 0.05$). Results were indicated by the mean of standard error values of three replication determinations [11].

2.2. Results and discussion

2.2.1. The colour of banana powder

During the preservation process, the colour of food in general and the colour of banana powder in particular often change. The goal of preservation measures is to limit this variation. The results of determining the colour change of banana powder samples are shown in Table 1.

Table 1. The colours of banana powder patterns in different growing regions

No.	Banana powder	Colour
1	Ha Giang	2.27^{a}
2	Tuyen Quang	2.35^{b}
3	Phu Tho	2.43^{c}
4	Hung Yen	2.85^{de}
5	Hai Duong	2.89^{de}

Numbers with different exponents have a statistically significant difference (with $P < 0.05$).

The research results in Table 1 show that among the 5 banana powder samples, the Hai Duong banana powder sample has the highest colour indicator of 2.89, followed by the Hung Yen banana powder sample with a colour indicator of 2.85. Phu Tho banana powder sample has a colour indicator of 2.43, the Tuyen Quang banana powder sample has a colour indicator of 2.35 and the lowest is the Ha Giang banana powder sample with a colour indicator of 2.27. This shows that the same banana variety grown in different regions has different colour indicators. Banana trees grow in Hai Duong and Hung Yen provinces on fertile alluvial soil in the Red River Delta have higher colour indicators than banana trees grown on hillside land in Phu Tho, Tuyen Quang, and Ha Giang provinces.

2.2.2. The soluble dry matter content, total sugar content, total protein content, and vitamin A content of banana powder

In the process of preserving banana powder, there is always a change in soluble dry matter content, total sugar content, total protein content, and vitamin A content. The purpose of preservation methods is to limit the change of these soluble dry matter content, total sugar content, total protein content, and vitamin A content. The results of determining the change of soluble dry matter content, total sugar content, total protein content, and vitamin A content of banana powder are shown in Table 2.

The research results in Table 2 show that the soluble dry matter content of banana powder is high. Specifically, the soluble dry matter content of Hai Duong banana powder is 21.73 ± 0.9^{o}Bx, Hung Yen banana powder is 21.48 ± 0.7^{o}Bx, Phu Tho banana powder is 20.37 ± 0.6^{o}Bx, Tuyen Quang banana powder is 19.86 ± 0.4^{o}Bx and Ha Giang banana is 19.62 ± 0.7^{o}Bx. The total sugar content of Hai Duong banana powder sample is the highest at 18.34 ± 0.7%, followed by Hung Yen banana powder sample at 18.19 ± 0.5%, Phu Tho banana powder sample at 17.63 ± 0.7%, Tuyen Quang banana powder sample at 16.43 ± 0.6% and Ha Giang banana powder sample at 16.42 ± 0.5%. The total protein content in banana powder samples ranges from 1.39 ± 0.1% to 1.56 ± 0.2%. The highest

is the Hai Duong banana powder sample, followed by Hung Yen banana powder samples, Phu Tho banana powder samples, Tuyen Quang banana powder sample, and Ha Giang banana powder sample. Research results also show that the vitamin A content in banana powder samples is also high, usually ranging from 5.43 ± 0.4 mg/100g to 6.27 ± 0.3 mg/100g. The highest vitamin A content is in the Hai Duong banana powder sample, followed by the Hung Yen banana powder sample, Phu Tho banana powder sample, Tuyen Quang banana powder sample, and Ha Giang banana powder sample. This research result is also consistent with the research results of author Hang.H.T.L *et al*., [12], when studying "The effect of harvesting maturity on postharvest quality and shelf life on Tieu Hong banana (*Musapara Disiaca* L.)". The authors determined the total soluble solids content to be 21.7^{o}Bx and the total sugar content to be 18.25% of Tieu Hong bananas grown in Gia Lam district, Hanoi city in 2017. This research result is also consistent with the research results of Rushikesh K *et al.*, [13]. Banana trees grown in Hai Duong and Hung Yen provinces on fertile alluvial soil in the Red River Delta have a higher soluble dry matter content, total sugar content, total protein content and vitamin A content than banana trees grown on hillside land in Phu Tho, Tuyen Quang and Ha Giang provinces.

Table 2. The soluble dry matter content, total sugar content, total protein content and vitamin A content of banana powder

No.	Banana powder	Analytical indicators			
		Soluble dry matter content (^{o}Bx)	***Total sugar content (%)***	***Total protein content (%)***	***Vitamin A content (mg/100g)***
1	Ha Giang	19.62 ± 0.7	16.42 ± 0.5	1.39 ± 0.1	5.43 ± 0.4
2	Tuyen Quang	19.86 ± 0.4	16.43 ± 0.6	1.42 ± 0.2	5.62 ± 0.3
3	Phu Tho	20.37 ± 0.6	17.63 ± 0.7	1.47 ± 0.2	5.87 ± 0.2
4	Hung Yen	21.48 ± 0.7	18.19 ± 0.5	1.53 ± 0.1	6.15 ± 0.2
5	Hai Duong	21.73 ± 0.9	18.34 ± 0.7	1.56 ± 0.2	6.27 ± 0.3

Values are presented as the mean ± standard deviation

3. Conclusions

The Hai Duong banana powder sample has the highest colour indicator of 2.89, followed by the Hung Yen banana powder sample with colour indicators of 2.85. The Phu Tho banana powder sample has a colour indicator of 2.43, the Tuyen Quang banana powder sample has a colour indicator of 2.35 and the lowest is the Ha Giang banana powder sample with a colour indicator of 2.27. Banana trees grown in Hai Duong and Hung Yen provinces on fertile alluvial soil in the Hong River Delta have a higher soluble dry matter content, total sugar content, total protein content and vitamin A content than banana trees grown on hillside land in Phu Tho, Tuyen Quang and Ha Giang provinces.

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