

Cavendish banana flour-based maltodextrin production: analysis of the effect of alpha-amylase enzyme use and study of industrial attitude

[Produksi maltodekstrin berbasis tepung pisang Cavendish: analisis pengaruh penggunaan enzim alfa-amilase dan kajian sikap industri]

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ABSTRACT

Cavendish bananas are susceptible to diseases during their growth. This has resulted in only about 70% of total Cavendish bananas being export-worthy and meeting quality standards, leaving 30% of unripe Cavendish bananas as rejects and of no commercial value. Although these unripe Cavendish rejects contain approximately 80% starch, they have not been optimally utilized. Therefore, it is necessary to process them into commercially valuable products, one of which is maltodextrin. Maltodextrin from Cavendish banana flour is considered a new product on an industrial scale, so it needs to be analyzed by industry attitudes. The purposes of the research were to determine the best concentration of α -amylase, analyze industry attitudes, and determine the level of importance of attributes. This research was non-factorial, arranged in a Completely Randomized Block Design (CRBD) with 4 replications. The treatment was 6-level α -amylase concentrations: 0.2%; 0.4%; 0.6%; 0.8%; 1.0%; 1.2%. Then, the best treatment was analyzed based on industrial attitudes by considering sensory attributes. The results showed the best concentration of α -amylase was 1.2% with yield (89.88%), moisture (4.20%), ash (1.06%), solubility (47.23%), pH (5.92), and DE value (18). The industrial attitude analysis showed a positive attitude, with the color attribute (89.5%) being the main influencing attribute.

Keywords: α -amylase enzyme, cavendish banana, industrial attitude analysis, maltodextrin, product importance level

ABSTRAK

Pisang Cavendish rentan terhadap penyakit selama pertumbuhannya. Hal ini menyebabkan hanya sekitar 70% dari total pisang Cavendish yang layak ekspor dan memenuhi standar kualitas, sehingga 30% pisang Cavendish mentah menjadi barang reject dan tidak memiliki nilai komersial. Meskipun pisang Cavendish mentah reject ini mengandung sekitar 80% pati, pemanfaatannya belum optimal. Oleh karena itu, perlu diolah menjadi produk bernilai komersial, salah satunya adalah maltodekstrin. Maltodekstrin dari tepung pisang Cavendish dianggap sebagai produk baru dalam skala industri, sehingga perlu dianalisis dari sudut pandang industri. Tujuan penelitian ini adalah untuk menentukan konsentrasi α -amilase terbaik, menganalisis sudut pandang industri, dan menentukan tingkat kepentingan atribut. Penelitian ini bersifat non-faktorial, disusun dalam Rancangan Acak Kelompok Lengkap (RAKL) dengan 4 ulangan. Perlakuan yang diberikan adalah 6 tingkat konsentrasi α -amilase: 0,2%; 0,4%; 0,6%; 0,8%; 1,0%; 1,2%. Kemudian, perlakuan terbaik dianalisis berdasarkan sikap industri dengan mempertimbangkan atribut sensorik. Hasil menunjukkan konsentrasi α -amilase terbaik adalah 1,2% dengan rendemen (89,88%), kadar air (4,20%), kadar abu (1,06%), kelarutan (47,23%), pH (5,92), dan nilai DE (18). Analisis sikap industri menunjukkan sikap positif dengan atribut warna (89,5%) sebagai atribut yang paling berpengaruh. Kata kunci: analisis sikap industri, enzim α -amilase, maltodekstrin, pisang cavendish, tingkat kepentingan produk.

Introduction

Cavendish bananas (*Musa acuminata* Colla) are one of the AAA banana types (having three sets of chromosomes) widely consumed due to their favorable organoleptic characteristics (Lobo et al., 2020). However, cavendish bananas are susceptible to diseases such as Moko disease (caused by *Ralstonia* sp.) (Afifah, 2023). Cavendish bananas intended for export must meet quality standards, particularly in terms

of fruit size. Fruits that do not meet these standards are categorized as rejected products, accounting for up to 30% of total production (Sukasih et al., 2019). One of the Cavendish banana producers in Indonesia, PT Great Giant Food (PT GGF, 2024), reported that approximately 2,100 tons of Cavendish bananas were classified as rejected. These rejected bananas are often underutilized, despite their potential for value-added processing.

Unripe cavendish bananas (approximately four months after inflorescence emergence) contain high starch levels (70–80%). Kumar et al. (2025), making them a promising raw material for banana flour production, which can be further processed into maltodextrin. Maltodextrin is a polysaccharide product derived from the partial hydrolysis of starch, consisting of a mixture of simple molecules in the form of medium chains, also known as oligosaccharides. It is commonly used as a food additive functioning as a thickener, emulsifier, stabilizer, sweetener, preservative, and filler in pharmaceutical products. Starch hydrolysis into maltodextrin can be carried out using acid or enzymes; however, enzymatic hydrolysis using α -amylase is considered more effective due to its specificity in breaking α -1,4 glycosidic bonds and its ease of control. Rosida et al. (2020) produced maltodextrin from cassava starch using α -amylase as a catalyst. Laga et al. (2018) also successfully produced maltodextrin from sago flour using α -amylase and pullulanase. Satmah et al. (2021) produced maltodextrin from durian seed starch using α -amylase. The α -amylase enzyme functions to break long starch chains into simpler molecules, specifically targeting its substrate, starch (amylose). The utilization of rejected Cavendish bananas as a starch source for maltodextrin production is considered a promising food diversification strategy, as its application in industry typically ranges from 5–20% of total formulation as a food additive. Maltodextrin can improve product yield and reduce water activity in food products (Wiriani et al., 2020).

Maltodextrin is an important product for the food industry, making industry attitude analysis essential. This analysis is necessary to evaluate product acceptance and to provide a basis for improvements to meet market needs (Waani et al., 2022). Industry attitude reflects whether industries favor a product or not. Such analysis can serve as a reference for product refinement, enabling it to become more competitive and aligned with evolving consumer demands. One widely used consumer attitude model is the ABC attitude model, also known as the Tri-Component Attitude Model, which includes three main indicators: cognitive (knowledge), affective (feelings), and conative (behavioral intention or purchase intention) (Sumarwan, 2011). These three indicators help informants form attitudes toward maltodextrin derived from Cavendish banana flour. The selected attributes of this product assist in evaluating the elements inherent in it. Maltodextrin derived from Cavendish banana flour is relatively new and less developed compared to other starch sources, such as cassava. However, the starch content in unripe bananas presents significant potential for maltodextrin production. As a relatively underdeveloped product, maltodextrin from banana flour requires analysis from an industry perspective. Therefore, this study aims to determine the optimal concentration of α -amylase enzyme to produce maltodextrin that meets standards and to assess industry attitudes toward the product.

Materials and methods

Material and equipment

The materials used in this study included unripe cavendish bananas (4 months after inflorescence emergence) categorized as rejected products from PT Great Giant Food, α -amylase enzyme with an activity of 1300.88 U/mL obtained from an e-commerce, CaCl_2 purchased from a chemical store, and TCA (trichloroacetic acid) of MERCK brand. Materials for chemical analysis included distilled water, standard glucose solution obtained from a chemical store, and 3,5-dinitrosalicylic acid (DNS) solution obtained from an e-commerce.

The equipment used included an oven, knife, slicer, weighing balance, grinder, 80-mesh sieve, and hydrolysis apparatus (hotplate, magnetic stirrer, beaker glass, and thermometer). Analysis equipment

included a stirring rod, measuring cylinder, pH meter, volumetric flask, test tubes and rack, furnace, dropper pipette, vortex mixer, filter paper, cuvette, and spectrophotometer. Industry attitude analysis was conducted using Microsoft Office Excel 2021 and Non-Numerical Unstructured Data Indexing Searching, and Theorizing (NVivo) 15.

Research methodology

This study employed a non-factorial Randomized Complete Block Design (RCBD) with the treatment consisting of α -amylase enzyme concentrations (0.2%; 0.4%; 0.6%; 0.8%; 1.0%; and 1.2%) and four replications. The data were analyzed using Bartlett's test, Tukey's test, analysis of variance (ANOVA), significance testing, and the Least Significant Difference (LSD) test at 5%. The best treatment was further evaluated through an industry attitude analysis toward the maltodextrin product using an in-depth interview method with PT Great Giant Food. The results obtained were processed using NVivo software and interpreted descriptively.

Research stages

Preparation of banana flour

The process of producing Cavendish banana flour followed the method of Sari et al. (2021) with modifications. One kilogram of unripe Cavendish bananas was soaked in 5 liters of hot water at 100°C for 2 minutes and then drained. The peel and pulp were then separated. The pulp was sliced using a slicer into transverse pieces with a thickness of 2–3 mm. These slices were dried in an oven at 60°C for 24 hours. The dried banana was then ground using a grinder and sieved through an 80-mesh sieve to obtain banana flour.

Preparation of maltodextrin hydrolysis

Maltodextrin production followed the method of Satmah et al. (2021) with modifications. Cavendish banana flour was mixed with water to form a suspension. Then, 0.1% calcium chloride (CaCl_2) was added and stirred until homogeneous. The pH of the solution was maintained between 6 and 7 by adding NaOH solution and was measured using a pH meter. Subsequently, gelatinization was carried out for 5 minutes at 70–90°C. After that, α -amylase enzyme was added according to the treatments (0.2%; 0.4%; 0.6%; 0.8%; 1.0%; and 1.2%). The mixture was then hydrolysed using α -amylase at 60°C for 180 minutes, with heating performed on a hotplate during the process. The reaction was terminated using 2% TCA, and the product was dried in an oven at 50°C for 24 hours. Finally, it was ground using a grinder and sieved through an 80-mesh sieve.

Research parameters

Yield analysis

Maltodextrin yield was determined using the gravimetric method (Liano & Herdyastuti, 2024) by calculating the ratio between the final weight and the initial weight of the sample using the following formula:

$$\text{Yield (\%)} = \frac{\text{Final dry weight}}{\text{Initial dry weight}} \times 100\%$$

Dextrose equivalent value

The dextrose equivalent (DE) value of maltodextrin was determined using the DNS method to measure reducing sugar content, referring to Liano & Herdyastuti (2024). Standard glucose solutions with concentrations of 0.1, 0.2, 0.3, and 0.4 mg/mL were prepared, and 1 mL of each was mixed with 3 mL of DNS solution to construct a calibration curve. The solutions were vortexed and heated for 5 minutes, then their absorbance was measured using a spectrophotometer at a wavelength of 540 nm. Subsequently, 1 mL of the maltodextrin sample was prepared and mixed with 3 mL of DNS solution. The sample was

vortexed, heated for 5 minutes, and its absorbance was measured at 540 nm. The regression equation obtained from the standard curve was $y = 1.169x + 0.0572$; $R^2 = 0.9368$. The dextrose equivalent (DE) value was calculated as follows :

$$\text{value DE} = \frac{\text{reducing sugar formed (g)}}{\text{initial substrate formed (g)}} \times 100$$

Moisture content analysis

The moisture content of maltodextrin was determined using the gravimetric method (AOAC, 2005), with the calculation formula as follows :

$$\text{Moisture content (\%)} = \frac{A-B}{A-C} \times 100\%$$

Notes :

A: Dry crucible + 2 grams of sample before drying

B: Crucible after drying

C: Empty dry crucible

Ash content analysis

The ash content of maltodextrin was determined using the gravimetric method (AOAC, 2005), with the calculation formula as follows :

$$\text{Ash content (\%)} = \frac{C-A}{B-A} \times 100\%$$

Notes :

A: Empty dry crucible

B: Dry crucible + 3 grams of sample before ashing

C: Crucible after ashing

pH analysis

The pH of maltodextrin was determined using a HANNA Instruments HI 2550 pH/ORP & EC/TDS/NaCl meter.

Solubility analysis

The solubility of maltodextrin was determined according to the method of Adhayanti & Ahmad (2021), using the following calculation formula :

$$\text{Solubility (\%)} = \left(1 - \frac{c-b}{\left(\frac{100-ka}{100} \right) \times a} \right) \times 100\%$$

Notes :

ka : Water content

a : Sample

b : Dry filter paper before use

c : Dry filter paper after use

Determining the best treatment

The determination of the best treatment was carried out using the De Garmo method (Kartika et al., 2025), with the following formula :

$$\text{Weight score} = \frac{\text{Score for each test parameter}}{\text{Total score of all test parameters}}$$

$$\text{Effectiveness value} = \frac{\text{Score of the treatment} - \text{Minimum score}}{\text{Maximum score} - \text{Minimum score}}$$

$$\text{Productivity value} = \text{Weight Score} \times \text{Effectiveness Value}$$

Industry attitudes analysis

The informant in this study was PT Great Giant Food, the largest Cavendish banana producer in Indonesia, which operates across various agricultural commodities.

Data sources and sample determination

Sampling was conducted using a non-probability purposive sampling technique, in which samples were selected based on predetermined criteria and considered relevant to the research objectives. The data used included primary data obtained through in-depth interviews with respondents who have authority in product development (decision makers) within the company (banana division employees), as well as secondary data from scientific sources.

Analysis of product importance and performance levels

The evaluated attributes included sensory attributes such as color, taste, aroma, texture, and the dextrose equivalent (DE) value. The organoleptic quality standards of maltodextrin include color (white), taste (sweet), and aroma (odorless). According to Srimati et al. (2023), good maltodextrin texture should be powdery, similar to flour. According to Algofar et al. (2021), the dextrose equivalent (DE) value of maltodextrin ranges from 2 to 20, depending on its intended function and application.

Method of data analysis

The in-depth interview data were analyzed using NVivo software to identify the level of importance and satisfaction for each attribute, as well as industry attitudes through the coding process, and were then interpreted descriptively.

Results and discussion

Results

The results of maltodextrin testing from Cavendish banana flour with different concentrations of α -amylase enzyme showed a highly significant effect based on the 5% LSD (Least Significant Difference) test, as presented in Table 1.

Table 1. The effect of α -amylase enzyme concentration (0.2–1.2%) on the yield, as well as the chemical and physical characteristics of maltodextrin.

Parameter	α -amylase concentration (%)					
	0.2	0.4	0.6	0.8	1.0	1.2
Yield	74.56 $\pm$ 2.21 ^d	78.38 $\pm$ 1.64 ^c	83.56 $\pm$ 4.02 ^b	87.31 $\pm$ 3.15 ^a	88.94 $\pm$ 2.59 ^a	89.88 $\pm$ 3.37 ^a
Dextrose Equivalent	9 $\pm$ 2.16 ^d	10 $\pm$ 2.06 ^d	12 $\pm$ 2.58 ^{cd}	14 $\pm$ 2.08 ^{bc}	15 $\pm$ 2.22 ^b	18 $\pm$ 4.11 ^a
Moisture Content	4.51 $\pm$ 0.02 ^c	4.37 $\pm$ 0.16 ^{bc}	4.50 $\pm$ 0.07 ^c	4.42 $\pm$ 0.06 ^{bc}	4.28 $\pm$ 0.17 ^{ab}	4.20 $\pm$ 0.11 ^a
Ash Content	1.09 $\pm$ 0.01 ^{bc}	1.10 $\pm$ 0.04 ^d	1.09 $\pm$ 0.01 ^{cd}	1.07 $\pm$ 0.02 ^{abc}	1.07 $\pm$ 0.01 ^{ab}	1.06 $\pm$ 0.01 ^a
pH	6.68 $\pm$ 0.41 ^d	6.38 $\pm$ 0.38 ^c	6.30 $\pm$ 0.23 ^{bc}	6.12 $\pm$ 0.17 ^{abc}	6.08 $\pm$ 0.22 ^{ab}	5.92 $\pm$ 0.08 ^a
Solubility	24.10 $\pm$ 3.64 ^e	31.50 $\pm$ 7.36 ^d	33.62 $\pm$ 8.31 ^{cd}	37.35 $\pm$ 8.36 ^{bc}	39.25 $\pm$ 8.63 ^b	47.23 $\pm$ 8.45 ^a

Note: Values followed by the same letter in the same row indicate no significant difference according to the least significant difference (LSD) test at the 5% level.

Yield

The yield of maltodextrin from Cavendish banana flour ranged from 72.35–93.25%, with an α -amylase enzyme concentration of 0.8% producing the highest yield and showing no significant difference compared with 1.0% and 1.2%. The 0.8–1.2% concentration was considered optimal because it effectively maximized starch hydrolysis into maltodextrin. When calculated based on the initial weight of bananas, the yield was approximately 13%. A low enzyme concentration results in suboptimal hydrolysis due to insufficient catalytic activity, whereas excessively high concentrations do not further improve yield because of limitations in enzyme active sites and substrate saturation. Enzyme activity can also be influenced by inhibitors, substrate availability, and the presence of inactivating compounds in the raw material.

Dextrose equivalent (DE)

The dextrose equivalent (DE) value of maltodextrin from Cavendish banana flour ranged from 6.84–22.11, with the highest value obtained at 1.2% α -amylase enzyme concentration. An increase in enzyme concentration enhances starch breakdown into reducing sugars, thereby increasing the DE value. The DE value is influenced by the amount of reducing sugars formed, where higher α -amylase activity accelerates starch hydrolysis through the cleavage of glycosidic bonds. The gelatinization process and starch characteristics (amylose–amylopectin content, granule structure, and inhibitors) also affect hydrolysis efficiency. The DE value serves as a key indicator of maltodextrin quality, where low DE results in high viscosity and low solubility, while high DE results in low viscosity and high solubility.

Moisture content

The moisture content of maltodextrin from Cavendish banana flour ranged from 4.09–4.53%. The 1.0% enzyme concentration produced the lowest moisture content and was not significantly different from the 1.2% concentration, but it differed from the other treatments. The concentration of α -amylase enzyme can affect the ability of starch to bind water; the higher the enzyme concentration, the lower the moisture content. Starch hydrolysis leads to starch degradation and a reduction in hydroxyl groups. Hydroxyl groups function to bind water in the material through hydrogen bonding; therefore, a reduction in these groups results in lower moisture content. The α -amylase enzyme breaks down starch granules in Cavendish banana flour, causing the starch to lose its ability to bind water (Rosida et al., 2020). Thus, the 1.2% α -amylase concentration (the highest concentration in this study) produced the lowest moisture content, as the enzyme caused faster starch degradation compared to other concentrations, leading to a loss of water-binding capacity in the material. Low moisture content in maltodextrin is considered beneficial because it helps extend shelf life, maintain a powdery texture, and preserve product flavor (Novitasari et al., 2021).

Ash content

The ash content of maltodextrin from Cavendish banana flour ranged from 1.05–1.14%. The 0.8% enzyme concentration produced the lowest ash content and was not significantly different from the 1.0% and 1.2% concentrations, but it differed from the other treatments. Differences in maltodextrin ash content are influenced by the Ca^{2+} cofactor used in each treatment. Mineral cofactors function as stabilizers and allosteric activators of enzymes during the hydrolysis process. According to Yuanita et al. (2025), cofactors can bind strongly (as prosthetic groups) or weakly (as cosubstrates). Ash content is influenced by the mineral content of the raw material involved in a reaction, such as hydrolysis (Mukarramah et al., 2016). The use of too low α -amylase enzyme concentrations results in the Ca^{2+} cofactor detaching from the enzyme's active site or failing to bind properly, as observed in the 0.2%, 0.4%, and 0.6% treatments. This causes Ca^{2+} ions to dissolve into the maltodextrin solution during hydrolysis, slightly increasing mineral content, although not significantly. Ash content is also influenced by the mineral composition of the banana flour used, which is approximately 1.83% (Kumar et al., 2025).

pH

The pH of maltodextrin from Cavendish banana flour ranged from 5.84 to 7.09. The 0.8% enzyme concentration produced the lowest pH and was not significantly different from the 1.0% and 1.2% concentrations, but it differed from the other treatments. Differences in maltodextrin pH are influenced by the use of TCA (trichloroacetic acid) as an agent to stop enzyme activity by lowering pH and denaturing the enzyme. The use of TCA is proportional to the enzyme concentration used (2% of the enzyme concentration). Thus, the higher the enzyme concentration, the more TCA is required. According to Dwiloka et al. (2022), pH is the negative logarithm of hydrogen ion concentration (mol/L), where a substance is acidic at $\text{pH} < 7$ and basic at $\text{pH} > 7$, depending on the concentration of hydrogen ions in the solution. The use of TCA causes the enzyme to operate outside its optimal pH conditions for breaking down starch chains during hydrolysis. Therefore, higher α -amylase concentrations result in increased TCA usage, which in turn lowers the pH of maltodextrin.

Solubility

The solubility of maltodextrin from Cavendish banana flour ranged from 20.46–55.68%. The 1.2% enzyme concentration produced the highest solubility and was significantly different from the other treatments. The use of higher α -amylase enzyme concentrations increases maltodextrin solubility because the enzyme breaks down complex starch chains into smaller and more soluble molecules (Rosida et al., 2020). During the hydrolysis of Cavendish banana flour, the breakdown of gelatinized starch polymers by α -amylase produces molecules with a lower degree of polymerization, which increases solubility. Therefore, the 1.2% concentration in this study resulted in the highest solubility. Conversely, when a large amount of high-molecular-weight starch remains, maltodextrin solubility decreases. Haryani et al. (2022) stated that the high solubility of maltodextrin at higher α -amylase concentrations is consistent with an increase in dextrose equivalent (DE) value. The DE value indicates the extent to which starch has been hydrolyzed into simpler and more soluble molecules. The higher the DE value, the higher the solubility, as hydrolysis leads to depolymerization, weakening of starch structure, and formation of simple water-soluble molecules. If this condition continues, maltodextrin solubility will further increase.

Determining the best treatment

The best treatment for maltodextrin from Cavendish banana flour was determined using the De Garmo method by evaluating the effectiveness index of each parameter based on weighting of importance, as presented in Table 2.

Table 2. Recapitulation of the best maltodextrin treatment

Parameter	Weight	0.2%	0.4%	0.6%	0.8%	1.0%	1.2%
		PV	PV	PV	PV	PV	PV
DE Value	0.29	0.00	0.03	0.10	0.16	0.19	0.29
Yield	0.24	0.00	0.06	0.14	0.20	0.22	0.24
Solubility	0.19	0.00	0.06	0.08	0.11	0.12	0.19
Water Content	0.14	0.00	0.07	0.01	0.04	0.11	0.14
Ash content	0.10	0.05	0.00	0.03	0.06	0.08	0.10
Ph	0.05	0.00	0.02	0.02	0.04	0.04	0.05
Total	1.00	0.05	0.24	0.38	0.60	0.76	1.00

Note : PV (Productivity Value)

Based on Table 2, the 1.2% α -amylase enzyme concentration was identified as the best treatment, with the highest productivity value (1.00). The productivity value is used to evaluate the effectiveness score of each parameter multiplied by its weighting, and the concentration that yields the highest productivity value is considered the best treatment. The resulting maltodextrin characteristics included yield (89.88%),

moisture content (4.20%), ash content (1.06%), solubility (47.23%), pH (5.92), and DE value (18). The maltodextrin product obtained from the 1.2% concentration was then further analyzed through an industry attitude analysis.

Industry attitudes results

The final stage of this study was the assessment of industry attitudes toward maltodextrin derived from Cavendish banana flour. Industry attitude is an important factor in decision-making and can help companies understand consumer needs. The evaluation by PT Great Giant Food began by viewing the product as a set of attributes, followed by assessing the importance level of each attribute, and finally providing a positive or negative response to the developed product. The informant assessed maltodextrin based on three main indicators of the ABC attitude model, namely cognitive (knowledge and perception), affective (feelings), and conative (purchase intention) (Waani et al., 2022)

Attitude analysis using NVIVO software

The attitude assessment process goes through three stages: cognitive (basic knowledge related to the maltodextrin product), affective (feelings toward the product, leading to attitude formation), and conative (purchase intention). Interview data were analyzed using NVivo software by coding based on predetermined attributes (color, taste, aroma, texture, and DE value). The test results and percentage of each attribute are presented in Figure 1 and Table 3.

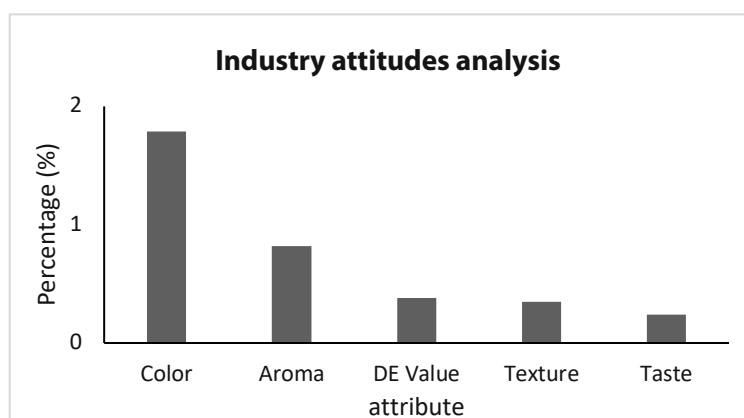


Figure 1. Bar chart of industry attitude analysis results using NVivo (Primary data, 2025)

Table 3. Percentage of industry attitude test results from 6 respondents

Attribute	Percentage (%)	Number of respondents who choose
Color	89.5	5
Aroma	41.0	2
DE value	19.0	1
Texture	17.5	1
Taste	12.0	1

Based on Figure 1 and Table 3, color was identified as the primary attribute influencing industry attitude (importance level) toward maltodextrin, followed by aroma, DE value, texture, and taste. The industry considered color (89.5%) to be very important because it affects the final product using maltodextrin. This is in line with Indonesian National Standard (SNI) No. 7599:2010, which states that maltodextrin should be white, although it may also appear slightly yellowish-white. However, in this study, the produced maltodextrin was cream-colored due to the banana raw material undergoing browning reactions caused by its glucose content during the drying process, making it less preferred by industry stakeholders. Aroma (41.0%) was the second most important attribute, as a slight banana aroma was detected and considered potentially influential on the final product using maltodextrin. This is consistent with the SNI requirement

that maltodextrin should be odourless. The DE value (19.0%) was also considered important as it influences maltodextrin characteristics.

According to Algofar et al. (2021), the DE value determines maltodextrin functionality: low DE (2–5) for high-viscosity and low-solubility products; medium DE (9–12) for moderate viscosity and better solubility; and high DE (15–20) for low-viscosity and high-solubility products. The DE value obtained in this study was 18, and respondents considered it an important attribute because it determines the target market segment. Finally, texture (17.5%) and taste (12.0%) were considered by respondents to have less significant impact on the product. According to Irwandi et al. (2024), consumer attitudes are formed through evaluation and tendency toward product attributes. The results indicate a relatively positive industry attitude, as product performance is close to industry expectations, considering product attractiveness, sustainability aspects, and evaluated attributes. However, improvements in color and aroma are still needed. This positive industry attitude has the potential to encourage purchase intention through evaluation and trust in maltodextrin derived from Cavendish banana flour.

Conclusion

The best α -amylase enzyme concentration was obtained at 1.2%, producing maltodextrin with the following characteristics: yield (89.88%), moisture content (4.20%), ash content (1.06%), solubility (47.23%), pH (5.92), and DE value (18). Maltodextrin from Cavendish banana flour received a positive industry attitude, considering product attractiveness, sustainability concepts, and the evaluated attributes. Color (89.5%) was identified as the most influential attribute affecting product importance, followed by aroma (41.0%), DE value (19.0%), texture (17.5%), and taste (12.0%). The color attribute needs to be improved to enhance industry purchase intention. The results of this study indicate that rejected Cavendish bananas can be processed into maltodextrin with quality that is acceptable to industry standards.

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