2025 SICASH MULTICONFERENCE

International Conference on Sustainable Biotechnology (ICoSBi)
Available on-line at: https://sicash.sliit.lk/

Comparative Analysis of Starch Extracted from Banana *(Musa* spp.*)* Corms: Evaluation of Antioxidant Properties and Other Nutritional Properties

T. M. W. Dahanayake[1], S. V. G. N. Priyadarshani[*1], H. W. Gammanpila[1]

[1]*Department of Applied Sciences, Faculty of Humanities and Sciences, Sri Lanka Institute of Information Technology, SLIIT-Malabe Campus, Malabe, 10115, Sri Lanka.*

Corresponding author*: nirosha.p@sliit.lk

Abstract

Banana corms are frequently regarded as agricultural waste globally, in contrast to the other parts of the banana plant. This study focuses on developing an optimal procedure for extracting starch from the banana corm and evaluating its antioxidant activity and nutritional composition to determine whether it has the potential to be used in food products. Starch was extracted from the banana corm using the wet milling method, and 1% Ascorbic acid was used to prevent browning. Three Sri Lankan banana varieties, *Embul*, *Ambun*, and *Alukesel* were used in the study. The starch yield ranged between 2.11% to 7.2%, with the highest obtained from Ascorbic acid-treated *Embul* (*Embul*-As). Ascorbic acid treatment significantly improved both starch yield and color ($p < 0.05$). The highest DPPH radical scavenging activity for Ascorbic free samples was given by *Embul*, which is 1.96 mg AAE/g. Nutritional profiling of *Embul*-As revealed favorable macronutrient content, including carbohydrate 82.2% and an energy value of 337 kcal/100g. These findings highlight banana corm-starch as a sustainable, underutilized resource with strong potential for innovative applications in food product development.

Keywords: *Ascorbic pre-treatment, banana corm, nutrition analysis, starch extraction*

https://doi.org/10.54389/KPLF4752

Introduction

Banana *(Musa spp.)* is one of the most consumed fruits in subtropical and tropical regions of the world. Banana fruit contributes significantly to food security and economic sustainability in many developing countries. According to Munir et al. (2024), sugars such as Sucrose, Fructose, and Glucose, as well as minerals like Iron, Potassium, and Vitamin B6, are among the many beneficial nutrients found in banana fruits. Also, the banana pulp and peels are rich in resistant starch and polyphenol compounds, with potential health benefits (Munir et al., 2024; Oboh et al., 2015).

Beyond the fruit, other plant parts such as the inflorescence, pseudo-stem, leaves, and corm are often underutilized or discarded as agricultural waste in Sri Lanka. The corm, an underground stem that anchors the plant and supports nutrient storage, has garnered increasing interest for its potential as a non-conventional source of starch and dietary nutrients. Given the growing demand for sustainable and locally sourced starch alternatives, investigating the extraction process of starch from banana corm, which is a starch-rich material, may contribute to value addition and waste reduction within banana cultivation systems.

Starch is a key dietary source and the main storage polysaccharide in plants, found in fruits, seeds, roots, and stems. It has wide applications in food, paper, textile, cosmetic, pharmaceutical, and polymer industries. Starch can alter the food in the required physicochemical ways while providing various nutrients (Dorantes-Fuertes et al., 2024). Starch extraction has been practised for a long time, using various methods, including conventional, mechanical, and modern innovative techniques. These include wet method, dry method, chemical, and enzymatic extraction, and the most recent techniques like ultrasound and pulsed electric fields (Dorantes-Fuertes et al., 2024). According to Marta et al. (2019), the wet milling process is suitable for isolating banana starch because of the minimal quantity of contaminants.

Oxidation is the second most convincing reason for food deterioration. The primary oxidative process is enzymatic browning (Ioannou & Ghoul, 2013). A study by Siriwardana et al. (2015), studied how to control enzymatic browning in banana fruits, using the Ascorbic acid pre-treatment. This study aims to extract starch from the corm of the banana, evaluate the antioxidant activity of extracted starch and characterize the nutritional composition of the *Embul* banana, which is the most widely cultivated variety in Sri Lanka, including moisture, ash, crude protein, fat, fibre, and carbohydrate content. By evaluating its nutritional profile, the research also assesses the feasibility of utilising *Embul* banana corm flour as a functional ingredient in food or non-food applications. The findings may contribute to the broader effort of valorizing agricultural by-products and promoting sustainable resource utilisation in tropical agriculture.

Materials and Methods

Plant Materials and Chemicals

Embul, *Ambun*, and *Alukesel* banana corms were collected from mature plants after fruit harvest, from small-scale farmers in Matara, Southern Province, Sri Lanka. Food-grade Ascorbic acid for starch extraction was purchased from Pettah Essence Suppliers, Colombo 1, Sri Lanka. All the chemicals used for the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay were analytical grade.

Optimization of Banana Corm Starch Extraction

Collected Banana Corms were first cut and cleaned to remove the roots, debris, and soil. Skin was peeled and cut into small pieces. The corm pieces weighing 120 g were ground with 250 mL of water using a mixer grinder and repeated three times. The resulting slurry was filtered using a muslin cloth, and the filtrate was allowed to settle to form the starch layer. Within 6-hour intervals, the water layer was removed, and clean water was added to clean the starch layer and increase purity. After 24 hours, the water layer was removed. The collected starch layer was sun-dried for 1-2 days in porcelain plates until a visually consistent dryness was achieved across samples, and identical drying conditions were applied to all samples to ensure consistency. The resulting starch weights were measured and stored in air-tight containers for further analysis.

Figure 1: *Starch Extraction Process. (a) Cleaned banana corm, (b) Peeled banana corm pieces, (c) 1% Ascorbic treated corm pieces, (d) Grinding corm pieces with water, (e) Filtering the slurry using the muslin cloth, (f) Allowing the filtrate to form the starch layer, (g) Leaving the starch layer for sun drying*

The same procedure was conducted to check the effect of Ascorbic acid on reducing the browning of starch as shown in Figure 1. A weight of 3 g of food-grade Ascorbic acid was dissolved in 300 mL of water to prepare 1% Ascorbic acid solution to soak 120 g of corm pieces for 10 minutes, before they were ground. The 1% Ascorbic acid solution was again added, removing the water layer, to the filtrate after keeping it for 6 hours. After 24 hours, the Ascorbic acid solution layer was removed, and the collected starch layer was sun-dried in the same way as the non-ascorbic-treated ones.

The starch yield of the extracted starch was calculated using the following equation (1).

$$\text{Starch Yield}=\frac{\text{Starch weight (g)}}{\text{Fresh Corm weight (g)}}\times 100\%\text{...........(1)}$$

DPPH Assay: Radical Scavenging Activity

The sample extraction was carried out according to Amarasinghe et al. (2021), with few modifications. Each extracted starch sample (weighing 2.5 g) was extracted with 25 mL of 70% Methanol using a mechanical shaker (170 rpm) overnight at room temperature, centrifuged the extract for 15 minutes at 3000 rpm, and filtered through Whatman No.1 filter paper to obtain a particle-free extract. The extracted solutions were kept at 4°C for subsequent analysis.

The DPPH radical scavenging assay was performed according to Amarasinghe et al. (2021), with few modifications. The DPPH Radical Scavenging activity percentages were calculated using the following equation (2). The results were expressed as ascorbic acid equivalents (AAE) in milligrams per g dried sample using a calibration curve of Ascorbic acid (y=1.7778x- 0.2481, R=0.9424).

$$\text{DPPH Radical Scavenging \%}=\frac{\text{(Absorbance of Control-Absorbance of Sample)}}{\text{Absorbance of Control}}\times 100\%..........(2)$$

Nutritional Analysis of Extracted Banana Corm Starch

To evaluate its nutritional composition, including the content of carbohydrates, proteins, fats, ash, moisture, and crude fibre, the extracted Ascorbic-treated *Embul* banana starch sample was sent to the Industrial Technology Institute (ITI), Sri Lanka.

Statistical Analysis

The study was performed in triplicate, and the obtained data were expressed as mean ±standard deviation (Sd). For data analysis, One-way Analysis of Variance (ANOVA) followed by Tukey's mean separation test was used to assess significant differences in extracted starch weights, while regression analysis was applied for generating standard curves in the DPPH assay. All the statistical analysis was performed using JASP 0.19.3 and Microsoft Excel (Amarasinghe et al., 2021).

Results

Starch Extraction

The Ascorbic-free and Ascorbic-treated starch samples clearly differed in colour, as shown in Figure 2. The white or light colour of the starch in all three varieties was improved by 1% Ascorbic treatment. Table 1 shows that the 1% Ascorbic treated *Embul* (*Embul*-As) sample had the highest mean starch weight (8.76 g). Additionally, it has been observed that the extracted starch weights have improved with 1% Ascorbic treatment. One-way ANOVA results show that the P value< 0.05, indicating a significant difference between the varieties. Tukey's HSD post hoc test confirmed that *Embul*-As differed significantly from all other samples.

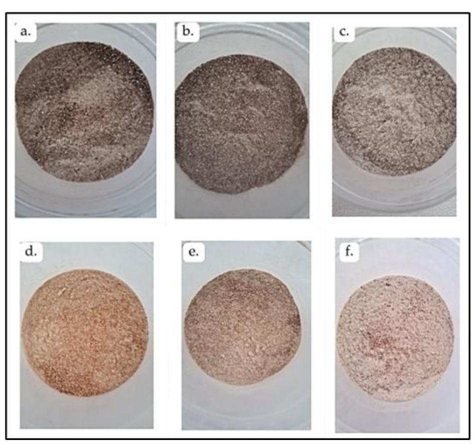

Figure 2: *Observed Color Difference in Extracted Starch. (a) Embul, (b) Ambun, (c) Alukesel, (d) Ascorbic-treated Embul (Embul-As), (e) Ascorbic-treated Ambun (Ambun-As), (f) Ascorbic-treated Alukesel (Alukesel-As)*

The calculated yield percentages according to the previously given equation (1), are shown in Figure 3, and according to that, Starch yield values ranged from 2.11% to 7.3%, where the lowest yield was from Ascorbic free *Ambun* (2.11%), and the highest yield was from the Ascorbic-treated *Embul* (7.3%). It is clearly shown that the starch yield has increased with 1% Ascorbic treatment.

Table 1: *Weight of extracted starch (resulting from 120 g of fresh corm weight)*

Variety	Starch Weights (g)
Embul	5.16 ± 0.3617^{c}
Ambun	2.54 ± 0.0084^{a}
Alukesel	3.9 ± 0.0951^{b}
Embul- As	8.76 ± 0.3858^{e}
Ambun- As	4.44 ± 0.4904^{bc}
Alukesel- As	6.4 ± 0.4782^{d}

Values are presented as mean ± Sd, n = 3; means not sharing the same superscript letter are significantly different (Turkey HSD, $p<0.05$)

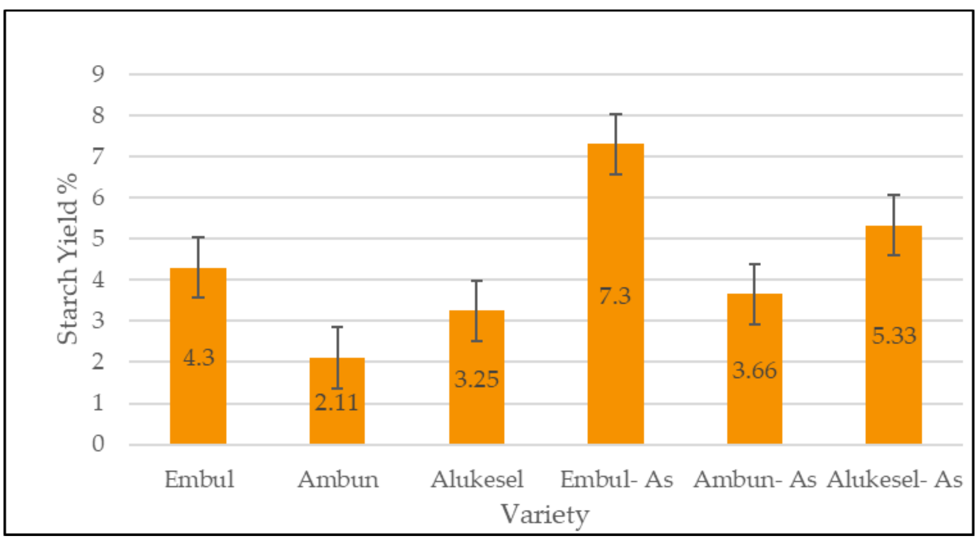

Figure 3: *Comparison of starch yield percentage*

Table 2: *Ascorbic-treated Embul Starch's Nutritional Composition*

Parameter	Value
Moisture (%)	15.2
Total Ash (%)	1.0
Fat (%)	0.3
Crude protein (N×625) (%)	1.3
Carbohydrate (%)	82.2
Crude fibre	1.0
Energy, kcal/100 g	337

DPPH Assay & Nutritional Composition

The calculated Radical scavenging activity percentages according to equation (2) are shown in Figure 4. Without Ascorbic treatment, the DPPH Scavenging activity percentage ranged from 38.54% to 49.32%, and the *Embul* variety had the highest value. According to the resulted standard curve for Ascorbic acid ($y = 1.7778x - 0.2481$, $R^2 = 0.9424$), the Ascorbic-free Sample's scavenging activity in ascorbic acid equivalents (AAE) in milligrams per g of dried sample are, *Embul*- 1.96 mg AAE/g, *Ambun*- 1.75 mg AAE/g, and *Alukesel*- 1.58 mg AAE/g. According to the above values, the highest Antioxidant activity was shown by *Embul*, and the lowest one among the three varieties was *Alukesel*.

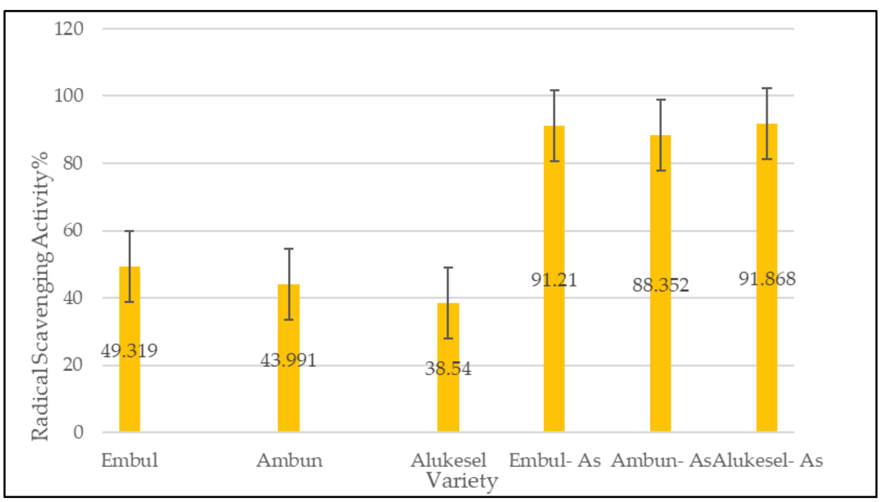

Figure 4: *Comparison of DPPH radical scavenging activity percentage.*

Discussion

The starch yield ranged from 3.25 to 9.49 g (average 5.7 g), for 150 g initial wet plantain peel samples, indicating yields ranging from 16.6 to 48.5% (average 29%) from dry mass, according to Hernández-Carmona et al. (2017). As reported by Kringel, Dias, et al. (2020), dry extraction yields 49.6% of the starch from flesh fruit, and wet extraction yields ranged from 56.8% to 73%. According to Kringel, Halal, et al. (2020), the peel and flesh of green bananas contain roughly 60% and 30% (dry weight) starch, respectively. Compared to the starch yield range derived from banana corms in the current study, those earlier findings demonstrated a higher starch yield. This might be because banana corms have less starch than the peel and fruit.

According to the study conducted by Kandasamy and Aradhya (2014), Acetone and Methanol extracts of banana corm/ rhizome of eight different commercial Indian banana cultivars displayed multiple antioxidant activities, and were observed as a source of high polyphenolic compounds. Accordingly, the antioxidant activities observed in the *Embul*, *Ambun*, and *Alukesel* banana corms can be attributed to the presence of polyphenolic compounds and other bioactive constituents.

Nutritional properties of Ascorbic acid-treated *Embul* corm starch aligned with previous studies on banana flour and starch. As reported by Amarasinghe et al. (2021), the acceptable level of moisture to achieve a stable shelf life is shown as less than 20%, and the Ascorbic acid-treated *Embul* sample had a 15% moisture content, indicating that it has characteristics favorable for improved shelf life. According to Khoza et al. (2021), the moisture content of flour products is significant since it can impact the chemical and physical properties of the food. Ash and protein values were relatively low, which, as noted by Miah et al. (2023), is indicative of higher starch purity and efficient extraction. Carbohydrate levels were comparable to banana flours (84–88%) reported by Alam et al. (2023), while fibre content, though low, contributes to digestive health and reduced diabetes risk (Falodun et al. 2019). *Embul*-As energy content (337 kcal/100g) was consistent with earlier findings (Alam et al., 2023; Falodun et al., 2019).

Conclusion

Banana corms tested in this study demonstrated potential as a viable source of starch, with Ascorbic acid pre-treatment enhancing both yield and quality. Notable Antioxidant activity was also demonstrated by banana corm starch, and the Nutritional content of *Embul* corm starch revealed a promising possibility of using this underutilized banana corm as a functional food ingredient. The results support the sustainable use of agricultural by-products in food biotechnology, offering a novel, health-focused alternative to conventional sources of carbohydrates.

References

Alam, M., Biswas, M., Hasan, M. M., Hossain, M. F., Zahid, M. A., Al-Reza, M. S., & Islam, T. (2023). Quality attributes of the developed banana flour: Effects of drying methods. *Heliyon*, *9*(7), e18312. https://doi.org/10.1016/j.heliyon.2023.e18312

Amarasinghe, N. K., Wickramasinghe, I., Wijesekara, I., Thilakarathna, G., & Deyalage, S. T. (2021). Functional, Physicochemical, and Antioxidant Properties of Flour and Cookies from Two Different Banana Varieties (Musa acuminata cv. Pisang awak and Musa acuminata cv. Red dacca). *International Journal of Food Science*, *2021*. https://doi.org/10.1155/2021/6681687

Dorantes-Fuertes, M. G., López-Méndez, M. C., Martínez-Castellanos, G., Meléndez-Armenta, R. Á., & Jiménez-Martínez, H. E. (2024). Starch Extraction Methods in Tubers and Roots: A Systematic

Review. *Agronomy*, *14*(4). https://doi.org/10.3390/agronomy14040865

Falodun, A. I., Ayo-Omogie, H. N., & Awolu, O. O. (2019). Effect of Different Drying Techniques on the Resistant Starch, Bioactive Components, Physicochemical and Pasting Properties of Cardaba Banana Flour. *Acta Universitatis Cibiniensis. Series E: Food Technology*, *23*(1), 35–42. https://doi.org/10.2478/aucft-2019-0005

Hernández-Carmona, F., Morales-Matos, Y., Lambis-Miranda, H., & Pasqualino, J. (2017). Starch extraction potential from plantain peel wastes. *Journal of Environmental Chemical Engineering*, *5*(5), 4980–4985. https://doi.org/10.1016/j.jece.2017.09.034

Ioannou, I., & Ghoul, M. (2013). Prevention of Enzymatic Browning in Fruits and Vegetables. *European Scientific Journal*, *9*(30), 49–62. https://doi.org/10.1021/bk-1995-0600.ch004

Kandasamy, S., & Aradhya, S. M. (2014). Polyphenolic profile and antioxidant properties of rhizome of commercial banana cultivars grown in India. *Food Bioscience*, *8*, 22–32. https://doi.org/10.1016/j.fbio.2014.10.001

Khoza, M., Kayitesi, E., & Dlamini, B. C. (2021). *Promoting Properties of Green Banana Flour*. 1–15.

Kringel, D. H., Halal, S. L. M. E., Zavareze, E. D. R., & Dias, A. R. G. (2020). Methods for the extraction of roots, tubers, pulses, pseudocereals, and other unconventional starches sources: A review. *Starch*, *72*(11–12).

Marta, H., Cahyana, Y., Djali, M., Arcot, J., & Tensiska, T. (2019). A comparative study on the physicochemical and pasting properties of starch and flour from different banana (Musa spp.) cultivars grown in Indonesia. *International Journal of Food Properties*, *22*(1), 1562–1575. https://doi.org/10.1080/10942912.2019.1657447

Miah, A. S., Islam, S., Abedin, N., Islam, N., Islam, F., Tisa, K. J., Saha, A. K., & Aziz, S. (2023). Physicochemical and functional properties of banana starch and its alternative returns. *Current Research in Nutrition and Food Science*, *11*(2), 866–879. https://doi.org/10.12944/CRNFSJ.11.2.34

Munir, H., Alam, H., Nadeem, M. T., Almalki, R. S., Arshad, M. S., & Suleria, H. A. R. (2024). Green banana resistant starch: A promising potential as a functional ingredient against certain maladies. *Food Science and Nutrition*, *12*(6), 3787–3805. https://doi.org/10.1002/fsn3.4063

Oboh, G., Ademosun, A. O., Akinleye, M., Omojokun, O. S., Boligon, A. A., & Athayde, M. L. (2015). Starch composition, glycemic indices, phenolic constituents, and antioxidative and antidiabetic properties of some common tropical fruits. *Journal of Ethnic Foods*, *2*(2), 64–73. https://doi.org/10.1016/j.jef.2015.05.003

Siriwardana, H., Abeywickrama, K., & Kannangara, S. (2015). Effect of pretreatments on quality of minimally processed cooking banana variety Alukesel. *The Journal of Agricultural Sciences, 10*(1), 11–20. https://doi.org/10.4038/jas.v10i1.8042