



# Visayan Journal of Science, Technology, and Innovation

## Development and Microbiological - Physicochemical Characterization of Spray-dried *Batuan* (*Garcinia binucao*) Powder

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### ABSTRACT

The indigenous Filipino fruit *Batuan* (*Garcinia binucao*), a common souring agent in local cuisine, faces challenges to wider utilization due to its seasonality and high perishability. This study aimed to develop a shelf-stable and convenient form of batuan powder by employing spray drying as a preservation technique, thereby extending its shelf life and enhancing its utility as a food ingredient. Fresh, unripe batuan juice was extracted and subjected to spray drying under optimized processing parameters (feed pressure: 450-500 psi; inlet temperature: 210-240°C; outlet temperature: 80-95°C). The resulting powder was analyzed through sensory evaluation, microbiological testing, and physicochemical characterization. Sensory results indicated high acceptability for taste, color, and flavor. Microbiological analysis demonstrated values well within international safety limits, including an aerobic plate count of <10 CFU/g. Physicochemical characterization revealed a low pH (2.36), low water activity (0.34), and acceptable moisture content (5.31%), collectively suggesting excellent microbial stability and extended shelf life. These findings confirm that spray drying is an effective and viable method for preserving batuan fruit into a safe, high-quality, and stable powder, opening significant opportunities for the commercialization and product innovation of this underutilized indigenous crop.

### KEYWORDS

*Garcinia binucao*, souring agent, spray drying

Received: 15 December 2023

Received in revised form: 23 October 2025

Accepted: 6 November 2025

Available online: 13 January 2026

The indigenous Philippine fruit *Batuan* (*Garcinia binucao*), primarily grown in the Visayas region, holds significant cultural and nutritional value as a traditional souring agent (DA-BAR, 2022), containing essential minerals (Quevedo et al., 2013), and beneficial anti-inflammatory and anti-oxidant properties (Dormido et al., 2019). Despite its culinary importance, *Batuan* remains underutilized and under-researched due to a major limitation: its seasonality (available only from April to June) and short postharvest life, which severely restrict its market availability and commercial potential (Ancheta et al., 2020). To overcome this limitation, processing technologies that can extend shelf life and enhance product stability are critically needed. Spray drying, a method that converts liquid extracts into stable, lightweight powders (Siddique & Ganesh, 2016), is a viable preservation technique but has been minimally applied to *Batuan*. Therefore, this study was conducted to address the gap in preservation technology for

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*Batuan* by developing a shelf-stable spray-dried powder using maltodextrin as a carrier agent, and to evaluate its quality characteristics, specifically its sensory acceptability, microbiological safety, and physicochemical properties, to establish baseline information for future food innovation and commercialization of this underutilized indigenous crop.

Fresh, mature but unripe *batuan* fruits were procured from local Guimaras growers and processed at the Western Visayas Food Innovation Center. After washing, the fruits were pulped and juiced with distilled water (6:1 ratio) to create the extract, which was then filtered and stored. Prior to spray drying, maltodextrin (10% w/v) was added as a carrier agent (Siddique & Ganesh, 2016). The extract was then processed using a laboratory-scale spray dryer operating at a feed pressure of 450–500 psi, an inlet temperature of 210–240 °C, and an outlet temperature of 80–95 °C. The resulting powder was sealed and stored at 4 °C. The spray-dried *batuan* powder was subjected to analysis, including sensory evaluation by 30 untrained panelists using a 9-point hedonic scale for color, aroma, taste, and flavor (International Organization for Standardization [ISO], 2012); microbiological analysis for aerobic plate count, yeast and mold, and *Escherichia coli* following Philippine National Standards (PNS, 2013) and AOAC methods (AOAC, 2019); and physicochemical analysis to determine pH (AOAC Method 981.12, using a digital pH meter), water activity (*aw*) (AquaLab Series 4TE), moisture content (AOAC Method 934.01), and titratable acidity (AOAC Method 942.15). All experiments were conducted in triplicate, and statistical analysis on sensory data was performed using One-way ANOVA and Tukey's HSD test ( $p < 0.05$ ).

The results confirm the successful production of a microbiologically safe and stable spray-dried *batuan* powder with generally high sensory acceptance. Sensory evaluation indicated that the powder was "liked very much" overall, with high scores for its characteristic sour taste, desirable flavor, and color, affirming the retention of *batuan*'s essential culinary properties. The only minor drawback was a lower acceptability for aroma, likely due to the typical loss of volatile compounds during the high-heat spray drying process (Chegini & Ghobadian, 2005). Crucially, microbiological analysis confirmed the product's safety for consumption, showing an extremely low aerobic plate count ( $< 10$  CFU/g) and acceptable yeast and mold levels (210 CFU/g) (ICMSF, 2011), all well within the acceptable limits set by the Philippine National Standards (PNS) and Codex Alimentarius guidelines for fruit powders. This excellent safety profile is supported by the physicochemical analysis, which revealed a low pH of 2.36 and, most significantly, a very low water activity (*aw*) of 0.34. This *aw* is substantially below the threshold for microbial growth (Beuchat, 1981), and when combined with the low pH and a stable moisture content (5.31%), it confirms that the spray-dried *batuan* powder possesses strong microbial stability and an extended shelf life (FDA, 2018), mirroring preservation mechanisms reported in other acidic fruit powders. The findings highlighted that spray drying is an effective method to convert *batuan* into a safe, acceptable, and shelf-stable ingredient, paving the way for its wider commercial application.

**Table 1.** Sensory Evaluation of spray-dried *batuan* powder

Attribute	Mean Score $\pm$ SD	Descriptive Rating
Color	7.63 $\pm$ 0.42	Like very much
Aroma	5.73 $\pm$ 0.56	Slightly like
Taste	7.13 $\pm$ 0.37	Like very much
Flavor	7.27 $\pm$ 0.41	Like very much
Overall	6.94 $\pm$ 0.44	Like very much

The successful production of a shelf-stable spray-dried powder from *batuan* fruit extract, utilizing maltodextrin as a carrier agent, was conclusively demonstrated by this study. The powder exhibited high consumer acceptance for its sour taste, flavor, and color, although future efforts must focus on improving aroma retention. Confirmed compliance with national and international safety standards via microbiological analysis, coupled with favorable physicochemical properties—specifically its low pH (2.36), low water activity (0.34), and low moisture content (5.31%)—strongly support the product's microbial stability and extended shelf life. These findings established spray drying as a viable method for preserving *batuan*, which not only adds value to this underutilized indigenous fruit but also promotes its potential commercialization as both a natural souring agent and a functional food ingredient. Future work should prioritize optimizing the

spray drying process by testing alternative carrier agents and concentrations to enhance aroma and yield, conducting comparative studies with other drying methods, and performing comprehensive shelf-life testing and nutritional profiling, alongside developing product prototypes to facilitate technology transfer and market integration.

**Table 2.** Microbiological quality of spray-dried *batuan* powder

Parameter	Result	Standard (PNS/Codex)
Aerobic Plate Count	<10 CFU/g	<10 <sup>3</sup> CFU/g
<i>E. coli</i>	<1.8 MPN/g	Absent or <3 MPN/g
Molds & Yeasts	210 CFU/g	<10 <sup>3</sup> CFU/g

**Table 3.** Physiochemical characteristics of spray-dried *batuan* powder

Parameter	Value	Standard
pH	2.36 ± 0.02	<4.5 (safe acidic foods)
Water activity (aw)	0.34 ± 0.01	<0.60 (microbial stability)
Moisture content (%)	5.31 ± 0.12	5–15% (stable powders)
Titrateable acidity (%)	9.49 ± 0.15	High acidity = flavor stability

## ACKNOWLEDGEMENTS

The authors wish to thank the following: The Western Visayas Food Innovation Center (WVFIC) for allowing our team to use their facility, the faculty, staff and students of GSU who volunteered in the sensory evaluation test, and DOST Regional Office VI for funding this research.

## AUTHOR CONTRIBUTIONS

- **Catalan, Eric P.:** Conceptualization, methodology, investigation, and project administration
- **Gallego, Daverose S.:** Investigation, visualization, and writing - review and editing
- **Junco, Ethel P.:** Conceptualization, funding acquisition, resources, and writing – original draft
- **Paglomutan, Rodrigo Jr., G.:** Investigation, data curation, and formal analysis
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## CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript. The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## ETHICS STATEMENT

The authors confirm that the research reported in this manuscript was conducted in full compliance with relevant ethical guidelines and regulations, particularly concerning studies involving human subjects and food product evaluation. All 30 untrained respondents who participated in the sensory evaluation provided informed consent prior to their participation in the study. The privacy and confidentiality of the participants were strictly maintained in accordance with ethical standards, and all procedures involving data collection, analysis, and reporting were performed with integrity and transparency, ensuring the study adheres to the established ethical principles for research.

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