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Development and characterization of powdered drink mix from *himbabao* (*Allaeanthus luzonicus, Blanco*) male flowers

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ABSTRACT

The growing demand for healthy, quick-dissolving powdered drink mixes inspired the researchers to develop a mix derived from locally available material with promising health benefits. *himbabao* is an endemic plant in the Philippines and possesses nutrients and phytochemicals with good health benefits. This study aimed to develop and characterize powdered drink mixes derived from *himbabao* male flowers using two distinct methods. The first method involved dehydration and pulverization, while the second focused on extracting water-soluble components followed by spray-drying. The developed products were analyzed in terms of their chemical and physical properties. The powdered drink mix developed through dehydration and pulverization exhibited a pH of 5.69, titratable acidity of 6.76, DPPH scavenging activity of 96.66%, total flavonoid content of 11.47 mg QE/g, and total phenolic content of 25.17 mg GAE/g. On the other hand, the mix developed via spray-drying showed a pH of 5.78, titratable acidity of 0.79, DPPH scavenging activity of 76.63%, total flavonoid content of 2.49 mg QE/g, and total phenolic content of 5.08 mg GAE/g. Proximate analysis showed that the dehydrated and pulverized mix contained 6.57% moisture, 9.16% ash, 31.31% crude protein, 9.87% crude fiber, 2.56% crude fat, and 40.53% nitrogen-free extract (NFE). On the other hand, the spray-dried mix comprised 3.68% moisture, 5.02% ash, 0.21% crude protein, 0.62% crude fiber, and 88.89% NFE. In terms of physical properties, the powdered drink mix from dehydration and pulverization had an angle of repose of 30.23°, viscosity of 12.90 cP, bulk density of 317.90 g/L, and total soluble solids of 0.5°Bx while the spray-dried mix exhibited an angle of repose of 22.02°, viscosity of 5.25 cP, bulk density of 239.50 g/L, and total soluble solids of 1.00 °Bx. The findings showed that the physicochemical properties of the developed *himbabao* powdered drink mix were affected by the methods used. Dehydration and pulverization yielded a product with better phytochemical and nutritional components while spray drying yielded a product with better physical properties. Further improvement of the process for the development of the *himbabao* powdered drink mix is recommended.

Keywords: *himbabao* flower, powdered drink mix, pulverization, spray drying

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1. Introduction

The growing global concern on health and wellness gears the research and development in the food industry toward creating functional foods and beverages from natural ingredients with targeted physiological benefits [1]. Among these, powdered drink mixes—or ready-to-reconstitute functional drinks—are gaining significant attention from consumers due to their nutritional value, ease of storage and transport, long shelf life, and wide range of flavor options.

Allaeanthus luzonicus (*Blanco*) *Fern.-Vill.,* locally known as *himbabao,* is an endemic species in the Philippines. It is one of the indigenous vegetables documented in the project implemented by the University of the Philippines Los Baños and funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (DOST-PCAARRD) [2]. The male flowers of *himbabao* are commonly harvested as an ingredient in vegetable dishes such as dinendeng, inabraw, and pinakbet of those from the Ilocos region and other parts of Luzon [3]. Relatively, its male flowers contain nutritional components such as protein, carbohydrates, total fats, ash, and vitamins including Vitamin C, beta carotene, and niacin. It also contains minerals such as calcium, phosphorus, iron, and sodium [2]. Phytochemicals such as alkaloids, flavonoids, saponins, glycosides, phenols, steroids, tannins, anthraquinones, cardiac glycosides, phenols, coumarin, and terpenoids are reported present in *himbabao* flower extracts [4] while carbohydrates, reducing sugars, flavonoids, tannins, alkaloids, and sterols were found in *himbabao* leaves [5]. Being rich in nutritional and phytochemical components, *himbabao* male flowers are a promising material for developing value-added products, such as powdered drink mix.

This study aimed to develop and characterize a powdered drink mix from *himbabao* male flowers using two methods

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involving drying and pulverization. Drying was employed since it is an efficient approach for preserving fruits, vegetables, and herbs [6]. Drying reduces the volume and weight of raw materials, enhances shelf life, and maintains product quality, while pulverization and spray drying further refine the material into a stable powdered form. These processes improve storage, transportation efficiency, and the desired attributes of food products, such as solubility and flow properties [7].

2. Materials and methods

Himbabao male flowers were collected in Batangas province. Food-grade maltodextrin was purchased from the local market. All experiments were conducted in triplicate unless otherwise stated.

2.1. Preparation of *himbabao* powdered drink mix

The *himbabao* male flower powdered drink mix was developed using two methods. The first method involved dehydration and pulverization. After washing, the *himbabao* male flowers were air-dried for two days and then further dehydrated using a food dehydrator (Model FDS-012/FDS - 018) at 60 °C until reaching constant weight. The dried flowers were pulverized using a food-grade pulverizer and sifted through a 120-mesh size (125 µm) sifter [8]. The *himbabao* flower powder was weighed and stored in airtight packaging at room temperature prior to analyses.

The second method involved the extraction of water-soluble components from *himbabao* male flowers and spraying drying. After washing, the *himbabao* male flower was blended with distilled water at a 1:10 w:v (*himbabao* flower and distilled water). The water-soluble extract was separated from residues by filtration. Prior to spray drying, the amount of maltodextrin to be used was determined by employing a preliminary experiment that involved the utilization of varying amounts of maltodextrin, specifically 1%, 2%, and 5%. Based on the yield and physical appearance of the produced products, the researchers decided to use 5 % maltodextrin. The maltodextrin was added to the water-soluble extract of *himbabao* male flowers (5% w/v) and spray dried at an inlet temperature of 150 °C and an outlet temperature of 90-98 °C, with a blower speed of 4 rpm [9]. The resulting *himbabao* powdered drink mix was weighed and stored in airtight packaging at room temperature before analyses.

2.2. Analysis of the developed *himbabao* powdered drink mix

2.2.1. pH and titratable acidity

The pH and titratable acidity were determined according to the AOAC Method 981.12, and AOAC Method 942.15, respectively [10]. A pH meter (Mettler pH s210K) was used in this study.

2.2.2. Proximate analysis

The proximate analyses of the developed product were carried out using the AOAC methods [10]. Moisture content was determined by heating the dried sample at 100-110 °C for 24 h, cooling it in a desiccator, and weighing it until a constant weight occurred. The ash content was determined by heating them in a muffle furnace for about 5-6 h at 500 °C. The Kjeldahl method was used to determine crude protein, and a conversion factor of 6.25 was used to get the nitrogen percentage of the crude protein. The crude lipid content was determined by extracting it from a moisture-free sample using petroleum ether (60-80 °C) in a Soxlhet apparatus. To estimate crude fiber content, the fat and moisture-free materials were treated with 1.25% dilute acid and 1.25% alkali, followed by washing with water and ignition of the residue. The determination of nitrogen free extract (NFE) was calculated by the method of difference using the formula:

$$NFE = 100 - (\%\ lipid + \%ash + \%moist + \%protein) \quad (1)$$

2.2.3. Total phenolic content

The total phenolic content was determined based on the study of Petkova et al. [11] using a Folin-Ciocalteu reagent. A 5000 ppm solution was prepared and 0.2 mL of this solution and 0.8 mL 7.5 % of sodium carbonate (Na_2CO_3) were combined with 1 mL Folin-Ciocalteu reagent. The reaction was carried out in the dark for 20 min at room temperature. The absorbance was measured against a blank at 765 nm. The results were represented as mg equivalent of gallic acid (GAE) per g dried weight.

2.2.4. Total flavonoid content

Total flavonoid content was determined the study of Ivanov et al. [12] using a modified colorimetric method. A 5000 ppm aqueous solution was prepared and 5 mL of this was added to the test tube and stirred for 5 minutes with 0.3 ml of 5% sodium nitrite ($NaNO_2$). After this, 0.3 mL of 10% aluminum chloride ($AlCl_3$) was added. After 6 min, the process was interrupted by adding 2 mL of sodium hydroxide (NaOH). The mixture was then diluted with distilled water to a volume of 10 mL. The absorbance was measured at 415 nm against the blank. The results were presented as mg equivalents quercetin (QE) per g dry weight (dw) according to the calibration curve linear in the range of 10-100 µg/mL quercetin.

2.2.5. DPPH free radical scavenging activity

The antioxidant activity of the aqueous extracts was determined using the modified method reported by Petkova et al. [11] which is known as 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay. A 2000 ppm solution was prepared and 0.15 mL was mixed with 2.85 mL 0.1 mM solution of DPPH in 100% methanol. The sample was incubated for 15 min at 37 ° C. The reduction of absorbance was measured at 517 nm in comparison to the blank containing methanol and the percentage inhibition was calculated using the following equation:

$$Inhibition\ (\%) = \frac{(A_{Blank} - A_{Sample})}{(A_{Blank})} \times 100 \qquad (2)$$

2.2.6. Determination of physical properties

The viscosity and total solids were determined according to the AOAC Method 976.16, and AOAC Method 932, respectively [10] while bulk density and angle of repose were determined [13].

3. Results and discussion

3.1. Percentage yield of the developed *himbabao* powdered drink mix

Figure 1 presents the percentage yield of the developed *himbabao* powdered drink mix using dehydration and pulverization with 16.31% and extraction of water-soluble components and spray drying with 3.11%. The dehydration and pulverization process obtained a higher yield than the extraction of water-soluble components and spray drying. The lower yield in spray drying is attributed to the high processing temperatures, which cause rapid surface evaporation, preventing proper liquid migration. Additionally, the low concentration of maltodextrin (5%) added to the *himbabao* juice extract before spray drying resulted in insufficient encapsulation of hydrophobic compounds, leading to substantial losses during drying [14]. The lower yield of extraction of water-soluble components and spray drying is also due to powder deposition on the dryer walls, where it becomes scorched or overcooked, further decreasing the collected product. Dehydrated and pulverized *himbabao* powder had a higher yield because it also contained water-insoluble components.

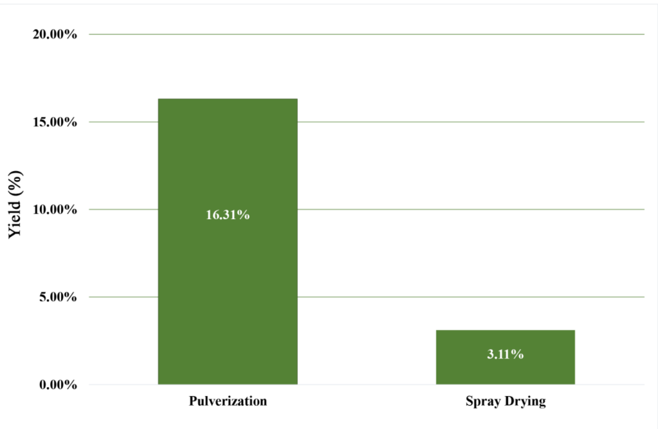

Figure 1. Percentage yields of the developed *himbabao* powdered drink mix using pulverization and spray drying methods

3.2. Characteristics of *himbabao* powdered drink mix

3.2.1. Chemical properties

Table 1 shows the chemical properties of the *himababao* powdered drink mix developed through dehydration and pulverization, and spray drying of water-soluble extract.

Table 1. Chemical properties of the *himbabao* powdered drink mix.

Parameters	Powdered drink mix from	
	Dehydration and pulverization	Spray drying of water-soluble extract
pH	5.69 ± 0.00	5.78 ± 0.00
Titratable acidity, %	6.76 ± 0.02	0.79 ± 0.02
Moisture, %	6.57 ± 0.36	3.68 ± 0.07
Ash, %	9.16 ± 0.04	1.58 ± 0.05
Crude protein, %	31.31 ± 0.38	5.02 ± 0.23
Crude fiber, %	9.87 ± 0.14	0.21 ± 0.08
Crude fat, %	2.56 ± 1.33	0.62 ± 0.18
Nitrogen free extract NFE), %	40.53 ± 0.00	88.89 ± 0.00
Total flavonoid content (mg QE/g)	11.47 ± 0.00	2.49 ± 0.05
Total phenolic compound (mg GAE/g)	25.17 ± 0.03	5.08 ± 0.00
DPPH scavenging activity (% Inhibition)	96.66 ± 0.00	73.63 ± 0.00

DPPH Scavenging Activity results is based on 2000 ppm extract concentration
TPC results is based on 5000 ppm concentration extract
TFC results is based on 5000 ppm extract concentration

The pH of the developed *himbabao* powdered drink mix using dehydration and pulverization was 5.69 while that of the mix developed using extraction of water-soluble component and spray drying was 5.78, indicating both samples are slightly acidic. The pH increased with higher drying temperatures consistent with other studies [15]. Elevated temperatures can degrade organic acids, reducing acidity and raising the pH. The addition of maltodextrin during spray drying did not influence the pH, as maltodextrin lacks functional groups that alter hydrogen ion concentration and act as a stabilizer and bulking agent. The titratable acidity of the developed *himbabao* powdered drink mix using dehydration and pulverization was higher (6.76 ± 0.02%) than that of the developed using spray drying of water-soluble extract (0.79 ± 0.02%). This finding aligns with the findings of Braza et al. [16], and the decrease in titratable acidity with increased temperature is consistent with the results of Koca et al. [17]. This reduction in acidity is due to the degradation of organic acids at higher temperatures, impacting the acid-base balance of the product.

The developed *himbabao* powdered drink mix using dehydration and pulverization contained 6.57% moisture, 9.16% ash, 31.31% crude protein, 9.87% crude fiber, 2.56% crude fat, and 40.53% nitrogen-free extract. In contrast, the powdered drink mix developed through spray-drying of water -soluble extract had 3.68% moisture, 1.58% ash, 5.02% crude protein, 0.21% crude fiber, 0.62% crude fat, and 88.89% nitrogen-free extract.

The decrease in moisture content with increased temperature is due to the enhanced efficiency of the heat transfer process and the increased water vapor pressure differential, facilitating faster dehydration. Higher temperatures (150 °C) resulted in lower moisture content (3.68%) compared to 60 °C (6.57%). The reduced crude protein, crude fat, crude fiber, and ash content in the developed *himbabao* powdered drink mix through spray-drying is attributed to the addition of maltodextrin and the prolonged exposure to high temperatures, leading to degradation through thermal decomposition and oxidation. The lower ash content in the spray-dried product may result from the volatilization of some minerals or dilution by maltodextrin, which binds with minerals and other ash-forming components.

The higher % nitrogen-free extract in the developed *himbabao* powdered drink mix using spray-drying of the soluble extract is attributed to the added maltodextrin, a carbohydrate used as a carrier agent, which increases the overall carbohydrate content in the final product. This aligns with findings from other studies indicating similar trends in the impact of drying methods on nutritional content.

The DPPH scavenging activity of the *himbabao* powdered drink mix was found to be 96.66% when prepared using dehydration and pulverization, compared to 73.63% when prepared using spray drying. This indicates significantly higher antioxidant activity in the product produced by dehydration and pulverization. The superior antioxidant activity is attributed to the higher total phenolic content in the pulverized powder, consistent with the findings of Koca et al. [17], which established a correlation between phenolic content and DPPH activity.

The reduced antioxidant activity in the spray-dried powder can be explained by the higher processing temperature (150 °C), which leads to the degradation of heat-sensitive flavonoids. In contrast, the pulverization process, conducted at a lower temperature of 60 °C, better preserves these compounds, as supported by the study of TA Tran, et al. [19].

Furthermore, the use of maltodextrin in the spray drying process contributes to preserving polyphenol content by forming a protective matrix around the polyphenols, shielding them from exposure to light, oxygen, and heat, Pham, et al. [20]. However, this protective effect may not fully compensate for the loss of phenolic compounds caused by the high-temperature conditions of spray drying.

3.2.2. Physical properties

Table 2 shows the physical properties of the *himbabao* powdered drink mix developed through dehydration and pulverization, and spray drying of water-soluble extract.

Table 2. Physical properties of the developed *himbabao* powder drink mix.

Parameters	Developed *himbabao* powdered drink mix via	
	Dehydration and pulverization	Spray Drying of Water-Soluble Extract
Angle of repose, °	30.23 ± 0.15	22.02 ± 0.31
Viscosity, cP	12.90 ± 0.00	5.25 ± 0.00
Bulk density, g/L	317.90 ± 0.00	239.50 ± 0.00
Total soluble solid, °Bx	0.50 ± 0.00	1.00 ± 0.00

The angle of repose is a measure of internal friction that indicates the flowability of granular materials. A lower angle of repose generally signifies better flow properties. The *himbabao* male flower powdered drink mix developed through spray drying exhibited an angle of repose of 22.02°, indicating excellent flowability and a more free-flowing nature. In comparison, the product developed through dehydration and pulverization had an angle of 30.23°, classified as good in terms of flowability. The reduced flowability of the pulverized powder is attributed to its higher moisture content, which increases particle cohesion and hinders flow. Conversely, the addition of maltodextrin in the spray-drying process enhances flowability by reducing moisture content and stickiness, resulting in powders with lower angles of repose. Fat content also plays a role, as higher fat levels lead to particle clustering and impaired flow. The lower fat content in the spray-dried sample further contributes to its superior flowability.

The viscosity of the spray-dried powder (5.2 cP) was significantly lower than that of the pulverized powder (12.8 cP). This difference is due to the natural fiber content in the pulverized product, which increases resistance to flow. In contrast, the heat processing involved in spray drying reduces water content, thereby lowering viscosity. Similarly, bulk density measurements revealed that the spray-dried powder (239.5 g/L) was less dense than the pulverized powder (317.90 g/L). This lower bulk density is attributed to the high inlet temperature during spray drying, which causes rapid particle hardening, preventing significant shrinkage and resulting in a lighter, less dense product.

Additionally, the spray-dried powder demonstrated a higher total soluble solids measurement (0.10 °Bx) compared to the pulverized powder (0.05 °Bx), due to the inclusion of maltodextrin, a soluble carbohydrate.

4. Conclusion

The study showed that the method of processing significantly influences the physical and chemical properties of *himbabao* powdered drink mixes. Dehydration and pulverization yielded a product with higher levels of phytochemicals such as total flavonoid content and total phenolic content, a higher antioxidant in terms of DPPH scavenging activity, and higher percentages of moisture content, ash content, crude protein, crude fiber, crude fat, and titratable acidity. On the other hand, spray drying yielded a product with better flowability and lower viscosity compared to the pulverized counterpart.

Based on the findings of this study, further research studies are recommended to ensure the development of *himbabao* powdered drink mix with improved physicochemical properties. The studies may focus on the following: (a) explore the use of alternative carrier reagents such as gum arabic, modified starches, and proteins for the spray drying process, (b) consider the use of different mesh sizes between 150-200 to improve the quality of the pulverized *himbabao*, and (c) consider freeze drying as an alternative method to enhance the yield of the *himbabao* powder drink mix without compromising its nutritional content. Additional parameters for the characterization may be included such as microbial analysis and sensory evaluation Furthermore, comparing the *himbabao* powdered drink mix with commercially available drink mixes could provide valuable insights.

References

[1] Nazir M, Arif S, Khan RS, Nazir W, Khalid N, Maqsood S. Opportunities and challenges for functional and medicinal beverages: current and future trends. Trends Food Sci Amp Technol [Internet]. 2019 Jun;88:513-26. Available from: https://doi.org/10.1016/j.tifs.2019.04.011

[2] Pelegrina LD, Panganiban JN. DOST-PCAARRD Portal [Internet]. DOST-PCAARRD/UPLB project to document indigenous vegetables in the Philippines; 2018 Apr 11. Available from: https://pcaarrd.dost.gov.ph/index.php/quick-information-dispatch-qid-articles/dost-pcaarrd-uplb-project-to-document-indigenous-vegetables-in-the-philippines#:~:text=Titled,%20“Documentation%20of%20the%20Indigenous,Professor%20Nestor%20C.

[3] Taculao PB. Agriculture Magazine [Internet]. himbabao: An indigenous vegetable loved by Ilocanos; 2020 May 27. Available from: https://agriculture.com.ph/2020/05/27/himbabao-an-indigenous-vegetable-loved-by-ilocanos/

[4] Antonio MA, Vivit MB. Phytoconstituents and in vitro anti-oxidant activity of selected indigenous vegetables in the ilocos. MMSU Sci Technol J [Internet]. 2017;VII (2):16-27. Available from: https://research.mmsu.edu.ph/stjournal/vol7_2_Phytoconstituents.pdf

[5] Choa JB, Lu RV, Nombrado MA, Rayos GK, Invento CD, Castañeda G. Phytochemical screening of Broussonetia luzonicus (Moraceae) leaves. J Chem Pharm Res [Internet]. 2016;8(2):335-8. Available from: https://www.researchgate.net/publication/296443651_Phytochemical_screening_of_Broussonetia_luzonicus_Moraceae_leaves

[6] Karam MC, Petit J, Zimmer D, Baudelaire Djantou E, Scher J. Effects of drying and grinding in production of fruit and vegetable powders: a review. J Food Eng [Internet]. 2016 Nov;188:32-49. Available from: https://doi.org/10.1016/j.jfoodeng.2016.05.001

[7] Largo Ávila E, Cortés Rodríguez M, Ciro Velásquez HJ. Influence of maltodextrin and spray drying process conditions on sugarcane juice powder quality. Rev Fac Nac Agron Medellin [Internet]. 2015 Jan 1;68(1):7509-20. Available from: https://doi.org/10.15446/rfnam.v68n1.47839

[8] Alyami H, Dahmash E, Bowen J, Mohammed AR. An investigation into the effects of excipient particle size, blending techniques and processing parameters on the homogeneity and content uniformity of a blend containing low-dose model drug. Plos One [Internet]. 2017 Jun 13;12(6):e0178772. Available from: https://doi.org/10.1371/journal.pone.0178772

[9] Bautista JV, Pedroza JT, Untalan MK. Development and evaluation of spray-dried Illinois mulberry (Morus rubra) fruit juice. Int Res J Innov Eng Sci Technol [Internet]. 2022;8:21-5. Available from: https://ojs.batstate-u.edu.ph/index.php/IRJIEST/article/view/87

[10] AOAC. Official Methods of Analysis of Association of Official Analytical Chemists, 18th ed. Washington, DC: AOAC International; 2010.

[11] Petkova N, Todorova M, Grozeva N, Gerdzhikova M. Phenolic content and antioxidant activity of water extracts from Rosa damascena petals grown in kazanlak valley, bulgaria. Horticulture [Internet]. 2020;LXIV (2):345-52. Available from: https://horticulturejournal.usamv.ro/pdf/2020/issue_2/Art47.pdf

[12] Ivanov IG, Vrancheva RZ, Marchev AS, Petkov NT, Aneva IY, Denev PP, Georgiev VG, Pavlov AI. Antioxidant activities and phenolic compounds in Bulgarian Fumaria species. Int J Curr Microbiol Appl Sci [Internet]. 2014;3(2):296-306. Available from: https://www.researchgate.net/publication/260035689_Antioxidant_activities_and_phenolic_compounds_in_Bulgarian_Fumaria_species

[13] European Pharmacopeia. Bulk Density and Tapped Density of Powders. European pharmacopoeia, 7th ed. Strasbourg: Council of Europe; 2010. 384 p.

[14] Dailami MT. Production of dragon fruit powder using spray drying method [Undergraduate thesis]. Malaysia: Universiti Malaysia Pahang; 2009. 11 p.

[15] The effects of maltodextrin as a drying aid and drying temperature on production of tamarind powder and consumer acceptance of the powder. Int Food Res J [Internet]. 2016 Jan;23(1):300-8. Available from: https://www.researchgate.net/publication/289157777_The_effects_of_maltodextrin_as_a_drying_aid_and_drying_temperature_on_production_of_tamarind_powder_and_consumer_acceptance_of_the_powder

[16] Braza J, Ronquillo RA, Tolentino JC. Characterization of spray-dried turmeric (Curcuma longa) and its acceptability as pandesal additives [Undergraduate thesis]. Batangas City: Batangas State University; 2020.

[17] Koca N, Erbay Z, Kaymak-Ertekin F. Effects of spray-drying conditions on the chemical, physical, and sensory properties of cheese powder. J Dairy Sci [Internet]. 2015 May;98(5):2934-43. Available from: https://doi.org/10.3168/jds.2014-9111

[18] Tan WC, Tan CH, Nyam KL, Tan CP, Julkifle A. Nutritive bambara groundnut powdered drink mix: characterization and in-vivo assessment of the cholesterol-lowering effect. J Food Sci Technol [Internet]. 2020 Sep 22. Available from: https://doi.org/10.1007/s13197-020-04802-x

[19] TA Tran T, VH Nguyen H. Effects of spray-drying temperatures and carriers on physical and antioxidant properties of lemongrass leaf extract powder. Beverages [Internet]. 2018 Nov 9;4(4):84. Available from: https://doi.org/10.3390/beverages4040084

[20] Pham TV, Nguyen MT, Do LV, Truong MN, Vo AN, Van KC, Le TD. Effect of operational conditions on physicochemical profiles of spray-dried powder of mango (Mangifera indica L.) juice from Tu Quy variety in Vietnam. Food Res [Internet]. 2022 Jun 16;6(3):342-9. Available from: https://doi.org/10.26656/fr.2017.6(3).319