THE EFFECTS OF MICROWAVE DRYING CONDITIONS ON PHYSICOCHEMICAL PROPERTIES OF NONI (*Morinda citrifolia* L.) POWDER

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ABSTRACT

The increasing popularity of *Morinda citrifolia*, commonly known as noni fruit, which is known for its rich bioactive compounds like saponins, polyphenols, flavonoids, and vitamin C, has led to its introduction into the market in the form of noni powder. Numerous methods are employed to dry noni fruit, with this study focusing on microwave drying. The primary objective was to investigate the impact of microwave drying conditions on the physicochemical properties of noni powder, while also exploring its preservation through moisture sorption isotherm and Q_{10} experiments.

The microwave drying process for noni fruit slices involved three different power settings, namely 1.29 W/g, 1.71 W/g, and 2.29 W/g. The results revealed that the most suitable microwave power setting for drying noni fruit was 1.71 W/g, when combined with a material loading of 4 kg/m^2. Under these conditions, the content of bioactive compounds, including saponins, polyphenols, flavonoids, and ascorbic acid, was maximized, with values of 48.0 mg AE/g db, 12.9 mg GAE/g db, 8.3 mg QE/g db, and 0.3 mg AA/g db, respectively. In the context of storage, the sorption curve of noni powder at 30°C was modeled using the BET model, with an M_o value of approximately 4%. Furthermore, the Q_{10} value for noni powder indicated that total polyphenols, saponins, flavonoids, and vitamin C can maintain 70% of their initial content over a span of 2 months at 5°C or 1 month at 10°C when stored under conditions devoid of oxygen and light.

1. INTRODUCTION

Morinda citrifolia L., commonly known as noni, belongs to the Rubiaceae family. It serves as a natural source of various bioactive molecules and has been traditionally used as a medicinal plant in South and Southeast Asian nations. Noni fruit is rich in bioactive compounds, including fatty acids, anthraquinones, flavonoids, polysaccharides, carotenoids, and sterols (Islam and Kabir, 2019). The fruit plays a significant role in supporting the treatment of common ailments such as back pain, arthritis, body aches, and neurasthenia. Moreover, it not only aids in prevention and medical treatment but is also a highly nutritious and safe option for consumers.

In microwave drying, the electromagnetic field affects the entire material, causing numerous water molecules within the material to oscillate millions of times per second. This oscillation, accompanied by the resulting energy, can significantly enhance the rate of moisture evaporation in the material. Microwave drying offers an alternative drying method with several advantages, including efficient heat conduction into the interior of the material, cleaning, energy recovery, rapid initiation and control of the drying process, and timely completion (Çelen, 2019).

The relationship between moisture content and water activity in food is often elucidated through moisture sorption isotherms. Among the most commonly used models for this purpose are the Brunauer-Emmett-Teller (BET) and Guggenheim-Anderson-de Boer (GAB) models. The BET model is primarily qualitative, with its water activity range typically falling between 0.05 and 0.45. This model is primarily applied to assess surface areas. In contrast, the GAB model is favored for its strong theoretical foundation, mathematical simplicity, and ease of interpretation. It is commonly employed when dealing with higher water activity levels, typically greater than 0.93 (Andrade P. et al., 2011). Additionally, this research places emphasis on the Q_{10} value, which represents the rate at which spoilage increases when the storage temperature is raised by 10°C. The Q_{10} value enables the prediction of a product's shelf life under real-world conditions based on test results conducted at elevated temperatures (Renumarn and Choosuk, 2020).

Noni fruit products are available in various forms, ranging from teas and wines to dried fruit sections, pills made from leaves, and juice powders. However, there is a notable scarcity of information regarding the effects of microwave drying conditions on noni fruit powder. Furthermore, there has been no prior evaluation of noni fruit powder produced through the microwave drying method. Consequently, this study was undertaken to explore the impact of microwave drying conditions, including different microwave energy powers and material loadings, on the physicochemical properties of noni fruit powder. Furthermore, the study involved estimating the shelf-life of noni powder using moisture sorption isotherms and Q_{10} measures.

2. METHODOLOGY

2.1. Materials

Fresh noni fruit (*Morinda citrifolia* L.) was procured from Tien Giang province and subsequently transported to the laboratory at Nong Lam University in Ho Chi Minh City. When the noni fruit reached two-thirds ripeness on the surface (measured from the flowering date, typically around 100-107 days), it demonstrated peak levels of bioactive compounds, including total saponins content (TSC), total polyphenols content (TPC), total flavonoids content (TFC), and ascorbic acid content (AAC). Following the harvest at this specific ripeness stage, the noni fruits were stored for 2-3 days before undergoing the microwave-drying process. Upon arrival, the noni fruit was stored in a freezer until it was ready for processing. After thawing at room temperature, the noni fruit was peeled and sliced into small pieces, each with a thickness of 8 to 10 mm.

Analytical chemicals, including the Folin-Ciocalteau (FC) reagent (Merck, Germany), sodium carbonate, vanillin, sulfuric acid, sodium nitrite, aluminium chloride, sodium hydroxide, oxalic acid, 2,6-dichlorophenol-indophenol (DCPIP), ethanol, sodium hydroxide, potassium acetate, magnesium nitrate, sodium chloride, and potassium chloride, were sourced from Bach Khoa Company Ltd in Ho Chi Minh, Vietnam. Standards such as gallic acid (G7384), quercetin (Q4951), aescin (E1378), and ascorbic acid (A92902) were purchased from Sigma-Aldrich, Singapore

2.2. Experimental design

2.2.1. Microwave drying process of noni fruit

After thawing, the fresh noni fruit was peeled and sliced into pieces with a thickness of 8-10 mm. These noni slices were placed in a microwave oven (Electrolux EMM2308X), where the drying process was periodically paused every 5 min to prevent overcooking. The slices were microwave-dried at different power settings, including 1.29 W/g, 1.71 W/g, and 2.29 W/g. After determining the most suitable microwave power level, the study proceeded to investigate material loading with three different levels (4, 5, and 6 kg/m^2).

It is important to note that all batches of noni slices underwent the same process, with the 5-min breaks simulating the behavior of industrial equipment. The drying process was considered complete when the moisture content of the noni slices reached approximately 3-4%.

Subsequently, the dried noni pieces were ground into a fine powder with a particle size of less than 500 µm using a laboratory blender (Phillip, Netherlands). The resulting powder samples were then stored in resealable PA/PE bags until further analysis within one day. Various physicochemical properties of the resulting powder, including moisture content, water activity, total saponins content (TSC), total polyphenols content (TPC), total flavonoids content (TFC), and total vitamin C content (AAC) were determined.

2.2.2. Moisture sorption isotherms

After selecting the most suitable microwave drying conditions, the study explored various storage conditions using five saturated salt solutions. Four grams of noni powders were carefully weighed and placed into aluminium containers. These containers were then positioned within hermetic glass desiccators containing saturated salt solutions, which included sodium hydroxide (NaOH), potassium acetate (CH_3COOK), magnesium nitrate ($Mg(NO_3)_2$), sodium chloride (NaCl), and potassium chloride (KCl). These salt solutions provided a range of relative humidities, spanning from 8% to 84%.

The sealed desiccators were subsequently stored at a temperature of 30°C. To determine the monolayer moisture content M_o (db, dry basis), calculations were performed using the BET, as outlined by Lee and Lee (2008).

$$M_o = \frac{M_C\, C\, A_w}{(1 - A_w)[1 + (C - 1)A_w]} \quad (1)$$

Where: M_C is moisture content of powders expressed in g per 100 g db; M_o is g of water equivalent to monomolecular layer adsorbed per 100 g db; Aw is water activity at moisture content M_C; C is BET constant.

These BET parameters can be estimated graphically by plotting [Aw/(1-Aw)M_C] against Aw using Excel software, resulting in a linear relationship. The slope [(C-1)/M_CC] and intercept [1/M_CC] of this line enable the estimation of the BET-monolayer M_o and parameter C.

2.2.3. Storage conditions of noni powder

Noni powders were placed into two distinct incubators. The first incubator was maintained at a temperature of 40°C, while the another was set at 50°C.

Measurements, including TSC, TPC, TFC, and AAC, were taken at the beginning of the experiment and subsequently at regular intervals (e.g., 1 day, 2 days) until the reduction in these variables exceeded 70%. This data was collected at both 40°C and 50°C to calculate the real-time preservation duration.

2.3. Analytical methods

2.3.1. Moisture content determination

Moisture content was determined using an infrared moisture drying balance (MX-50 model, Sartorius, Japan). To determine the moisture content, one gram of the sample was carefully weighed and subjected to the drying process. The process continued until a constant weight was achieved, ensuring accurate measurement of moisture content in the samples.

2.3.2. Water activity determination

Water activity was assessed using an AquaLab DewPoint 4Te water activity meter (Decagon Devices Inc., Pullman, WA, USA) at a controlled temperature of 25 ± 0.5°C.

2.3.3. Bioactive compound determination

Extraction

For the extraction process, 4 grams of noni powder were combined with 40 ml of 99.7% ethanol in a 250 ml glass beaker, maintaining a solid-to-solvent ratio of 1/10. This mixture of ethanol and noni powder was then placed in a 50°C shaking water bath and incubated for 15 min. Subsequently, the mixture was initially coarsely filtered using a cloth before undergoing a finer filtration process with filter paper. The resulting liquid was then utilized for the analysis of bioactive compounds.

Total saponin content

The total saponin content (TSC) was determined using UV-vis spectrophotometer (Jenway, USA) with slight modifications, as described by Tan et al. (2014). Initially, 0.3 mL of the sample's ethanolic extracts were combined with 0.3 mL of an 8% (w/v) vanillin solution and 3 mL of 72% (v/v) sulfuric acid. The mixture was thoroughly mixed and then incubated at 60°C for 15 min, followed by a cooling period of 10 min. Subsequently, the absorbance of the samples was measured at 560 nm. Aecsin was employed as the standard, and the results were expressed as aecsin equivalents (AE) per gram of dry basis of the sample, represented as mg AE/g db.

Total polyphenol content

Polyphenols in noni fruits were quantified using the Folin-Ciocalteau method as described by Singleton et al. (1999). Initially, 0.5 mL of the sample was combined with 2.5 mL of a 10% Folin-Ciocalteu reagent. After allowing the mixture to stand for 5-8 min, 2 mL of a 7.5% sodium carbonate solution (Na_2CO_3) was introduced. The resulting mixture was incubated at ambient temperature in the absence of light for a duration of 60 min. Subsequently, the absorbance of the mixture was measured at 765 nm using a UV-Vis spectrophotometer. Gallic acid served as the standard, and the results were expressed as gallic acid equivalents (GAE) per gram of dry basis of the sample, denoted as mg GAE/g db.

Total flavonoid content

The total flavonoids content (TFC) was determined using the aluminium chloride colorimetric assay, following the method outlined by Marinova et al. (2005). To accomplish this, 1 mL of the sample was introduced into a 10 mL volumetric flask containing 4 mL of distilled water. Subsequently, 0.3 mL of a 5% sodium nitrite ($NaNO_2$) solution was added to the flask. After a 5-min incubation period, 0.3 mL of a 10% aluminium chloride ($AlCl_3$) solution was introduced. Afterward, 2 mL of 1 M sodium hydroxide (NaOH) was added, and the total volume was adjusted to 10 mL with distilled water. The resulting solution was thoroughly mixed using a vortex, and the absorbance was measured at 510 nm. Quercetin served as the standard, and the results were expressed as quercetin equivalents (QE) per gram of dry basis of the sample, denoted as mg QE/g db.

Ascorbic acid content

The ascorbic acid content (AAC) was determined using the 2,6-dichlorophenol indophenol (DCPIP) titration method, as outlined by CoSeteng et al. (1989). In this method, 1 mL of a working standard solution (1 mg/mL) of ascorbic acid and 2 mL of 4% oxalic acid were pipetted into a 150 mL conical flask. The contents in the flask were titrated against the dye solution until a pale pink color appeared and persisted for a few minutes. Approximately 1 ml of the sample was titrated in a similar manner with the dye solution. The ascorbic acid content in the sample was expressed in mg AA/g of the sample.

2.3.4. Shelf-life determination

Shelf-life of the noni powder was predicted using equation as follows.

$$t_2 = t_1 \times Q_{10}^{(T_1 - T_2)} \quad (2)$$

Wherein, t_1 and t_2 represent the time intervals between tests at higher T1 and lower T2 temperatures, respectively; Q_{10} is the factor by which the rate of degradation of bioactive compounds increases when the temperature is raised by 10°C.

2.4. Statistical analysis

All experiments and subsequent measurements were replicated three times. The experimental data were subjected to statistical analysis using JMP software. The results are reported as the mean and standard deviation (Mean ± SD). Differences between the mean values were evaluated through ANOVA (Analysis of Variance) and LSD (Least Significant Different) tests at a significance level of 5% ($P < 0.05$).

3. FINDINGS AND DISCUSSION

3.1. Microwave drying process

3.1.1. Drying curve

About 350 grams of noni fruit samples were sliced into small pieces, with each slice having a thickness ranging from 8 to 10 mm. The average initial moisture content of these fresh noni slices was 82.76%. These slices were subjected to drying using three different microwave power setting levels: 450 W, 600 W, and 800 W, which correspond to power densities of 1.29 W/g, 1.71 W/g, and 2.29 W/g, respectively. To achieve the desired moisture content of noni powder (3-4%), the microwave drying times at 1.29, 1.71, and 2.29 W/g were determined to be 60, 35, and 20 min, respectively (Figure 1). The results illustrating the relationship between moisture content and drying time are depicted in Figure 1.

In general, microwave power had a direct impact on the moisture content and drying time. An increase in microwave power resulted in a more rapid reduction in moisture content, reaching levels of 4% or less. As noted by Zhao et al. (2019), drying time was significantly reduced, and the drying rate increased substantially as the microwave power level increased from 500 W to 800 W. This effect can be attributed to the simultaneous increase in electromagnetic intensity with the rise in drying power level, generating a significant amount of heat energy within a rapidly alternating electric field.

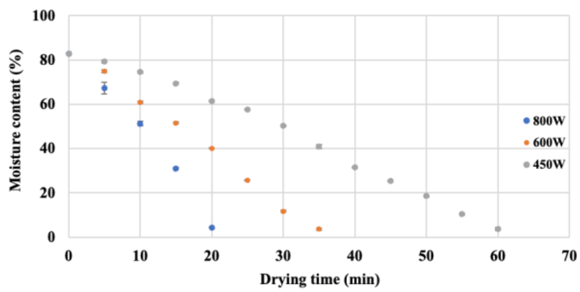

Figure 1. Drying curves of noni fruit at different microwave power levels

3.1.2. The effect of microwave power settings on bioactive compounds

Table 1 illustrates that the content of saponins, polyphenols, flavonoids, and vitamin C in the noni powder is influenced by varying microwave power levels.

The highest recorded content of TPC and TSC was observed at 1.71 W/g (11.7 mg GAE/g, db and 36.0 mg AE/g, db, respectively), while the lowest content was found at 2.29 W/g (5.8 mg GAE/g, db and 26.9 mg AE/g, db, respectively). Considering the results for total flavonoids, the noni powder samples treated with high output power of 1.71 W/g exhibited the highest TFC (5.2 mg QE/g, db), whereas the lowest amount was observed at 1.29 W/g. It's worth noting that microwave power levels lower than those associated with high TFC may not provide sufficient disruption of plant cell wall polymers, resulting in more effective extraction. Conversely, power levels higher than the optimum can lead to a decrease in TFC (Dong et al., 2011). At lower output power levels, a decline in the content of TSC, TPC, and TPC was observed, attributed to the prolonged drying time. Similar findings have been reported in studies on apples (Chong et al., 2014) and kiwifruit (Bhat et al., 2022), where an extended drying duration led to a reduction in TPC. However, the adverse impact of heat application on TPC becomes evident at higher output power levels (high temperature). The rapid application of heat over a short duration have been shown to aid in preserving polyphenols by regulating the activity of oxidative enzymes (Bhat et al., 2022).

Table 1. The effect of microwave power settings on bioactive compounds

Content (mg/g, db)	Microwave power level (W/ g)		
	1.29	**1.71**	**2.29**
TSC	28.8±0.8[b]	36.0±0.5[a]	26.9±1.5[b]
TPC	7.4±0.2[b]	11.7±0.2[a]	5.8±0.7[c]
TFC	2.9±0.3[b]	5.2±0.6[a]	3.4±0.6[b]
AAC	0.32±0.02[a]	0.27±0.03[b]	0.18±0.02[c]

The reduction in bioactive compounds, including TSC, TPC, and TFC, can be attributed to two primary factors. Firstly, the activation of oxidative enzymes during the drying process leads to the depletion of saponin and phenolic molecules. Secondly, the binding of phenolic compounds to proteins and alterations in chemical structures induced by the drying process also contribute to the reduction in TPC (Bhat et al., 2022).

Concerning the vitamin C content, as evident in Table 1, the degradation of vitamin C is significantly influenced by the microwave drying conditions. The highest amount was recorded at 1.29 W/g (0.3 mg AA/g, db), while the lowest level was observed at 2.29 W/g (0.2 mg AA/g db).

The results in this experiment are in line with a previously published study by Kha et al. (2020). In their study, polyphenol content increased in the following order: 800, 600, 400, 200, and 100W, which significantly impacted polyphenol content when using the microwave drying method. Additionally, the content of flavonoids decreased as microwave power increased from 100 to 800 W, corresponding to 5.56 to 4.55 (mg QE/g db), respectively (Kha et al., 2020).

In summary, the most suitable power level for the subsequent experiment on the effect of material load on the extraction of bioactive compounds would be 1.71 W/g. At this power level, TSC, TPC, and TFC were observed to be the highest.

3.1.3. The effect of material load on bioactive compounds

Table 2 shows that the content of saponins, polyphenols, flavonoids, and vitamin C in the noni powder is influenced by the material load.

At the same power level, prolonging the microwave drying time led to a reduction in the content of bioactive compounds. For instance, at microwave power setting of 1.71 W/g, the total polyphenols content decreased from 12.9 mg GAE/g sample for a material loading capacity of 4 kg/m^2 (25 min) to 9.8 mg GAE/g sample for a capacity of 6 kg/m^2 (38 min). Similar trends were observed in TSC, TFC, and AAC. These results can be attributed to the impact of temperature. Increased temperature may lead to the decomposition of less heat-stable compounds such as polyphenols (Cacace and Mazza, 2003).

Table 2. The effect of material loads on bioactive compounds

Content (mg/g, db)	Material load (kg/m^2)		
	4	5	6
TSC	48.0±0.6^a	43.6±1.6^b	37.3±2.5^c
TPC	12.9±0.4^a	11.4±0.2^b	9.8±0.5^c
TFC	8.3±0.3^a	7.1±0.2^b	5.0±0.3^c
AAC	0.26±0.03^a	0.21±0.03^{ab}	0.16±0.03^b

Similar findings were reported by Li et al. (2010). In their study, the yield of triterpene saponin extract from defatted residue of yellow horn kernel (*Xanthoceras sorbifolia* Bunge.) increased from 2.75% to 3.31% with an increase in microwave time from 3 to 7 min. However, when the duration exceeded 7 min, there was a decline in the yield. Longer drying times were associated with excessive power consumption and a reduction in bioactive compounds (Li et al., 2010).

3.2. Moisture sorption isotherm

The influence of moisture content on noni powder was assessed at ambient temperature under five distinct humidity conditions. The time required for the powder samples to reach weight equilibrium was determined to be 15 days. Figure 2 depicts the graphical relationship between the equilibrium moisture content (EMC, %, db) and the equilibrium relative humidity (ERH, %) of the noni powder.

In general, the EMC values tend to increase as the ERH values increases at a constant temperature. This observation aligns with the findings of several authors who have noted that moisture isotherms for dried plant foods often exhibit a sigmoidal curve (Janjai et al., 2006; Kha et al., 2011; Yan et al., 2008). In the ERH range of 6-25%, the powder samples displayed only a marginal increase in EMC. The low moisture content and water activity within this range indicate that there is a minimal amount of free water present in the powders. This, in turn, suggests that the samples may exhibit greater stability in terms of physical, chemical, and biological properties.

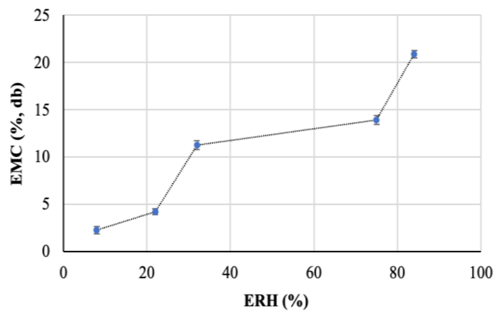

Figure 2. Moisture sorption isotherm of microwave-dried noni powder

As per the BET equation, the monolayer moisture content (M_o%, db) determined for the noni powder was about 4% (R^2 = 0.91). In general, M_o for a dried food product is considered the most favorable condition for storage stability. This is because higher rates of lipid oxidation occur at lower humidity levels than M_o, and lower humidity can lead to food spoilage through the promotion of Maillard's browning as well as enzymatic and microbial activity. However, food is typically not dried to the M_o value due to the energy requirements for evaporation. Therefore, it is preferred that the initial moisture content of a product be at or slightly above its M_o value to achieve maximum shelf life with minimal spoilage (Fellows, 2009). In this study, the noni powder sample had a moisture content of 4.38 ± 0.09%, which is close to the M_o value. This suggests that the sample can be stored for an extended period of time with good stability.

3.3. Effect of humidity conditions on the bioactive compounds of noni powder

In Table 3, it is evident that the content of saponins, polyphenols, flavonoids, and vitamin

C reached their highest levels when stored at RH of 8%, measuring 26.2 mg AE/g db, 5.5 mg GAE/g db, 4.1 mg QE/g, and 0.3 mg AA/g db, respectively.

As discussed earlier, it is crucial to note that sample deterioration occurs quickly and significantly at the ERH levels exceeding 75% due to excessive moisture uptake, which, in turn, supports chemical, biological, and microbial degradation. Therefore, it is strongly recommended that noni powder be dried to achieve a water activity level below 0.2 in order to preserve the highest levels of bioactive compounds during storage. This will help maintain the quality and stability of the product over time.

Table 3. The effect of different saturated salts on the retention of bioactive compounds

Content (mg/g, db)	Relative humidity (%)				
	8	22	51	75	84
TSC	26.2[a] ±0.2	21.5[b] ±0.2	11.8[c] ±0.3	14.8[d] ±0.2	10.9[e] ±0.1
TPC	5.5[a] ±0.1	4.5[b] ±0.0	4.2[c] ±0.0	4.6[d] ±0.1	3.9[e] ±0.0
TFC	4.1[a] ±0.0	3.7[b] ±0.1	3.6[c] ±0.1	3.4[d] ±0.0	3.3[d] ±0.1
AAC	0.3[a] ±0.0	0.3[a] ±0.0	0.2[b] ±0.0	0.24[b] ±0.0	0.2[c] ±0.0

3.4. Storage study

In this experiment, it is evident that the percentage decay was more pronounced at the higher temperature compared to the lower one, as depicted in Figure 3.

Based on the data from Figure 3, to maintain a saponin content of 30%, noni powder should be stored for approximately 1.96 days at 50°C and about 4.10 days at 40°C. The caculated Q_{10} value is about 2.09. To maintain 70% of TPC, noni powder should be preserved for approximately 2 months at 5°C or 1 month at 10°C.

A similar calculation can be applied to the content of polyphenols, flavonoids, and vitamin C, and it suggests that noni powder should also be stored within 2 months at 5°C or 1 month at 10°C to maintain 70% of TSC, TPC, TFC, and AAC.

It is worth noting that the shelf-life of noni powder appears to be shorter than that of Gac powder, as reported in the study of (Khac et al., 2014). Gac powder can maintain carotene at 70% when stored at 10°C for 3 months or at 5°C for 5 months. This difference may be attributed to the fact that the water activity of noni powder is higher than that of Gac powder, which can influence its shelf-life.

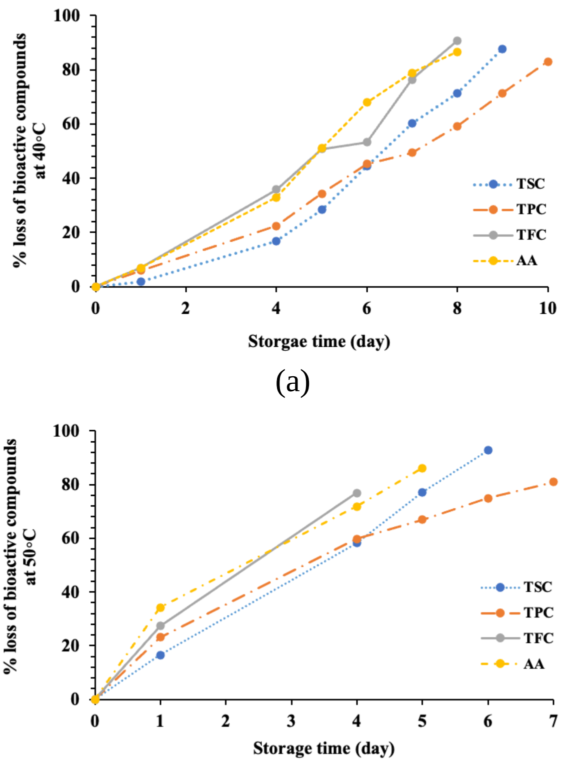

Figure 3. Loss of bioactive compounds at different storage temperatures of 40°C (a) and 50°C (b)

4. CONCLUSION

The process of producing noni powder through microwave drying, with varying microwave power settings and material loads, significantly impacts the bioactive compounds in noni fruit, including TSC, TPC, TFC, and AAC. The highest levels of these compounds were achieved with a microwave power setting of 1.71 W/g for 35 min, surpassing the performance of other power settings (1.29 W/g and 2.29 W/g). When maintaining a material load of 4 kg/m^2 and a consistent microwave power of 1.71 W/g, TSC, TPC, TFC, and AAC reached values of 48.0 mg AE/g, 12.9 mg GAE/g, 8.3 mg QE/g, and 0.26 mg AA/g, respectively.

For effective food preservation, it's crucial to note that the moisture content of the noni powder sample was 4.38 ± 0.09%, closely aligning with the M_o (4.0%) value determined by the BET equation. It is, therefore, advisable to maintain the initial moisture content of noni powder at or slightly above its corresponding M_o value to extend its shelf life while minimizing deterioration. To retain approximately 70% of TSC, TPC, TFC, and AAC, noni powder can be stored at 10°C for 1 month or at 5°C for 2 months.

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ẢNH HƯỞNG CỦA ĐIỀU KIỆN SẤY VI SÓNG ĐẾN ĐẶC TÍNH LÝ HÓA CỦA BỘT NONI (Morinda citrifolia L.)

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THÔNG TIN CHUNG

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TỪ KHOÁ

Hợp chất có hoạt tính sinh học;

Sấy vi sóng;

Cây chùm ngây;

Bột nhàu;

Nghiên cứu lưu trữ

TÓM TẮT

Trái nhàu (tên khoa học Morinda citrifolia) được sử dụng rộng rãi trên thị trường dưới dạng bột do hàm lượng cao các hợp chất có hoạt tính sinh học như saponin, polyphenol, flavonoid và vitamin C. Có nhiều phương pháp được sử dụng để sấy khô trái nhàu, nhưng phương pháp sấy bằng vi ba được sử dụng trong nghiên cứu này. Mục tiêu chính của nghiên cứu là đánh giá ảnh hưởng của điều kiện sấy bằng vi ba đến các tính chất hóa lý của bột nhàu, đồng thời nghiên cứu cách bảo quản bột noni thông qua các thí nghiệm về đẳng nhiệt hấp phụ và Q10.

Lát trái nhàu được sấy bằng vi ba ở ba mức công suất 1.29 W/g, 1.71 W/g, and 2.29 W/g. Kết quả cho thấy công suất sấy bằng vi ba tốt nhất là 1.71 W/g, kết hợp với lượng nguyên liệu 4 kg/m2. Dưới các điều kiện này, hàm lượng của các hợp chất có hoạt tính sinh học, bao gồm saponin, polyphenol, flavonoid và axít ascorbic, đạt được tối đa lần lượt là 48,0 mg AE/g vck, 12,9 mg GAE/g vck, 8,3 mg QE/g vck, và 0,3 mg/g vck. Về mặt bảo quản, đường cong hấp phụ nước của bột nhàu ở 30°C được mô hình hóa bằng mô hình BET, với giá trị Mo là 4%. Hơn nữa, giá trị Q10 cho bột nhàu cho thấy rằng hàm lượng polyphenol, saponin, flavonoid và vitamin C có thể duy trì 70% so với hàm lượng ban đầu trong khoảng 2 tháng ở 5°C hoặc 1 tháng ở 10°C khi lưu trữ trong điều kiện không có không khí và ánh sáng.