Evaluation on physicochemical properties and stability of Thanaka bark powder for natural face powder products

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Abstract. Thanaka (Hesperethusa crenulata Roem.) has been traditionally applied as cosmetics in Myanmar and the northern of Thailand [1] and exhibited anti-oxidant, anti-inflammatory, anti-microbial, skin lightening, and sun protection properties [1-4]. Thanaka’s specifications for cosmetic development are sparse to be presented, although its flowability was reported [1]. Of which, the bark was more suitable than the stem for solid dosage form development [1]. Thus, this study was aimed to assess the physicochemical properties and stability of Thanaka bark powder. The yellowish light brown powder ($L^* = 75.63 \pm 0.01$, $a^* = 5.58 \pm 0.02$ and $b^* = 23.45 \pm 0.02$) (Figure 1A) with bulk and tapped densities of 0.25 ± 0.00 and 0.29 ± 0.00 g/mL, was able to absorb water and oil (17.31 ± 0.77% and 13.39 ± 0.29%). The powder was ICP-MS proved to be uncontaminated with heavy metals prohibited for cosmetics. The powder morphology was plate-like crystals with fractured as SEM observed (Figure 1B). Thermal properties examined by DSC resulted in glass transition, crystallization and melting temperatures of 66.43, 70.25 and 73.39°C, with 51.32 ± 4.13% of crystallinity by XRD. The color ($\Delta E \leq 1.43 \pm 0.04$), morphology, thermal properties, water absorption capacity and oil absorption capacity slightly shifted following to 3-month storage under ambient temperature and 45°C.

Introduction

Thanaka (Hesperethusa crenulata Roem.) has been being used in Myanmar and some parts of Thailand as the traditional cosmetics by grinding it on the flat stone moist with water and apply on the skin [1]. In the previous studies, there are several kinds of Thanaka research concerning anti-oxidant, anti-inflammatory, anti-microbial, skin lightening and sun protection properties [1-4]. Thanaka’s specifications for cosmetic development are sparse to be presented, although its flowability was reported [1]. Of which, the bark was more suitable than the stem for solid dosage form development [1]. This research is to study Thanaka to be used as an absorbent alternative in the face powder since it contains tannins [5] which could have oil control property and it is not fully soluble in water [2]. Besides, Thanaka has a yellowish-white color which is suitable for Asian skin. However, other specifications of Thanaka for cosmetic development are meagerly informed. The objectives of this study aimed to analyze the physicochemical properties of Thanaka bark powder and examine its stability for applying in face powder products.
2. Experimental

2.1 Preparation of Thanaka Bark Powder

Thanaka stem was purchased from Mae Sai District, Chiang Rai. Thanaka bark was separated and was dried in a hot air oven at 45°C. It was finely ground and sieved to the particle size of powder < 45 μm.

2.2 Evaluation of Physicochemical Properties of Thanaka Bark Powder

2.2.1 Appearance, Particle Morphology and Color

Visual assessment was performed, and the particle morphology was examined by field emission gun-scanning electron microscopy [6]. The color was evaluated by UltraScan PRO spectrophotometer and recorded \( L^*, a^* \) and \( b^* \).[7]

2.2.2 Bulk and Tapped Densities & Cohesiveness and Flowability [8-9]

The Cohesiveness and the flowability were expressed triplicate in terms of the Hausner ratio and compressibility index respectively, where Hausner ratio is obtained as tapped density/bulk density, and the compressibility index is as the percentage of the density difference between tapped and bulk by tapped density. Bulk density was determined triplicate as the mass of Thanaka bark powder by apparent volume, \( m/V_0 \), in g/mL meanwhile, tapped density was continued measuring from bulk density as \( m/V_t \), in g/mL.

2.2.3 Water and Oil Absorption Capacities [10-11].

Water and oil absorption capacities were measured slightly modified to the methods of Twinomuhwezi et al. (2020) and Chandra et al. (2015) by percent bound for 0.1 g of sample.

2.2.4 Thermal Properties and Crystallinity

The thermal properties were measured by Differential Scanning Calorimetry (DSC). The gelatinization onset \( (T_g) \), peak \( (T_p) \) and end \( (T_e) \) temperatures were analyzed [12]. The crystalline structure was examined by X-Ray Diffraction (XRD). Diffractograms were obtained from \( 5^\circ-90^\circ \) \((2θ)\) at a scanning speed of 6°C/min [13]. The % crystallinity was calculated as \([100 \times (A_c/A_0+2A_a)]\), where \( A_c \) is the area of crystalline peaks of diffraction, and \( A_a \) is the area of amorphous peaks of diffraction.

2.2.5 Elemental Analysis

The ICP-MSMS was used to detect As, Cd, Pb and Hg in Thanaka bark powder and calculated the result into parts per million [14].

2.3 Stability of Thanaka Bark Powder

The stability was measured at ambient temperature (TA) and 45°C for 3 months [1]. The appearance, particle morphology, color, water and oil absorption capacities, thermal properties and % crystallinity were evaluated by comparing with the initial.

3. Results and discussion

3.1 Evaluation of Physicochemical Properties of Thanaka Bark Powder

3.1.1 Appearance, Particle Morphology and Color

Thanaka bark powder is a fine and fluffy powder, and the color is yellowish light brown (Figure 1A) which \( L^*, a^* \) and \( b^* \) values, 75.63 ± 0.01, 5.58 ± 0.02 and 23.45 ± 0.02, respectively were corresponding. However, in the previous study the \( L^*, a^* \) and \( b^* \) of Thanaka bark powder from the different source were 81.49 ± 0.01, 2.21 ± 0.00 and 28.24 ± 0.11, which was slightly different [1]. The morphology was plate-like crystals with fracture as observed by SEM in Figure 1B.

3.1.2 Bulk and Tapped Densities & Cohesiveness and Flowability

Bulk and tapped densities were observed 0.25 ± 0.00 g/mL and 0.29 ± 0.00 g/mL, respectively. The bulk density was similar to the previous report, while that of tapped was lower [1]. The difference of tapped density shall be governed by the particle distribution as per surface and inherit moisture contents [8]. Flowability parameters in terms of compressibility index and Hausner ratio were calculated as 12.04 ± 0.24 and 1.14 ± 0.00, respectively, referring to less cohesiveness and good
flowability of the powder in regard with the European Pharmacopoeia [8-9]. It should be noted that the flowability of this presenting study is different from the previous finding [1], at which particle distribution and moisture (surface and inheritance) delineated accordingly density and flowability.

3.1.3 Water and Oil Absorption Capacities
Thanaka bark powder absorbed water and oil efficiently (17.31 ± 0.77% and 13.39 ± 0.29%). These properties enhanced the consistency for adhering moisture from the surface/environment include sweat and sebum, that applicable for cosmetic solid dosage form [10-11, 15].

3.1.4 Thermal Properties and Crystallinity
The assessment revealed (Figure 1C) that the Thanaka bark powder started to be melted at 66.43°C (Tm), the melting ended at 73.39°C (Tc) and the gelatinization enthalpy was -0.28 J/g. At which the melting temperature of the powder was shown to be at 70.25°C (Tm). The low melting point of the powder shall be low in smoothness during topical application reduces spreadability accordingly, although its flowability is good. Nonetheless, the wearability will be good instead. Thus, those of solid dosage form should be more applicable for Thanaka bark powder than semi-solid one. That is in harmony with the crystallinity examined by XRD (51.32 ± 4.13%). Crystallinity refers texture of the material including thermal stability [16].

3.1.5 Elemental Analysis
In terms of contaminants, elemental analysis of Thanaka bark powder was undertaken to ensure the material’s safety for topical product application. It should be noted that those of prohibited metals, i.e., Hg, Pb, As and Cd (0.0072 ± 0.00005, 0.03026 ± 0.00013, 0.21331 ± 0.01404 ppm and less than 0.00004 ppm, respectively) that are crucial for cosmetic products, were detected below the limitations as regulated by ASEAN guidelines [17].

3.2 Stability of Thanaka Bark Powder
After 3 months of stability assessment at ambient temperature (TA) and 45°C, Thanaka bark powder color was visually undetermined [7], although that of ΔE were 1.43 ± 0.04 and 1.26 ± 0.11, respectively [7]. In addition, the powder morphology was conformed with the initial state as exhibited in Figure 1B. Thus, densities and flowability parameters of powder should be stable in accordance with the exhibited morphology that governs the particle property of powder.

Figure 1. Thanaka bark powder (A), particle morphology by SEM (B) and thermal properties by DSC (C).

The melting temperature of Thanaka bark powder became slightly higher temperature for both conditions. Furthermore, the water and oil absorption capacities and % crystallinity of Thanaka bark powder insignificantly (p > 0.05) changed after the stability test (Figure 2).
Conclusions

Thanaka bark powder does not contaminate with restricted elements to a certain level. It has low cohesion and good flowability, and its water absorption and oil absorption efficacy have been confirmed. After the stability test, the color, morphology, water and oil absorption capacities, melting temperature and crystalline structure had some minor shifts. Therefore, this study results suggested that Thanaka bark powder may be potentially used as a natural raw material powder in color cosmetics, especially for face powder products.

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