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RiceSorb® as Talcum Substitute for Loose Face Powders: Formulation and Characterization

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Synopsis

Excessive and daily inhalation of talcum, a main ingredient of face powders, causes pulmonary talcosis, which has led to the replacement of talcum with safer natural ingredients. RiceSorb®, or *Oryza sativa* starch from Japanese rice, was used as an alternative owing to its nontoxic and excellent oil absorption capacity. The objectives of the present work were to formulate loose face powders from RiceSorb® and to investigate the physicochemical properties of the prepared formulations. Five formulations of loose face powders were prepared by varying the ratios between talcum and RiceSorb®: 4:0 (FT0), 3:1 (FT1), 1:1 (FT2), 1:3 (FT3), and 0:4 (FT4). The physicochemical properties were evaluated mainly based on USP 41 and NF 36 such as morphology by using a scanning electron microscope, bulk density, flow property (angle of repose), moisture content (MC), and pH. The stability of the formulations were also performed at ambient temperature and 45°C for 2 months. The formulations had pH 6.90–8.62, bulk density 0.33–0.49 g/ml, and an angle of repose 30°–41°. Overall, the formulations which contained only RiceSorb® (FT4) or higher proportion of RiceSorb® (FT3) had finer particles, lower bulk density, pH, and angle of repose than those of the formulations containing high proportion of talcum: FT0 and FT1. Under storage conditions for 2 months, the formulations containing high proportion of RiceSorb® exhibited noticeably increased MC and angle of repose. However, the other physicochemical properties were somewhat the same. The present results suggest the applicability of RiceSorb® for loose face powders.

INTRODUCTION

Human beings have been decorating their faces with rudimentary cosmetics such as face powders since ancient times. Simple powdered materials available in local areas such as grinded wheat, grinded rice, and white pigments were commonly used to whiten their faces. After the industrial revolution in the 19th century, more sophisticated substances have

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been formulated for modern face powders. Face powders are applied on the face or the neck to enhance skin's natural beauty and to cover wrinkles or blemishes such as dark spots, freckles, and acne scars (1). In general, modern face powders can be classified into two types: loose face powders and compact face powders. The main difference between these two forms is binding agents which are very important ingredients in compact face powders (2). In the current work, we focused on the loose face powders owing to the relatively easy preparation process. Modern face powders are composed of a variety of materials which are blended together to achieve the desired characteristics: covering power, adhesion, absorbency, slip, and bloom. Generally, the mainly used ingredient of loose face powders is talcum or talc, a hydrated magnesium silicate (1,2). Although talcum improves slip and adhesiveness of face powders to the skin, long-term daily inhalation of talcum has been shown to cause pulmonary talcosis (3,4). Thus, alternative materials for talcum substitutes have been explored.

Among them, starches are of our interest because they are skin-friendly cosmetic ingredients and thus suitable for sensitive skin (5). Starch flours such as corn starch and rice starch are also basic substances for face powder formulations. Generally, they are used as covering power owing to their fineness. Among several starches, rice starch is drawing attention because of its safety and unique properties. RiceSorb®, *Oryza sativa* starch derived from peel seeds of Japanese rice, is an interesting substance for cosmetic application. Developed in France, RiceSorb® is white fine powders with particle sizes <10 μm. Protein, fats, and impurities are removed to obtain RiceSorb®. It is highly purified and sterilized. RiceSorb® is applicable for face powder formulae because of its exceptional absorption capability, especially for oily liquids, and its small size granules. As a result, a possibility of using RiceSorb® as talcum replacement had been evaluated. Interestingly, RiceSorb® acts as an oil absorbent that does not absorb moisture/water from the skin (6). This makes RiceSorb® suitable for oil-control products. Talcum can cause skin dryness because it not only absorbs oils but also absorbs water/moisture from the skin.

Apart from the power base (white or off-white materials), color shades of face powders are considerably important factors. The color shades of face powders are dependent on the skin tones and fashion. Synthetic colors (e.g., pigments or lakes) have been usually used for formulating face powder preparations. In the current work, the coloring agent used for the prepared loose face powders was obtained from a plant extract (natural colorant). Plant extracts have been generally incorporated into the skin care products because of the awareness of harmful synthetic chemical substances (7). *Tamarindus indica* fruit pulp extract in powder form was used as a colorant in the present work. Widely cultivated in tropical countries, *Tamarindus indica* or tamarind has been shown to possess several beneficial medicinal properties (8). Afterward, its application in a cosmetic field has been recognized. The tamarind extract powder has light brown–yellow range of colors, which suitably match the natural skin tones of Asian women. Like many plant extracts, it possesses antioxidant property because of the presence of several organic acids such as tartaric acid, citric acid, and malic acid (9). Color bleeding due to perspiration is not expected because RiceSorb® in the formulation could absorb moisture (e.g., sweat). Laboratory-scale preparation was carried out using a mortar and a pestle to mix all ingredients together.

The main objectives of the present study were to (i) formulate the loose face powders using RiceSorb® as a substitute for talcum and (ii) investigate the physicochemical properties and stability of loose face powders containing RiceSorb® in comparison to those containing talcum.

EXPERIMENTAL METHODS

MATERIALS

RiceSorb® (100% natural GMO-free rice starch), cosmetic grade, was supplied by Chanjao Longevity Company Limited, Bangkok, Thailand. Tamarind fruit pulp extract (powder), food grade, was purchased from Fuyang Bestop Import and Export Ltd., Anhui, China. The fruit pulps (sour type) without seeds were subjected to a solvent extraction method (water). The spray drying process was used to prepare the tamarind fruit pulp extract powder. Talcum, other white materials (e.g., zinc oxide and zinc stearate), and preservatives were purchased from P.C. Drug Center, Bangkok, Thailand. Ethanol (95% v/v) was supplied by KSP Octatech, Songkhla, Thailand. All chemicals were pharmaceutical grade, except where specified.

INVESTIGATION OF PHYSICOCHEMICAL PROPERTY OF RICESORB®

Certain characteristics of RiceSorb® were evaluated as follows: morphology, bulk density, flowability, and pH compared with those of talcum. These properties of raw materials affected the properties of the finished product, loose face powders.

Morphology investigation. The morphologies of RiceSorb® and talcum were evaluated by using a scanning electron microscope (SEM) [model Quanta 400 (SEM-Quanta), FEI Company, Brno, Czech Republic] equipped with an Everhart–Thornley detector. For better resolution and image quality improvement, the samples were coated with a thin layer of gold using a sputter coater (SPI Supplies, West Chester, PA). The SEM analysis was performed under a high vacuum condition ($<1.3 \times 10^{-2}$ Pa) at 20.00 kV.

Bulk density. The bulk density of powders can be measured by determining the volume of the powder sample (known weight) which has been passed into a graduated cylinder. This was performed to check the uniformity of the bulk powder materials. The samples were passed through a sieve (60 mesh), if they were agglomerated. The powder samples were weighed (30 g) and gently poured into 100-ml cylinders without tapping according to USP 41 and NF 36 (10). The untapped apparent volume of the powder was read to the nearest graduated unit, and the bulk density was calculated as given in equation 1. The bulk density was used to estimate the flowability of powders and to check the uniformity in bulk powder materials.

$$\text{Bulk density} = \frac{\text{weight of the powder}(\text{g})}{\text{bulk volume}(\text{ml})} \tag{1}$$

Flow property. The flow of powder samples was tested using a glass funnel with fixed height (fixed funnel method). The base upon which the cone formed was fixed with a diameter of 10 cm [radius (r) = 5 cm]. The powder samples were gently passed through a glass funnel until a powder cone was formed. The height (h) of the cone was measured, and the angle of repose (θ) was obtained using equation 2. The degrees of angle of repose can characterize the flow behaviors of powders. For example, when the angle of repose is more than 66°, the flow is considered to be very very poor; on the other hand, if the angle of reposes is between 31° and 35°, the flow is considered to be good (10).

$$\tan(\theta) = \frac{h}{r} \tag{2}$$

pH measurement. pH values of RiceSorb® and talcum were measured based on Thai Industrial Standards (TIS) 443-2525-cosmetics: skin powder (11) of loose face powders. The pH measurements of powder samples were performed by preparing a suspension of each powder sample. The procedures were started by weighing a sample (10 g), transferring into a 150-ml beaker, and adding 90 ml of freshly boiled and cooled distilled water. Within 5 min of preparation, the pH values of the water phase were measured by a SevenCompact S220 pH/Ion meter (Mettler Toledo Co. Ltd., Schwerzenbach, Switzerland). If necessary, a filtration process was performed when the powder particles were not wetted by water.

PREPARATION OF LOOSE FACE POWDERS

The formulation of loose face powders is composed of a variety of constituents to obtain satisfactory finished products. It is achieved by blending different materials which have various required properties together. Generally, the basic ingredients of loose face powder formulations are talcum, titanium dioxide, zinc oxide, kaolin, starches, magnesium carbonate, zinc stearate, and magnesium stearate (2). In the current study, the formulations used to prepare loose face powders are given in Table I. The ratios of talcum and RiceSorb® were 4:0, 3:1, 2:2, 1:3, and 0:4 for the formulations F0, F1, F2, F3, and F4, respectively. No fragrance was added to the formulations.

The white base powder ingredients were mixed together using a mortar and a pestle by a geometric dilution technique. The blended white powders were passed through a 250-μm sieve. Later, each formulations, F0 through F4, were incorporated with powder of tamarind fruit pulp extract (white powder bases 90% w/w and tamarind fruit pulp extract 10% w/w). The formulations of face powers with tamarind extract were named as FT0, FT1, FT2, FT3, and FT4, respectively.

CHARACTERIZATION OF LOOSE FACE POWDERS

The test samples were freshly prepared formulations and formulations under the stability study. The physicochemical investigation of the loose face powders included appearances

Table I
Formulations of Loose Face Powder (White Base Powder)

	% w/w				
Ingredient	F0	F1	F2	F3	F4
Talc (adhesion and slip)	80	60	40	20	—
RiceSorb® (absorbency, covering power, and blooming)	—	20	40	60	80
Other white base materials	19.8	19.8	19.8	19.8	19.8
Preservatives	0.2	0.2	0.2	0.2	0.2

using naked eye and a colorimetric examination, bulk density, flow property (angle of repose), and pH according to the previously mentioned methods. In addition, the specific assessment of the finished products, loose face powders, based on TIS 443-2525 (11) was performed as mentioned following paragraphs.

TESTING OF MOISTURE

The testing procedure was modified from the method of TIS 443-2525 (11). Moisture present in loose face powder formulations was determined using an HB43-S Moisture analyzer equipped with a built-in balance (Mettler Toledo Co. Ltd.). An empty aluminum sample pan (Mettler Toledo Co. Ltd.) was placed in a sample pan handler of the moisture analyzer. After taring, a sample (3 g) was accurately weighed on the sample pan. The drying and measuring processes were carried out at 105 ± 2°C. The percentage of the moisture content (%MC) of the sample was automatically achieved using the analyzer.

TESTING OF INSOLUBLE SUBSTANCES IN BOILING WATER

The sample (1 g) was accurately weighed, transferred into a 500-ml beaker, and wetted with ethanol. Then, 200 ml of distilled water was added to the sample and boiled. After sedimentation, a clear water portion of the mixture was filtered through a Gooch crucible, a sintered glass filter or a porous porcelain. The filter equipment was accurately weighed before the filtration process. The remaining sample in the beaker was rinsed with distilled water and subjected to filter. The obtained filtrate was dried in a hot air oven (ED400/E2-N, Scientific Promotion Co. Ltd., Bangkok, Thailand) at 105 ± 2°C until a constant weight was obtained. The percentage of insoluble substances in boiling water was calculated based on the following equation:

$$\%\ \text{insoluble substances in boiling water} = \left(\frac{\text{weight of filtrate}(\text{g})}{\text{weight of test sample}(\text{g})}\right)\times 100. \qquad (3)$$

STABILITY OF LOOSE FACE POWDERS

The stability of loose face powders was monitored by storing the samples at 45 ± 2°C (RH = 75% ± 5%) and ambient temperature for 2 mo (12). The changes in physicochemical properties (e.g., color, odor, moisture, and pH) of the samples were recorded after the end of each month. All experiments were performed in triplicate.

STATISTICAL ANALYSIS

Student's *t*-test and one-way analysis of variance were used to test the statistical difference, and a *p*-value of <0.05 was considered significant difference.

RESULTS AND DISCUSSION

PHYSICOCHEMICAL PROPERTY OF RICESORB® AND TALCUM

Morphology. Using the SEM technique, it was found that RiceSorb® had almost a spherical shape with rather smooth surface morphology. Uniformity of particles was observed. Its particle size was around 6 µm (Figure 1). Talcum possessed irregular surfaces and bigger particle sizes about 25 µm. It was observed that the particle sizes of talcum were not uniform. Talcum used in the current study was pharmaceutical grade; its greater particle sizes thus provided lower surface areas for sebum or oil absorption in comparison to RiceSorb®. Also, more spherical shapes of RiceSorb® could improve the skin feel (1).

Bulk density, flow property, and pH. As seen from Table II, bulk densities of RiceSorb® and talcum were 0.40 ± 0.01 and 0.55 ± 0.11 g/ml, respectively. The bulk density of the two materials differed significantly ($p < 0.05$). It was noted that RiceSorb®, which had almost spherical shapes and smaller particle sizes, exhibited lower bulk density than talcum. The flow of powder is essential for the manufacturing process, especially during mixing and packaging. The flow characteristics of the substances were determined by angle of repose measurement. Several methods have been proposed for angle of repose determination such as the tilting box method, fixed funnel method, and hollow cylinder method (13). In the current study, the fixed funnel method was selected. It was found that the angle of repose of RiceSorb® was lower than that of talcum (Table II). Based on the USP 41 and NF 36 (10), RiceSorb® with an angle of repose of 35° could be classified as having good flowability, whereas talcum, which had an angle of 38°, could be classify as fair (aid not needed) flowability. This is probably due to rather rounded shape and smooth surface of RiceSorb®. Such properties are capable of reducing resistance to movement between particles, resulting in a lower angle of repose. The pH values of two materials were markedly different. Talcum had a higher basic pH of 8.8. RiceSorb® showed a weak acidic pH of 6.2, which is more compatible with the skin surface pH. Based on these results, the basic properties of RiceSorb® were more promising than those of talcum.

LOOSE FACE POWDERS: PHYSICOCHEMICAL PROPERTY AND STABILITY

The ingredients of loose face powders composed of RiceSorb® or talcum, other white materials such as zinc oxide and zinc stearate, tamarind fruit pulp extract, and preservatives. Five formulations of loose face powders were prepared, namely, FT0, FT1, FT2, FT3, and FT4 based on the ratios of talcum and RiceSorb® (4:0, 3:1, 2:2, 1:3, and 0:4). The physicochemical properties of the freshly prepared formulations (24 h) were investigated

Table II
Bulk Density, Angle of Repose, and pH of RiceSorb® and Talcum

Substance	Bulk density (g/ml)	Angle of repose (°)	pH
	[mean ± standard deviation (SD), n = 3]		
RiceSorb®	0.40 ± 0.01	35.10 ± 1.27	6.16 ± 0.01
Talcum	0.55 ± 0.11	38.07 ± 0.44	8.75 ± 0.01

n: number of samples.

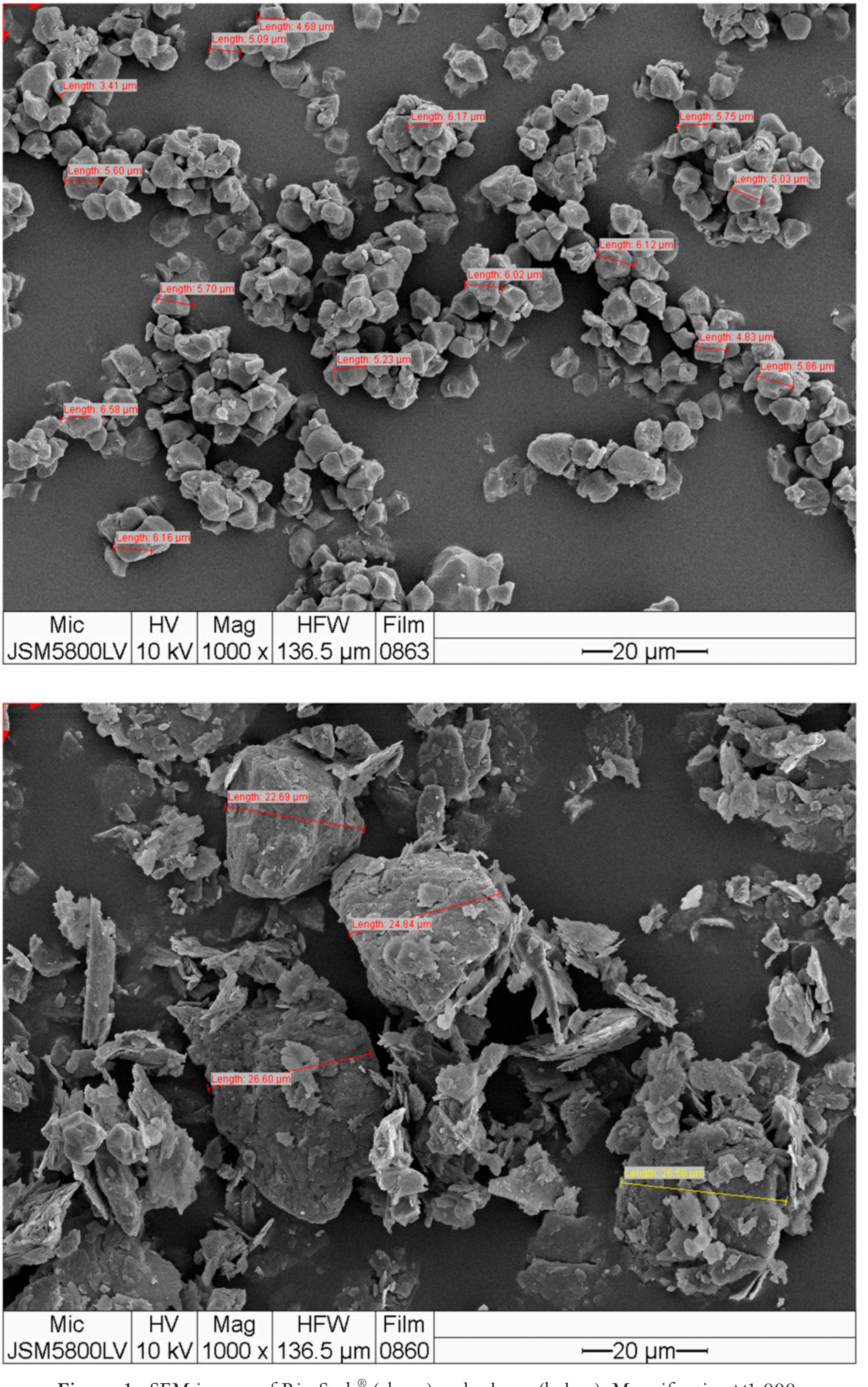

Figure 1. SEM images of RiceSorb® (above) and talcum (below). Magnification ×1,000.

Table III
Melanin Index of Loose Face Powder Formulations Determined by a Colorimeter

	Melanin index, (mean ± SD, *n* = 3)				
		1 mo	1 mo	2 mo	2 mo
Formulation	Freshly prepared	Ambient	45 ± 2°C	Ambient	45 ± 2°C
FT0	0.625 ± 0.029	0.609 ± 0.094	0.731 ± 0.092	0.725 ± 0.009	0.696 ± 0.076
FT1	0.637 ± 0.043	0.797 ± 0.094	0.792 ± 0.120	0.799 ± 0.064	0.715 ± 0.047
FT2	0.641 ± 0.033	0.739 ± 0.076	0.737 ± 0.083	0.839 ± 0.052	0.890 ± 0.070
FT3	0.676 ± 0.048	0.775 ± 0.072	0.728 ± 0.098	0.700 ± 0.072	0.828 ± 0.074
FT4	0.652 ± 0.020	0.874 ± 0.107	0.737 ± 0.119	0.736 ± 0.091	0.780 ± 0.100

n: number of samples.

in comparison to the formulations under storage conditions: ambient temperature and 45 ± 2°C (RH 75% ± 5%) for 1 and 2 mo. The freshly prepared loose face powders had creamy yellow color with tamarind extract scent. Uniform color was observed for all formulations. When the amounts of RiceSorb® increased, the textures of the formulations became finer. After storage for 1 and 2 mo at two temperature conditions, the face powders were slightly coagulated, yet they were returned to fine powders after gentle shaking. Apart from observing the color of the face powders with naked eyes, a colorimeter was used to measure the melanin index of loose face powders (Table III). The freshly prepared formulations exhibited similar melanin index because of the same amount of tamarind extract used. Under ambient and high temperature (45°C) storage, the melanin index of the formulations did not differ significantly in comparison to that of the freshly prepared powders. This suggests the suitability of tamarind fruit pulp extract as a colorant for the prepared loose face powders.

As seen from Table IV, the bulk densities of all formulations were approximately between 0.33 and 0.49 g/ml. The bulk density of loose face powders tended to decrease when the amounts of RiceSorb® increased from 0% (FT0) to 80% w/w (FT4) for all conditions; freshly prepared, ambient, and 45°C storage. This is probably due to the fact that the bulk density of pure RiceSorb® was lower than that of pure talcum (see Table I).

Table V summarizes the angle of repose of five formulations. The angle of repose of loose face powders was found to be in the range of 30°–41°. Based on the criteria of USP 41

Table IV
Bulk Density of Loose Face Powder Formulations

	Bulk density (g/ml), (mean ± SD, *n* = 3)				
		1 mo	1 mo	2 mo	2 mo
Formulation	Freshly prepared	Ambient	45 ± 2°C	Ambient	45 ± 2°C
FT0	0.47 ± 0.00	0.49 ± 0.01	0.49 ± 0.01	0.48 ± 0.01	0.47 ± 0.00
FT1	0.43 ± 0.00	0.43 ± 0.01	0.43 ± 0.01	0.43 ± 0.00	0.42 ± 0.01
FT2	0.35 ± 0.00	0.36 ± 0.00	0.37 ± 0.01	0.39 ± 0.00	0.37 ± 0.01
FT3	0.35 ± 0.01	0.36 ± 0.00	0.35 ± 0.00	0.37 ± 0.01	0.34 ± 0.01
FT4	0.34 ± 0.01	0.35 ± 0.01	0.35 ± 0.01	0.34 ± 0.00	0.33 ± 0.00

n: number of samples.

Table V
Angle of Repose of Loose Face Powder Formulations

	Angle of repose (°), (mean ± SD, $n = 3$)				
		1 mo	1 m	2 mo	2 mo
Formulation	Freshly prepared	Ambient	45 ± 2°C	Ambient	45 ± 2°C
FT0	36.72 ± 1.51	37.95 ± 0.58	37.95 ± 0.58	34.97 ± 1.26	36.96 ± 1.51
FT1	33.93 ± 1.33	36.00 ± 0.71	36.50 ± 0.60	36.21 ± 1.84	35.48 ± 1.28
FT2	33.13 ± 1.66	34.46 ± 0.97	34.73 ± 0.73	35.20 ± 1.92	36.48 ± 1.21
FT3	31.24 ± 0.39	32.60 ± 1.16	33.42 ± 0.65	36.74 ± 0.91	34.73 ± 0.37
FT4	29.54 ± 0.41	31.51 ± 1.04	29.82 ± 0.81	40.90 ± 0.81	36.97 ± 1.23

n: number of samples.

and NF 36 (10), overall, the loose face powders showed rather good flow property. In the case of freshly prepared formulations, it was observed that the higher the amount of RiceSorb® in the formulations, the lower the angle of repose was obtained. The formulation FT4, which contained the highest amount of RiceSorb®, had excellent flow property (30°), whereas the formulation FT0 (0% RiceSorb®) showed fair (aid not needed) flow property (37°). However, after storage for 2 mo at ambient temperature and 45°C, poorer flow property of the formulation FT4 was obtained, as indicated by significantly higher angle of repose ($p < 0.05$). This is likely caused by the moisture absorption capacity of RiceSorb®. The angle of repose of formulation FT0 which contained only talcum was similar for all conditions.

Several factors have been reported to influence the angle of repose including particle size, shape, morphology of substances, and MC (13). The MC (%) of all formulations was investigated, and the results are given in Table VI. The loose face powder formulations, FT0 through FT4, displayed significant differences in percentages of MC for all conditions (p-value < 0.05). The highest MC was observed in the formulation FT4 which contained the greatest amount of RiceSorb®. The formulation FT0 which had no RiceSorb® showed the lowest MC. Under storage conditions, the formulations FT3 and FT4 had statistically higher MC than the freshly prepared formulations (p-value < 0.05). Lesser changes were observed in the case of formulation FT0 containing only talcum. Noticeably, the amount

Table VI
Percentage of Moisture Content of Loose Face Powder Formulations

	% MC, (mean ± SD, $n = 3$)				
		1 m	1 mo	2 m	2 m
Formulation	Freshly prepared	Ambient	45 ± 2°C	Ambient	45 ± 2°C
FT0	1.53 ± 0.02	1.69 ± 0.19	1.31 ± 0.08	1.41 ± 0.09	1.88 ± 0.06
FT1	3.46 ± 0.00	3.84 ± 0.21	3.81 ± 0.14	3.79 ± 0.08	4.16 ± 0.05
FT2	5.53 ± 0.01	5.97 ± 0.25	5.84 ± 0.06	6.09 ± 0.15	6.35 ± 0.04
FT3	6.61 ± 0.01	7.76 ± 0.02	8.47 ± 0.31	8.05 ± 0.09	8.41 ± 0.04
FT4	7.19 ± 0.01	9.97 ± 0.31	10.72 ± 0.19	10.14 ± 0.23	11.04 ± 0.04

n: number of samples.

Table VII
pH of Loose Face Powder Formulations

	pH, (mean ± SD, *n* = 3)				
		1 m	1 mo	2 m	2 mo
Formulation	Freshly prepared	Ambient	45 ± 2°C	Ambient	45 ± 2°C
FT0	8.62 ± 0.12	7.91 ± 0.09	7.53 ± 0.12	8.09 ± 0.11	7.50 ± 0.11
FT1	7.75 ± 0.07	7.69 ± 0.06	7.53 ± 0.04	7.78 ± 0.05	7.55 ± 0.06
FT2	7.67 ± 0.06	7.75 ± 0.02	7.47 ± 0.02	7.75 ± 0.05	7.54 ± 0.04
FT3	7.27 ± 0.08	7.26 ± 0.04	7.31 ± 0.04	7.35 ± 0.06	7.40 ± 0.05
FT4	6.90 ± 0.06	7.07 ± 0.03	7.22 ± 0.03	7.34 ± 0.09	7.28 ± 0.02

n: number of samples.

of RiceSorb® affected the MC of loose face powders. This is probably due to greater surface areas of particles of RiceSorb® causing greater moisture absorption. Thus, adding suitable moisture absorbers are essential for the preparation process.

According to Table VII, pH values of loose face powders range from 6.90 to 8.62. Overall, the pH values of freshly prepared formulations and the stored formulations were similar. The formulation FT0 (0% RiceSorb®) had higher pH than the formulation FT4 (80% RiceSorb®) owing to alkaline pH of talcum (see Table II). The pH was found to decrease when the proportion of RiceSorb®, which had weak acidic pH, increased. The pH of the formulations containing RiceSorb® is more suitable for skin application.

Testing of insoluble substances in boiling water was another test for loose face powders based on TIS 443-2525 (11). The results are summarized in Table VIII. It was found that percent of insoluble substances in boiling water ranged from 3% to 39%. The range order of the insoluble substances in boiling water was found to be FT4 > FT3 > FT2 > FT1 > FT0. The increased proportion of RiceSorb® resulted in the increased percentage of insoluble substances in water. The formulation FT4 provided the highest percentage, whereas the formulation FT0 gave the lowest percentage of insoluble substances in water. Under storage conditions, significant changes in this parameter were obviously detected in the formulations which contained RiceSorb®, FT1 through FT4.

Table VIII
Percentage of Insoluble Substances in Boiling Water of Loose Face Powder Formulations

	Insoluble substances in boiling water (% w/w),(mean ± SD, *n* = 3)				
		1 mo	1 mo	2 mo	2 mo
Formulation	Freshly prepared	Ambient	45 ± 2°C	Ambient	45 ± 2°C
FT0	5.97 ± 3.88	3.35 ± 0.78	3.35 ± 1.31	3.84 ± 1.55	4.97 ± 1.58
FT1	3.19 ± 0.15	7.81 ± 3.32	7.29 ± 1.11	7.81 ± 1.38	7.29 ± 1.11
FT2	22.34 ± 6.31	9.75 ± 5.95	20.42 ± 3.36	12.42 ± 0.91	20.42 ± 3.36
FT3	32.52 ± 2.58	25.88 ± 6.20	21.39 ± 7.65	26.88 ± 2.94	21.39 ± 7.65
FT4	38.64 ± 5.96	32.52 ± 2.13	22.52 ± 0.64	32.53 ± 2.13	22.52 ± 0.64

n: number of samples.

CONCLUSIONS AND FUTURE WORK

In the current study, RiceSorb® was introduced to be used as a talcum substitute in loose face powder preparation. First, the general physiochemical properties of single talcum and RiceSorb® were examined. These included morphology, bulk density, flow property, and pH. It was found that the physicochemical properties of RiceSorb® and talcum were distinctly different. The SEM image revealed that the surfaces of RiceSorb® were rather smooth with almost spherical shapes, whereas talcum had rough surfaces. In addition, the sizes of RiceSorb® (about 6 μm) were markedly smaller than those of talcum (25 μm). The bulk density, angle of repose, and pH of talcum were obviously greater than those of RiceSorb®. After that, the preparation of loose face powders which contained talcum and RiceSorb® at various ratios (4:0, 3:1, 1:1, 1:3, and 0:4) was formulated and tested for their physicochemical characteristics. The colors of the prepared loose face powders were creamy yellow with melanin index between 0.6 and 0.8. The physicochemical properties of loose face powders depended on the proportion of RiceSorb® in the formulations. The changes were clearly observed in the formulations which contained only talcum, FT0, or only RiceSorb®, FT4. Overall, the results indicate that RiceSorb® may be used as a talcum substitute. Nevertheless, its drawback concerning moisture absorption should be solved. To keep the RiceSorb®-containing formulations from moisture, we are planning to add suitable moisture absorbers such as silica to the loose face powders. In addition, a moisture barrier packaging is another alternative.

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