Perlis Sunshine Mango Seed Flour Body Scrub: Product Development for Physical and Sensory Properties

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Abstract - Mango had a large scale of usage in industry as active ingredient in juice, flavor, fragrance and color agents. After the industrial consumption, 18% of mango seed were produced as the by-product. Mango seed could be converted to value added products such as additional ingredient in cosmetic product which would reduce the environmental pollution and minimize the waste production. Thus, the purpose of this project were to analyze the texture of Perlis Sunshine mango seed flour that made of three different ratios which Sample 1 consist of 97% wheat flour to 3% Perlis Sunshine mango seed flour, Sample 2 (95 : 5) and Sample 3 (90 : 10), to formulate body scrub from Perlis Sunshine mango seed flour and to analyze the physical and functional properties of the body scrub. Then, two types of body scrub from Perlis Sunshine mango seed flour were formulated using sea salt and brown sugar as the main exfoliant and each type were divided into four samples (control sample, sample 1, sample 2, sample 3). Next, physical analyses had been done which the moisture content for salt scrub and sugar scrub obtained were below 14% which considered in acceptable range. For water activity (aw), the value obtained from all sugar scrub samples were acceptable as the value were below than 0.94aw. Next for sample hardness of texture analyses of sample 1 of salt scrub had the best value which was 41.33g. For oil holding capacity, sample 3 of sugar scrub had the highest value which was 37.94%. In conclusion, sample 3 of salt scrub was the best formulation compare to other samples.

1. Introduction
Mango is a tropical fruit belongs to Anacardiaceae flowering family from the order of Sapindales of the Kingdom of Plantae with the binomial name Mangifera indica L. It is cultivated widely in tropical region of Southern Asia. Although mango comes from over 1000 varieties, however only a few of them have
potential and able to commercial worldwide [1]. India is selected as the biggest mango producer with 13.6 millions of tons, second is China with 4.2 millions of tons and third is Thailand with 2.5 millions of tons during 2008 [2]. Table 1 indicates the top 5 countries that leading the mango production, export and import to the worldwide. Food and Agricultural Organisation, [3] stated total mango exported worldwide are 912,853 metric tonnes during 2005.

Table 1. Top five countries of mango production, exporting and importing [3]

| Countries   | Mango production statistics (1000 MT) | 2003-2005 (%) |
|-------------|---------------------------------------|---------------|
|             | 2001      | 2002      | 2003      | 2004      | 2005      |           |
| India       | 10,060    | 10,640    | 10,780    | 10,800    | 10,800    | 38.58     |
| China       | 3273      | 3513      | 3571      | 3582      | 3673      | 12.90     |
| Thailand    | 1700      | 1700      | 1700      | 1800      | 1800      | 6.20      |
| Mexico      | 1577      | 1523      | 1362      | 1573      | 1679      | 5.50      |
| Indonesia   | 923       | 1403      | 1526      | 1438      | 1478      | 5.29      |
| World total | 17,533    | 18,779    | 18,939    | 19,093    | 19,430    | 68.47     |

| Countries   | Mango exporting statistic (1000 MT) | 2003-2005 (%) |
|-------------|-------------------------------------|---------------|
|             | 2001      | 2002      | 2003      | 2004      | 2005      |           |
| Mexico      | 195       | 195       | 216       | 213       | 195       | 22.64     |
| India       | 46        | 42        | 179       | 156       | 223       | 20.25     |
| Brazil      | 94        | 104       | 138       | 111       | 114       | 13.18     |
| Pakistan    | 52        | 48        | 60        | 82        | 49        | 6.94      |
| Netherlands | 43        | 33        | 58        | 51        | 69        | 6.42      |
| World total | 430       | 422       | 651       | 613       | 650       | 69.43     |

| Countries   | Mango importing statistic (1000 MT) | 2003-2005 (%) |
|-------------|-------------------------------------|---------------|
|             | 2001      | 2002      | 2003      | 2004      | 2005      |           |
| United States | 238      | 263       | 278       | 276       | 261       | 32.70     |
| Netherlands  | 70        | 71        | 91        | 76        | 98        | 10.62     |
| United Arab Emirates | 46      | 52        | 62        | 58        | 51        | 6.82      |
| Saudi Arabia | 36        | 35        | 40        | 42        | 51        | 5.32      |
| China       | 34        | 38        | 47        | 57        | 19        | 4.91      |
| World total | 424       | 459       | 518       | 509       | 480       | 60.37     |
Mango trees can grow up to 35 – 40 m in height with radius of 10 m. Their taproot can descent down to 6m depth of soil, spread their feeder root widely and penetrate the soil with their anchor roots. The leaves are evergreen, alternate in shape, simple with 15 – 35 cm long and 6 – 16 cm broad. The leaves are orange-pink during young but gradually change to dark, glossy red, then dark green as they mature. The flower are generates from the terminal of panicles with 10 – 40 cm long, which are small in size, white in colour and have 5 petals 5 - 10 mm long. The time taken for the fruits to ripe completely is three to six month [2].

Perlis Sunshine mango known as Sala mango is a breed from Thailand and later on was introduced to Perlis. Perlis Sunshine is widely planted by local residents of Perlis as for its big size and sweet flavour. This breed has bright potential in food industry and can be processed as cordial for mango flavour. Thus, Federal Agricultural Marketing Authority (FAMA) took the initiative to rebrand Sala mango to 'Perlis Sunshine' hence gave new light to 220 entrepreneurs in Perlis when its prices rose almost three - fold from RM0.80 to RM2.50 per kilogram during 2015 due to industry demand.

Mango has a large scale of usage in industry of food as active ingredient in juice, flavour, fragrance, colour agents due to its rich of aroma, unique flavour and delicious taste. Ripe mangoes are processed into frozen mango products, canned products, dehydrated products and ready to serve beverages [4]. After the industrial consumption, a large amount of by-product of mangoes which peel : 15% of byproduct, pulp : 8 - 10% of byproduct and seed : 18% of byproduct are produced since the industry only use the edible portion of mango for their product.

The aggregate number of waste produce from mango processing is between 150,000 to 400,000 tones worldwide which can lead to environmental problem and economic losses if not utilized effectively [5]. In order to reduce the number of waste yield from the mango processing, many researcher have done different research in order to find out alternative ways in managing the waste. As the result, byproduct especially mango seed was revealed to have high nutrients content and can become the source of potential valuable bioactive compounds. This byproduct can be applied and biodegradable into new product of the sectors food, pharmaceutical, nutraceutical and cosmetic industries.

Next, for the beauty and health market in Malaysia, the market is growing fast. Consumer expenditure rate on cosmetics and toiletries increasing during the last few years to be 40% from RM1.4 billion in 1995 to RM1.9 billion in 2007 projecting sales volume to hit $1.1 billion by 2010. According to Malaysia department of statistics, the total spending in cosmetics and toiletries is about US$407 million in 2013. Malaysian consumers tend to obtain beauty products from top name brands that are marketing specifically in term of enhancing youthful appearance. Among the sale of cosmetics and toiletries, skincare products represented more than US$229 million by value in 2013 and followed by eye cosmetics color with value of US$20.6 million, then followed by powder make-up, lip make-up preparation, manicure and pedicure.

Body scrub is one of the skincare products that keep on grabbing the attention from the users. Body scrub is used during bath to enhance the moisture of skin besides to exfoliate dead cells of skin. Nowadays, there are many type of body scrub from various main ingredients such as coffee, fruits, oats and herbs. However, there is none body scrub from Perlis Sunshine mango seed flour was produced yet. In this research, Perlis Sunshine mango seed flour used as one of ingredient in body scrub formulation due to its composition of proximate analysis, total dietary fiber, antioxidant activity and total phenolic content that needed for healthy skin.

Physical analysis of cosmetic describes approaches to predicting how well the cosmetics resist common stresses such as water loss and microbial growth. Typically, manufacturers determine whether to perform such specialized testing based on the vulnerabilities of the particular cosmetic product and its anticipated shipping, storage display and use conditions. Meanwhile, sensory evaluation is indispensable for objective assessment for each type of products to measure their acceptability and marketability potential based on the opinion of consumer [6].
2. Methodology

2.1 Body Scrub Material
Sea salt, brown sugar, honey, Perlis Sunshine mango seed flour, wheat flour and sunflower oil.

2.2 Plant materials
Perlis Sunshine mangoes were purchased from a market in Perlis. The seeds were removed and the kernels were taken out to undergo drying process. The dried kernels then ground and the resulting powder then were blended with wheat flour based on percentage as shown in Table 2.

|                  | Wheat flour (%) | Perlis Sunshine mango seed flour (%) |
|------------------|-----------------|--------------------------------------|
| Control          | -               | -                                    |
| Sample 1         | 97              | 3                                    |
| Sample 2         | 95              | 5                                    |
| Sample 3         | 90              | 10                                   |

2.3 Preparation Perlis Sunshine Mango Seed Flour Body Scrub
Two types of body scrub were formulated using different exfoliant agents which were salt and brown sugar to produce salt scrub and brown sugar scrub by following formulation steps below: 45ml of sunflower oil was added into 90g of exfoliant. Both ingredients were mixed together by using a spatula. The exfoliant was not completely dissolve which was expected outcome and the texture was grainy. One spatula of honey was added into the mixture. 3g of Perlis Sunshine mango seed flour was added into the mixture (except for basic sample). All the ingredients were stirred until they mix well. The body scrub was then transferred into container once finished combining all the ingredients.

Notes: 4 samples of each types of body scrub were prepared by following all the formulation steps using different ratio of wheat flour to mango seed powder. As the control sample did not added with mango seed flour the other three samples were added with mango seed flour as shown in Table 2. The tests were repeated three times for more accurate data.

2.4 Physical Composition Analyses
2.4.1 Texture analysis. The textural characteristics of body scrub sample were analyzed by using American Association of Cereal Chemists, AACC International Approved Method 06-10.01 Admixture of flour. The sample hardness in term of force (g) was measured using Texture Analyzer, using a load cell of 5kg. Software Texture Expert was used in data analyzer.

2.4.2 Moisture content analysis. The moisture content of samples were determined using Official Method of Analysis of AOAC International (16th edition) Washington, DC where the initial weight and final weight difference was measured by earlier drying of sample in oven at 105°C for 3 hours.
2.4.3 **Water activity (aw).** Water activity of samples were determined using water activity meter by placing the samples into sample cup half-filled and opened pawkit was placed onto the sample cup. Button (I) on the instrument was pressed thus the water activity measurement was begin. Measurements of the tests were recorded.

2.4.4 **Functional Properties Analyses.** As stated by [7] with minor modification of the methods, oil and water holding capacity analyses were done by adding 10 mL of sunflower oil for oil holding capacity and 10 mL of water for water holding capacity into the centrifuge tube contained of 1 g of sample. The mixture then was mixed using vortex for 30 seconds and thus were centrifuged at 3000 rpm for 15 minutes. The supernatant was discarded and hydrated sample was weighed.

2.4.5 **Sensory Assessment.** Body scrub made of Perlis Sunshine mango seed flour were subjected to sensory evaluation based on characterizations of hardness, aroma/smell/odor, greasy, after test effect such as skin’s allergy, skin’s moisture and overall acceptability of the product for the skin usage by distributing the product to 20 consumers. Selection of 20 consumers were considered enough and acceptable since the minimum required for evaluators for multi-purpose assessment were 5 to 7 consumers. However, having larger number of consumers would greatly increase reliability and consistency of production decisions based on sensory assessment. All the consumers which were selected having different types of skin. A form for consumers evaluation for the product were given by using five grading categories which were excellent, very good, good, satisfactory and unsatisfactory. The skin condition of consumers selected for the assessment are also included in the assessment which divided to dryness, redness, smoothness and normal skin [8].

2.4.6 **Statistical Analysis.** By using ANOVA single factor test, all the results obtained in the present study were represented as the mean value of three individual replicates ± standard deviation (SD). The aim of this analysis was to ensure the data was interpreted correctly and the apparent interaction between physical and functional properties was significant.

3. **Results and Discussion**

3.1 **Scanning Electron Microscopy (SEM)**

Scanning Electron Microscopy (SEM) of wheat flour and mango seed powder blend was studied. Three different composition of flour were observed which were the ratio of wheat flour : mango seed powder for sample 1 was 97 : 3, sample 2 was 95 : 5 and sample 3 was 90 : 10. Three type of magnifications image which were x500, x1000 and x5000 with the range 5μm to 50μm were recorded by SEM. Figure 1 - Figure 3 shows the comparison of microstructure between each sample at different magnifications. Exfoliation opens up pores which allows easy absorption of moisturizer into it.

From Figure 1, the image for each samples revealed the formation of the product with high uniformity and compaction. Figure 2 showed that Sample 1 had more number of small sphere starch granules which appeared with smooth, clean surfaces, free from protein matrix and also distributed more evenly over the entire area of compaction compare to other samples. Sample 3 had the least number of small starch granules and the shape is not too sphericing but more too oval. Figure 3 which viewed highest magnifications showed more detail of the images for all samples. Pieces of different structural formation were attached to smooth surface of starch granules. [9] stated that these structural elements are believe to be “adhesive protein” that closely associated with the phospholipids, plays the important role in flour formation and is structurally different from “wedge protein” which occupies the interstitial spaces between starch grains.
Figure 1. Scanning Electron Microscope (SEM) image of mango seed flour at magnification of x500 for (a) Sample 1, (b) Sample 2, (c) Sample 3
Figure 2: Scanning Electron Microscope (SEM) image of mango seed flour at magnification of x1000 for (a) Sample 1, (b) Sample 2, (c) Sample 3

Figure 3: Scanning Electron Microscope (SEM) image of mango seed flour at magnification of x5000 for (a) Sample 1, (b) Sample 2, (c) Sample 3
3.2 Physical Composition Analyses of Body Scrub

3.2.1 Moisture content. Based on the result obtained in Table 3, the mean percentage of moisture content of mango seed flour body scrub for each salt and sugar scrub is below 14% which was acceptable value. The moisture content of body scrub sample 1, sample 2 and sample 3 were slightly higher than the value of base sample which did not added with mango seed flour. This was due to the ability of mango seed flour to absorb and release the water. As the base sample did not contain the flour, thus the moisture content of body scrub was the lowest as the water trapped with the exfoliant during drying time.

Based on the data obtained in Table 3, the value of moisture content was increase as the percentage of mango seed flour added to body scrub was increase. The moisture content for both scrubs was increase except for sample 3 of sugar scrub which showed the decrement of moisture content value compared to previous sample. The increment was due to ability of mango seed flour to absorb more water compared to wheat flour. Thus, the higher the presence of mango seed flour, the higher the moisture content value of body scrub. Control sample (sunflower oil, exfoliant, honey, salt/sugar) had the lowest moisture content since there was no addition of mango seed flour thus the water loss during drying process was higher compare to sample 1, 2 and 3. Moisture content test was important in order to ensure the quality, stability and defense of the product from organisms or molds that can lower the quality of products [10].

Table 3. Moisture content (%) of salt and brown sugar scrub (Mean ± Standard deviation (n=4)

|                  | Control      | Sample 1    | Sample 2    | Sample 3    |
|------------------|--------------|-------------|-------------|-------------|
| Salt scrub       | 0.77 ± 0.08  | 0.86 ± 0.03 | 0.93 ± 0.34 | 1.36 ± 0.96 |
| Sugar scrub      | 1.07 ± 0.06  | 1.16 ± 0.13 | 1.36 ± 0.18 | 1.34 ± 0.31 |

3.2.2 Water activity (aw). Based on data as shown in Table 4, there were quite value different between salt and sugar scrub as the value of water activity of salt scrub was >0.99 while sugar scrub was <0.94 which was more acceptable than the value of salt scrub. These different was due to the type of exfoliant used which salt was soluble in oil compared to brown sugar. As some composition of salt was dissolve in oil, the viscosity and water level increase thus lead to increments of water activity compare to low solubility of brown sugar which help to reduce the water activity level. To fix this error, the ratio of salt : oil had to be adjusted to lower the solubility of salt. For both types of scrub, the base sample had higher water activity compare to others sample with addition of mango seed flour. Meanwhile, the water activity of sample with addition of mango seed scrub was increased as the composition of mango seed powder increased. However, the result was still in acceptable range as the value did not need the addition of preservatives into the body scrub [11].

Table 4. Water activity (aw) of salt and brown sugar scrub

|                  | Control      | Sample 1    | Sample 2    | Sample 3    |
|------------------|--------------|-------------|-------------|-------------|
| Salt scrub       | 1.5 ± 0.02   | 1.42 ± 0.01 | 1.43 ± 0.03 | 1.46 ± 0.02 |
| Sugar scrub      | 0.87 ± 0.02  | 0.78 ± 0.01 | 0.79 ± 0.01 | 0.84 ± 0.02 |

Mean ± Standard deviation (n=4 )

3.2.3 Texture analysis for hardness of body scrub. Table 5 shows the texture analyses of body scrub. For salt scrub, the control sample had higher value of hardness compared to others sample. Too high of hardness value could cause skin peeling that can damage the skin. With the addition of mango seed flour, the hardness of body scrub could be reduced. This could be attributed to the presence of protein in the flour. The additions of protein content were not significant for the formation of composite matrix
of the flour [12]. Therefore, the addition of mango seed flour resulted in retarding the formation of gluten matrices, which contributed to the substantial decrease in hardness [13]. However, the hardness of body scrub increase as the percentage of mango seed flour increased. This indicated the composition of protein in mango seed powder was lower than wheat flour. Hardness of sugar scrub shows that the texture analyses were increased as the composition of mango seed powder added were increased. These results were undesirable as too high of hardness could give damage to skin [12]. The hardness might be due to condition of brown sugar which was quite dried compare to salt scrub during the test.

Table 5. Hardness (g) of body scrub

| Sample          | Control  | Sample 1 | Sample 2 | Sample 3 |
|----------------|----------|----------|----------|----------|
| Salt scrub     | 54.33 ± 9.50 | 41.33 ± 0.58 | 46.67 ± 7.64 | 53.00 ± 5.00 |
| Sugar scrub    | 56.67 ± 8.74 | 47.67 ± 10.12 | 63.33 ± 4.04 | 3.67       |

3.3 Functional Properties Analyses

3.3.1 Water Holding Capacity (WHC). Table 6 showed the water holding capacity (WHC) of salt and sugar scrub. The WHC of base sample was slightly lower compared to other samples. The lower WHC could attribute to the presence of lower amount of hydrophilic constituent in flour and samples [14]. The value of WHC between sample 1, sample 2 and sample 3 had no significant different. However, the results were quite odd as all the values obtained were negative values. The negative values showed the loss of water from the samples. The possibility reason for the negative values was due to the solubility of exfoliants which were salt and brown sugar in the water. As the sample were the mixture of the exfoliants and the flour, means that the composition of body scrub was not made of flour 100%, thus we could conclude that only small percentage of flour posed in the body scrub. When the sample was vortex with the water, big composition of salt and sugar were dissolved as only small amount of flour was left. This caused the decrement of weight before and after the centrifuge of sample thus the values produced were negative. From the result also, we could see that WHC of base sample was lower than other samples. This was due to no addition of flour. WHC was important as it posed the ability of the sample to hold the nutrients. Lower WHC reaches the saturation point much sooner than higher WHC. After the sample was saturated with water, all of the excess water and some of the nutrients that were in the sample solution were leached downward in the sample profile [15]. This situation was undesirable as the nutrients were very important for the skin. WHC was also important as it also affect the texture of body scrub.

Table 6. Water Holding Capacity of body scrub (%)

| Sample          | Control   | Sample 1   | Sample 2   | Sample 3   |
|----------------|-----------|------------|------------|------------|
| Salt scrub     | -89.16 ± 1.81 | -81.54 ± 2.36 | -82.54 ± 2.36 | -82.04 ± 2.28 |
| Sugar scrub    | -86.58 ± 2.12 | -80.27 ± 1.85 | -80.04 ± 1.28 | -82.02 ± 2.59 |

3.3.2 Oil Holding Capacity (OHC). Oil holding capacity (OHC) of control sample for sugar scrub was significantly lower compare to other samples. The OHC of flour was equally important as it improve the skin feel sensitivity. The higher OHC suggested that the presence of polar amino acids in mango seed flour [14]. [16] stated that high OHC value indicated the ability of the protein in the sample to entrap the fat. For salt scrub, the pattern of mean from sample 1 to sample 3 was not uniform with sample 2 however for sugar scrub the value of OHC from sample 1 to sample 3 were increase indicate the ability of mango seed flour to entrap the lipid was higher than wheat flour. With the present of mango seed flour, the volume of fat entrapment by the protein was higher compared to non-presence of mango seed flour. High protein content could contribute to elastic and healthy skin. Body need protein to help build...
and repair skin and other body tissues. Protein also help fight balance body fluids and carry oxygen through body [17].

| Table 7. Oil Holding Capacity of body scrub (%) |
|-----------------------------------------------|
| Control | Sample 1 | Sample 2 | Sample 3 |
| Salt scrub | 22.52 ± 5.24 | 21.91 ± 2.11 | 18.75 ± 3.07 | 24.51 ± 5.41 |
| Sugar scrub | 31.05 ± 8.49 | 33.36 ± 5.57 | 35.78 ± 0.69 | 37.94 ± 7.50 |

3.4 Sensory Assessment

Figure 4 and 5 showed the means for sensory attributes for salt and brown sugar scrub. From Figure 4, we could see the mean of Sample 1 was the highest in all categories except for hardness and after feel effect. Base had the lowest mean in most categories (hardness, skin feel, fragrance and after feel). Sample 3 had the highest mean in hardness and fragrance. This was due to the composition of mango seed powder in Sample 3 was the highest and consumers prefer the hardness and fragrance of the sample with the highest presence of mango seed powder. Based on Figure 5, we could see the mean of Sample 2 was the highest in all categories except for fragrance and after feel effect. Base had the lowest mean in fragrance, greasiness and after feel effect. Sample 3 had the highest mean in fragrance and after feel effect. The means of sensory attributes of each sample were various as the sensory evaluation were subjective and depended on preferable of consumers.

![Figure 4: Means of sensory attributes of salt scrub](image-url)
4. Conclusion

In the present study, the Perlis Sunshine mango seed flour is a value-added product for body scrub besides inexpensive, easily available material and content of high proximate composition, total dietary fiber, antioxidant activity, and total phenolic content. The result obtained for morphology observation of mango seed flour microstructure shows formation of matrix complex of the molecules. For moisture content result, the value obtained for both salt and sugar scrub are 0.77% and 1.07% which under 14% and very desirable as it can avoid mold, bacteria, and insect. For water activity study, the result for sugar scrub, 0.87 aw is acceptable as it is below 0.94 aw while the result for salt scrub is 1.50 aw which is undesirable. The texture analysis for salt scrub and sugar scrub is acceptable except for hardness of sugar scrub is too high due to condition of exfoliant itself. For water holding capacity test, the values of negative are undesirable but cannot be avoided as the solubility of exfoliant in water is high. For oil holding capacity, the values for both types of scrub are acceptable. For sensory assessment, the range scales of consumers are favourable and prove that the development of body scrub from mango seed waste has potential for marketability. All the results obtain are analyzing using ANOVA one-way analysis and the results were interpreted by the form mean standard deviation. From the overall data from each test, it can be concluded that production of body scrub from Perlis Sunshine mango seed waste has marketability potential and commercial value which sample 3 of salt scrub was the best formulation compared to others sample.

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