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Physico-Chemical and Functional Properties of Perlis Sunshine Mango Seed Flour

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ABSTRACT

The research was aimed to determine the physico-chemical and functional properties of mango seed flour with three different levels (Control, 3%, 5% and 10%) of mango seed flour. Chemical properties that had been investigated were moisture content, ash content, crude protein, crude fat, crude fibre, carbohydrate and calories. Increasing level of substitution from 3% to 10% of mango seed flour has shown the increment with the crude fat, crude fiber, crude protein and caloric values from 9.55% to 21.71%, 22.89% to 29.92% and 5.79% to 9.58%, 351.75 kcal/g to 452.91 kcal/g respectively. However, there was a decreasing trend noticed for moisture content, ash content and carbohydrate value from 12.25% to 9.44%, 11.75% to 4.22% and 60.66% to 55.05% respectively. While the addition of mango seed flour did not show much effect on the functional properties of composite flours produced. On the other hand, the physical properties, water activities and repose angle were decreased as the mango seed flour portion increased in composite flour, from 1.34 a_w to 1.25 a_w and 46^o to 42.51^o respectively. Sieving analysis displayed that all of the variants with composite flours were categorized as fine flour.

Keywords: Physico-Chemical, Functional Properties, Perlis Sunshine Mango Seed Flour.

1. INTRODUCTION

Mangoes belong to the genus *Mangifera* of the family Anacardiaceae. Most of the fruit trees that are commonly known as mangos belong to the species *Mangifera indica*. According to The Food and Agriculture Organization, 30.7 million tonnes of mango were produced by 2010 in a year globally, and covers ~50% of world tropical fruit production [1]. Approximate 77% world mangoes production is producing from Asian, while 13% and additionally 9% are producing in the Americas and Africa countries, respectively [2]. The major by-product of mango processing industry is seed and peel of mango which is estimated to be 35-60% of the total weight of the fruits. In some case, more than one million tons of mango seeds have been discarded as wastes annually and it is not been utilized for the commercial purpose [3].

In Nigeria, mango seed flour had been used as the ingredients in the diet of infants as well as adult to improve the nutrients and antioxidants intake. Incorporation of mango seed powder in the flour of commercial biscuits preparation able to increase the fat, protein and phenolic contents [4]. The city of Brazil has reported that 1300 tons of mango seeds are produced annually. This waste is used in producing carbon nanoparticles and primarily used in the production of animal feed, extraction of glucose from the starch content present in the mango seed as well as the activated carbon source for treating waste water [5].

Composite flour is not the same as ready-mixed flours that have been prepared for bakery products. Ready-mixed flours contain all of the necessary non-perishable constituents of the recipe for the particular baked product. According to the earlier research, composite flours are used for minimizing the largest possible percentage of wheat flour in producing the baked product. Maize, cassava starch, soy flour, peanut flour as well as fruit seed flour are chosen as the additional source in creating composite flour variants [6]. Thus, Perlis Sunshine mango seed flour can be the potential ingredient as the additive flour in making composite flour and explored a further evidence with this study.

2. MATERIAL AND METHODS

2.1 Chemicals

Diethyl ether purchased from HmbG Chemical, Sodium hydroxide and Sulfuric acid were procured from Merck KGaA, Sodium carbonate was purchased from HmbG Chemical and Copper sulphate was from Bendosen, Follin-Ciocelleau reagent and Sodium potassium tartrate were purchased from Merck KGaA.

2.2 Raw Materials

Mangoes seed (*Mangifera Indica*) was collected from Kangar market, then, bleached and dried at the temperature range of 60 ^{o}C to 65 ^{o}C. The dried material was grounded into flour. The experimental variations of composite flour were formulated by using refined wheat flour (WF) and mango seed flour (MSF). The proportions of composite flour in the three experimental variations were: I (WF: MSF =97:3), II (WF: MSF =95:5) and III (WF: MSF =90:10). The variations were selected to identify the most favorable and acceptable flour.

2.3 Procedures

2.3.1 Moisture Content

A flour sample of 3g was weighted, then, the sample was heated in the oven for 3 hours with the temperature at 105 ^{o}C for drying. The difference in the weight was calculated as a percentage.

2.3.2 Ash Content

A flour sample was measured to be 3 g, then, transferred into a furnace with the temperature of 550 ^{o}C and the ignition was continued until the sample turns into grey a ash. The difference in the weight was calculated as a percentage.

2.3.3 Crude Fat

Pre-treatment process was performed by drying the sample in the oven for 2 hours at the temperature of 102 ^{o}C. The solvent solution, diethyl ether was filled into the round bottom flask and placed in the heating mantle, followed by boil by setting the temperature to 35 ^{o}C. Boiling, rinsing, evaporation and recovery are the mandatory steps in this process. The process was run for 40 minutes, the extraction cup was displaced and the sample was dried in the oven at 103 ^{o}C for 30 minutes. The difference in the weight was calculated as a percentage.

2.3.4 Crude Fiber

200 ml of 0.2549 N sulphuric acids was added and the mixture was boiled for 30 minutes. Then, the mixture was removed from the heat and 10 ml of sodium hydroxide solution with the concentration

of 407.42 g/L was added. The mixture was boiled again for 30 minutes. Separated the mixture by filtration and the filtrate was washed with the running water. The residue was transferred to a crucible and was dried for 1 hour at 100^{o}C then cooled the residue was kept in a desiccator and weighted.

2.3.5 Crude Protein

Homogenized samples with 10ml were prepared in triplicate in a capped test tube with 5 ml of NaOH and stand at room temperature for 24 hours. The samples were centrifuged at 500 rpm for 10 minutes. 0.5 ml of protein extract was pipetted into the test tubes and 5 ml of analytical reagent was added. The mixture was incubated at room temperature for 10 minutes. Then, Folin Ciocalteau solution, (0.2 ml) was added to each tube and was incubated for 30 minute. The absorbance value was measured for each sample at 660 nm by spectrometer against the blank sample (distilled water). The concentration of the unknown sample was determined by using the standard curve that was plotted earlier [7].

2.3.6 Carbohydrate

Carbohydrate content in a food sample can be determined by calculating as follows:

$$Percentage\ of\ Carbohydrate(\%) = 100\% - (\%moisture + \%protein + \%fat + \%ash) \quad (1)$$

2.3.7 Calories Value

Calories of food can be determined by calculating as follows:

$$Calories\ \left(\frac{kcal}{100g}\right) = (\%\,protein \times 4) + (\%\,fat \times 9) + (\%\,carbohydrate \times 4) \quad (2)$$

2.3.8 Water Activity

The water activity of the sample was determined by using water activity meter. The flour sample was added into the sample cup and was placed inside the unit and the measurement was performed.

2.3.9 Repose Angle

The tip in a funnel was adjusted at 2 cm from the horizontal surface beneath. A quantity of flour sample carefully flowed through the funnel until the apex of the pile just touches the lower tip of the funnel. The base of the pile was marked by using a pencil in the form of a circle and the sample was removed. Tan angle of repose Ɵ was calculated.

2.3.10 Power Fineness

A sample of dry flour of known weight (100g) was separated through a series of the sieve with progressively smaller openings. The sieve time was set as constant for 5 minutes. Once the separation was completed, the weight of the particles was retained on each and weighted, then, compared to the total sample weight. A sample of flour was categorized according to the fineness of powder.

2.3.11 Water and Oil Absorption Capacity

A flour of 1 g was vortexed with 10 ml distilled water in a pre-weighed centrifuge tube for 30 minutes. The sample was stood for 30 minutes at room temperature, then, it was centrifuged for 25 minutes at 3000 rpm. The mass of sediments was recorded after the complete removal of the supernatant.

2.3.12 Foaming Capacity and Stability

A flour sample of 1 g was added to 50 ml of distilled water at 30 °C in a 100 ml measuring cylinder. The suspension was mixed properly by shaking the measuring cylinder for 5 minutes to create foam. The volume of the foam after whipping for 30 s was recorded [8] as the foaming capacity. The foaming capacity was expressed as a percentage of the increase in volume. The foam volume was recorded at 1 hour after whipping to determine the foaming stability.

2.3.13 Bulk Density

A known weight of the flour was taken into the preweight (W_1) measuring cylinder. The weight of the cylinder (W_2) and the volume of flour (V_1) we recorded [9]. The Loose bulk density (LBD) was calculated as below.

$$LBD = \frac{W_2 - W_1}{V_1} \quad (3)$$

The flour in the cylinder was tapped gently to eliminate air spaces between the particles of the flour. The new volume (V_2) of the sample and mass of the cylinder (W_3) will be recorded and the packed bulk density (PBD) was calculated

$$PBD = \frac{W_3 - W_1}{V_2} \quad (4)$$

3. RESULTS AND DISCUSSION

There was a significant difference among the group with a p-value less than 0.05 for all the parameters tested as shown in Table 1. This indicated that the addition of the mango seed flour affects the outcomes of the result.

Table 1 Proximate composition of flours

Types	Wheat flour	Composite flour I	Composite flour II	Composite flour III
Moisture (%)	12.98 ± 1.49	12.25 ± 0.22	10.21 ± 1.58	9.44 ± 0.12
Ash (%)	9.18 ± 0.53	11.75 ± 1.59	7.05 ± 2.63	4.22 ± 0.22
Crude fat (%)	5.97 ± 1.53	9.55 ± 1.41	11.11 ± 3.02	21.71 ± 3.11
Crude fibre (%)	22.68 ± 0.38	22.89 ± 0.19	23.34 ± 0.63	29.91 ± 0.21
Crude protein (%)	4.46 ± 0.09	5.79 ± 0.25	6.62 ± 0.02	9.58 ± 0.22
Carbohydrate (%)	67.41	60.66	65.01	55.05
Calorie (kcal/g)	341.21	351.75	386.51	452.91

All the samples tested were considered to be acceptable which is lower than the moisture content stated in the specification sheet (13.5%). The research from Legesse & Emira (2012) [10] found that the ash content for mango seed flour was 1.79 % which is lower than the composite flour III (4.22 %). The ash content is an indication of mineral elements present in the flour. Hence, the mineral content decreases as the mango seed flour percentage increase in blending flour. The variety of mango affects the result , therefore, the previous research found that the crude fat of mango seed kernel is lower (13.0 %) [11] than the composite flour III (21.71 %), which is the highest content of crude fat among the flour variants. The high percentage of crude fat have a high nutritional value and it is highly demanded in the food industry for the effects on the functional properties of food [12]. The result was showing the increasing trend as the percentage of the mango seed flour was increasing in the formulation, with the percentage of 29.91% in composite flour III.

Consumption of dietary fiber helps in decreasing the absorption of cholesterol from the gut and slow down the conversion of starch to simple sugars and this will help in the management of diabetes and other diseases such like cardiovascular disease, colon cancer and obesity [13]. The value that obtained for crude protein for composite flour III (9.58 %) is greater than those mango seed kernel flour (6.36 %) [14]. Composite flour III showed the lowest amount of carbohydrate, 55.05 %, while calorie value(452.91 kcal) was in opposite trend, which is the highest value as compared to other samples.

Table 2 Water activity of flours

Type	Water Activities (a_w)
Wheat flour	1.59 ± 0.06
Composite flour I	1.34 ± 0.03
Composite flour II	1.30 ± 0.02
Composite flour III	1.25 ± 0.07

Water activities, a thermodynamic measurement of the energy of water stored in flour, it is one of the parameters that used for assessing the rate of shelf life loss of flour. The result was clearly displayed in Table 2, the water activities for all the samples exceeded the growth limit for microbial growth which is 0.70 a_w [15]. Perhaps, further treatment was required to reduce the water activity value of flours.

Table 3 Repose angle of flours

Type	Angle of Repose (degree)
Wheat flour	46.13 ± 1.02
Composite flour I	44.72 ± 2.90
Composite flour II	45.82 ± 0.71
Composite flour III	42.51 ± 0.43

Table 3 showed the repose angle of flour from for every set. Granular powder formed a classical conical heap while the powdered flour forms a strongly irregular heap. According to the result, the flow property of wheat flour was categorized as poor flow ability and three other composite flour were categorized as passable flow ability due to the increased size of particles in the flour samples.

Table 4 Sieving analysis of wheat flour

Mesh	Screen opening Dpi, mm	Mass fraction retained, Xi	Average diameter in increment, ¯Dpi	Cumulative fraction smaller than Dpi
500	0.5000	0	-	1.0000
250	0.2500	0.0050	0.3125	0.9950
125	0.1250	0.2623	0.1875	0.7327
63	0.0630	0.6653	0.0940	0.0674
pan	-	0.0500	0.0315	0.0174

Table 5 Sieving analysis of Composite flour III

Mesh	Screen opening Dpi, mm	Mass fraction retained, Xi	Average diameter in increment, ¯Dpi	Cumulative fraction smaller than Dpi
500	0.5000	0.0036	-	0.9963
250	0.2500	0.1993	0.3125	0.7970
125	0.1250	0.6373	0.1875	0.1597
63	0.0630	0.1550	0.0940	0.0047
pan	-	0.0016	0.0315	0.00130

Based on the sieving analysis as shown in Tables 4, all of the flour samples were categorized as the fine powder, since all the powders passed through the No. 180 sieve [16]. Wheat flour (0.67) had the high mass fraction trapped in the No. 63 as compared to the composite flour III (0.16). The addition of mango seed flour had increased the particles size of the sample, as the mango seed flour portion increase in blending flour, the less mass fraction that had been trapped in smallest meshing size.

4. CONCLUSIONS

In conclusion, mango seed flour is the potential additive in composite flour in terms of chemical and physical properties that had been proven by this research. The chemical analysis had emphasize on the nutritional value of the composite flour III, which is the highest percentage of the mango seed flour, with the highest amount of crude fat (21.71%), crude protein (9.58%), crude fibre (29.91%) and calorie value (452.91 kcal/g). Physical properties analysis showed that addition of mango seed flour increases the particle size of the flour sample. Larger particle size lowers the angle of repose of composite flour III (42.51^{o}) and increases the flowability of the composite to a passable level, which is considered to be acceptable and satisfactory in operational process.

The addition of mango seed flour did not show any significant difference in the functional properties of composite flour except the FC and FS values. The presence of mango seed flour turned the flour into highly ordered globular and sensitive to surface denaturation, thus, a negative result was obtained for this testing. Therefore, the mango seed flour did not affect the reaction and the nutritional behaviour of the composite flour in an ambient environment.

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