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Formulation and Nutritional Evaluation of Mango Seed Kernel-Coffee Flavoured Multi-Purpose Flour

Nur Athirah Mustafa Kamal[1], Zalilah Murni Yunus[1]*

[1] *Faculty of Applied Sciences and Technology, UTHM Kampus Cawangan Pagoh, Hab Pendidikan Tinggi Pagoh, KM 1, Jalan Panchor, 84600 Pagoh, Muar, Johor, MALAYSIA*

*Corresponding Author: zalilah@uthm.edu.my
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Abstract

Mango Seed Kernel (MSK) and Spent Ground Coffee (SGC) are being combined to create a multi-purpose flour. These tropical fruits and spent ground coffee, which generate significant waste in the food industry, can be repurposed for new products, reducing waste and providing health benefits. This study aims to create a MSKC flavoured multi-purpose flour for gluten intolerance, reducing gluten consumption, and promoting healthier eating habits. The research aims to characterize the physicochemical properties of MSKC flavoured multi-purpose flour, including antioxidant content, moisture content, and pH value. The study also aims to formulate MSKC flavoured multi-purpose flour from MSK and SGC waste using three formulations for gluten intolerance. Finally, the multi-purpose flour is characterized in terms of water holding capacity, antioxidant content, moisture content, and bulk density. The analysis used are antioxidant content, moisture content, pH value, water holding capacity and bulk density. All 12 formulations were analysed, with formulation 10 having the highest antioxidant content, lowest moisture content and water holding capacity which is 95.43 ± 0.15^{d}, 11.51 ± 0.05^{a}, 15.53 ± 1.52^{a}, with formulation 8 having the highest bulk density reading. Overall, the best formula is formulation 10, which contains the best characteristics in terms of antioxidant content, moisture content, and water holding capacity.

1. Introduction

Multipurpose flour, also known as all-purpose flour, is a versatile and user-friendly flour that can be used for both baking and savory dish **Error! Reference source not found.**. It is made from a blend of hard and soft wheat varieties, providing a balanced protein content that allows it to form gluten when mixed with water. The versatility and user-friendliness of alternative flour, which is also popularly known as multi-purpose flour, have earned it widespread recognition across the industry. Maintaining it after it has been opened is a straightforward task. In circumstances where time is of the essence, multi-purpose flour can demonstrate its versatility as a viable alternative [2].

Mangifera indica L., also known as mango, is a tropical fruit cultivated in Asia, with India being responsible for 60.5% of global production. An area of land that is around 1.002 million hectares is used for the cultivation of mangoes in Asia, which results in a total production output of approximately 12.42 million metric tonnes. Mangoes are members of the family with the name Anacardiaceae. Mangoes are not seasonal and are acceptable in a number of places nowadays [3]. Coffee consumption is primarily motivated by its pleasant flavour and aroma, as well as the pleasurable sensations and physiological consequences it provides. Coffee stands out from

other beverages due to its soluble antioxidant activity, and espresso coffees have been reported to have more antioxidant activity than red wine or green tea [4]. Spent ground coffee contains high levels of total caffeoylquinic acids, which can be used to generate hydrophilic bioactive compounds [5].

Gluten allergy, or sensitivity, is a condition resulting from the presence of glutamine protein in gluten-containing grains like wheat, rye, and barley. This protein can cause abdominal discomfort, bloating, and weakness, and is a prevalent condition affecting 1 in 100 to 133 individuals globally. Celiac disease, gluten allergy, or gluten sensitivity is a prevalent condition affecting approximately 1 in 100 to 133 individuals worldwide. Adhering to a gluten-free diet is crucial for those suffering from gluten-related ailments. The recommended treatment for this allergy is the lifelong consumption of gluten-free food [6]. Therefore, the objective of this work is to formulate MSKC multipurpose flour that contains high nutrition and can be consumed by the gluten intolerance community.

2. Materials and Methods

2.1 Materials Specifications

The components of the MSKC multipurpose flour that will play a role in this research study were acquired from Kemaman fruit market and local shop which is from Rahmat Café, Pagoh.

2.2 Methods

2.2.1 Mango Seed Kernel

Mango seed was taken from unripe mango and was brought to the laboratory. The mango seeds were cleaned. The cleaned mango seeds were dried at 65 ◦ C for 6 hours to remove moisture content using a drying oven. Mango seed were removed from husks manually by using a stainless-steel knife. The dried mango was chopped into smaller pieces, ground using an electric blender and sieved. The powder of mango seed was stored in airtight container at 4 ◦ C [7].

2.2.2 Spent Ground Coffee

Impurities and residues in spent ground coffee were removed. Then, spent ground coffee was dried at 65 ◦ C for 6 hours to remove moisture content using a drying oven. Separated and dried spent ground coffee was ground or milled into fine powders using an electric blender. Spent ground coffee was sieved to remove any larger particles or impurities. The powder of spent ground coffee was stored in airtight container at 4 ◦ C [7].

2.2.3 Response Surface Method

The response surface methods formulation is based on the percentage of ingredients of formulations of multipurpose flour.

Table 1 *An Example of Response Surface Methods Formulation from Design Expert 13 (Trial Version)*

Run	A: Mango seed (%)	B: Spent Ground Coffee (%)
1	84	3
2	84	3
3	84	3
4	90	1
5	84	3
6	92.48	3
7	78	1
8	78	5
9	90	5
10	75.51	3
11	84	5.82
12	84	3
13	84	0.17

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2.3 Physicochemical Properties of Raw Materials

This investigation looked at a variety of physicochemical parameters, some of which are antioxidant content analysis, moisture content analyses and pH value.

2.3.1 Antioxidant Content (DPPH)

The DPPH technique involved ultrasonicating 0.1 g of the homogenized material in 20 mL of ethanol. Additionally, a blank volume of 3 mL of ethanol and 3 mL of the filter extract were mixed in a dark chamber with 1 mL of a DPPH ethanolic solution containing 0.1 mL for 30 minutes. Once incubation was complete, the absorbance of the two solutions was measured at 517 nm using a spectrophotometer (UV - 1800 Shimadzu). The results were presented as the percentage of inhibition, or degree of colour loss, for the free radical DPPH, comparing the sample to the blank [8] (see equation (1)).

$$\%\,RSA = \frac{\text{Abs blank - Abs sample}}{\text{Abs blank}} \times 100 \tag{1}$$

2.3.2 Moisture Content

An approximately 5g sample was placed in a pre-weighed crucible (which came with a cover) that had been preheated to 130 ◦ C. The sample was left to dry for one hour in an air oven set at 130 ◦ C. After placing the crucible in the oven, it was moved to desiccators and weighed as soon as it cooled to room temperature. There were three separate runs of the experiments. Equation 2 were used to compute the percentage of moisture after determining the weight loss from the sample (AOAC (2005) method 14.004):

$$\text{Moisture content (\%)} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100 \tag{2}$$

2.3.3 pH

Method using a pH meter (AOAC, 2003). Briefly, 10g of flour samples were suspended in 75 ml of distilled water and allowed to macerate for 30 min. The suspension was filtered and the pH of the dispersion obtained was measured. Experiments were done in three independent runs by using EUTECH pH 700.

2.4 Physicochemical Properties of MSKC

This investigation looked at a variety of physicochemical parameters, some of which are antioxidant content analysis, moisture content analyses, water-holding capacity and bulk density.

2.4.1 Water Holding Capacity

One gram of the pre-dried flour sample was measured and placed into a centrifuge tube. Before adding 10 mL of distilled water, the mixture was vortexed for 30 seconds. The specimen was let to soak in moisture for one hour while left at room temperature. After that, a benchtop centrifuge was used to spin the samples at 3000 rpm for 30 minutes. Weight was then applied to the hydrated sample after the supernatant was removed **Error! Reference source not found.** [9].

2.4.2 Bulk Density

Bulk density of sample was determined by method of Okala and Potter (1977). 10 g of flour were put into a 100 mL measuring cylinder and tapped to constant volume. The bulk density (g cm^{-3}) was calculated using the formula [10] (see equation (3)).

$$\text{Bulk Density} = \frac{\text{Weight of flour (g)}}{\text{Floor Volume (cm}^2\text{)}} \times 100 \tag{3}$$

2.5 Statistical Analysis

The results were described using the average of three replications. A one-way ANOVA with Tukey's post hoc analysis test ($p<0.05$) was utilized for means that showed significant differences [11].

3. Results and Discussion

3.1 Physicochemical Properties of Raw Materials in Terms of Antioxidant Content, Moisture Content, and pH Value.

Mango seed kernel and spent ground coffee physicochemical properties were carried out which included antioxidant content, pH value and moisture content by using method as described previously.

Table 2 *An Example of Antioxidant Content, pH Value and Moisture Content for Mango Seed Kernel and Spent Ground Coffee*

Sample	Antioxidant Content	Moisture Content (%)	Ph Value
MSK	94.51 ± 0.50	6.71 ± 1.10	6.33 ± 0.10
SGC	90.86 ± 0.07	7.30 ± 0 .04	6.71 ± 0 03

Value was expressed in mean ± standard deviation

As stated in Table 2, both raw materials contain high readings in antioxidants content which is 94.51 ± 0.50 and 90.86 ± 0.07 for mango seed kernel and spent ground coffee. The reading shows that antioxidant content for raw materials have a significant difference. Based on a previous journal has found antioxidant content reading for mango seed kernel is 62.4 – 70.3mg of total polyphenols/g [12]. Apart from that, the spent ground coffee reading in previous journal is 112.06±2.21 [5]. which contain higher than stated in Table 2. This is due to the lower absences of phenolic compounds which allow the oxidation process. Thus, MSK contains higher antioxidants than SGC.

According to Table 2, both raw materials had successfully achieved moisture content lower than 6.9% to 7.05% which creates an environment that prevents bacteria and other microorganisms from inhibiting. Then, both of raw materials go through pre-treatment to reduce moisture content of raw materials due to more than 10% readings of moisture content. The moisture content of mango seed kernel after drying stated in a previous study by [7] is 7.05%. Moreover, for spent ground coffee moisture content has achieved less than 6.9% as described in a previous journal by [13]. The previous journals have proved that both raw materials contain similar moisture content. Thus, there is no significant difference between mango seed kernel and spent ground coffee for moisture content.

Then, pH value has described as an important indicator to determine whether the raw materials were acidic or alkaline. It was measured on a range of 0 to 14 to determine the raw materials. In this case, values below 7 is categorized as acid and values above 7 is categorized as alkaline. Moreover, pH values can significantly influence on mouthfeel, colour, taste, and odours of the finished product. In addition, the pH values for mango seed kernel were expected to be in between 4.5 and 5.6 [14] and pH values stated by [15] for spent ground coffee is in between 4.5 to 5.8.

According to Table 2, the pH value is between 6.25 until 6.45 which entering towards acidity. This is because certain mango seed kernels are half ripe and fully ripe which leads pH value below 7. Alongside that, spent ground coffee contains higher pH value than mango seed kernel which is from 6.69 to 6.75 slightly acidic to neutral. In addition, roasting temperature used, type of soil and storage condition can affect the pH value of spent ground coffee. Thus, the result of the pH value is bigger than previous study.

3.2 Physicochemical Characterize the Multipurpose Flour in Term of Water Holding Capacity, Antioxidant Content, Moisture Content and Bulk Density.

There are 12 formulations has been tested in the characterization of multipurpose flour were taken from the formulation and responses surface method.

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Table 3 *An Example of Characterization of Multipurpose Flour in Term of Water Holding Capacity, Antioxidant content, moisture content and bulk density*

Sample	Antioxidant Content	Moisture Content (%)	Water Holding Capacity	Bulk Density
Formulation 1	93.72 ± 0.12^{a}	12.01 ± 0.04^{b}	19.86 ± 1.52^{abc}	0.710 ± 0.005^{b}
Formulation 2	94.59 ± 0.19^{bc}	11.40 ± 0.03^{a}	17.53 ± 1.52^{ab}	0.710 ± 0.005^{b}
Formulation 3	95.03 ± 0.07^{cd}	11.37 ± 0.02^{a}	19.20 ± 2.64^{abc}	0.710 ± 0.005^{b}
Formulation 4	94.46 ± 0.12^{bc}	11.96 ± 0.03^{b}	24.00 ± 2.00^{c}	0.707 ± 0.005^{b}
Formulation 5	95.09 ± 0.19^{cd}	11.89 ± 0.26^{b}	22.53 ± 1.15^{bc}	0.710 ± 0.005^{b}
Formulation 6	93.98 ± 0.16^{ab}	11.41 ± 0.04^{a}	19.20 ± 2.64^{abc}	0.622 ± 0.004^{a}
Formulation 7	95.06 ± 0.53^{cd}	12.00 ± 0.04^{b}	19.53 ± 2.51^{abc}	0.704 ± 0.000
Formulation 8	94.80 ± 0.20^{cd}	12.00 ± 0.06^{b}	16.53 ± 1.52^{ab}	0.710 ± 0.005^{b}
Formulation 9	94.09 ± 0.23^{a}	12.01 ± 0.02^{b}	22.53 ± 2.08^{bc}	0.704 ± 0.000^{b}
Formulation 10	95.43 ± 0.15^{d}	11.51 ± 0.05^{a}	15.53 ± 1.52^{a}	0.622 ± 0.004^{a}
Formulation 11	93.93 ± 0.20^{ab}	11.40 ± 0.02^{a}	19.20 ± 2.64^{abc}	0.622 ± 0.004^{a}
Formulation 12	95.40 ± 0.12^{d}	12.04 ± 0.02^{b}	17.53 ± 2.30^{ab}	0.625 ± 0.008^{a}

The values displayed are measured in mean ± standard deviation. The mean values for lowercase letters (a, b, c, d) in the same column have a significant difference at $p<0.05$.

Based on Table 3, the results show that formulation 10 exhibits the highest antioxidant reading at 95.43 ± 0.15^{d}, while formulation 1 showcases the lowest reading at 93.72 ± 0.12^{a}. This inconsistency can be attributed to the fact that formulation 10 contains the highest percentage of mango seed kernel powder compared to the other formulations. The outcome is likely influenced by the high antioxidant content present in mango, as indicated in Table 2, surpassing that of spent ground coffee. Moreover, Table 3 highlights significant differences between all formulations ($p<0.005$), underscoring the substantial variance in antioxidant content. Therefore, the obtained results can be attributed to the high antioxidant content inherent in both raw materials.

According Table 3, as shown above, moisture content for 12 formulations, there are significant difference between formulation 3, 2, 6, 10, and 11 with Formulations 1, 4, 5, 7, 8, 9, and 12. The highest moisture content is formulation 12 and the lowest is formulation 10 which is 12.04 ± 0.02^{b} and 11.51 ± 0.05^{a}. Moreover, the range of moisture content gained from MSKC is between 10.16% until 12.07%. Besides, there might be some error occurs during moisture analysis which is the storage temperature is impermanent and the packaging is impermeable. Thus, the moisture content gained is higher than previous study and can shorten the shelf life of the finished product.

Water holding capacity reading as stated in Table 3 is discussed and calculated in percent. According to reading in Table 3, formulation 10 is the lowest multipurpose flour that can absorb water and hold onto under particular circumstances which is 15.53 ± 1.52^{a}. Then, the highest water holding capacity is formulation 4 which is 24.00 ± 2.00^{c}. Then, the percentage reading of water holding capacity is between 140% to 26.20%. This shows that there is a significant difference between formulation 10 and formulation 4 due to $p<0.005$. Thus, the best formulation for water holding capacity is formulation 10 due to the lowest water holding capacity which can prevent microbial spoilage.

As mentioned in Table 3, there are significant difference between formulations 6, 10, 11, and 12 with formulation 1, 2, 3, 4, 5, 7, 8, and 9. Other than that, the highest reading for bulk density is formulation 8 which is 0.710 ± 0.005^{b} and the lowest bulk density is formulation 6 which is 0.622 ± 0.004^{a}. The result has shown that mango seed kernel flour and spent ground coffee flour is easy to compact in packaging. Thus, due to its lower volume required, high bulk density is favoured for long-distance transport; nevertheless, greater weight and denser materials can be more stable during handling and processing, reducing the chance of spills or dust dispersal [16].

4. Conclusion

In conclusion, this study has achieved the collection data of physicochemical properties of raw materials in term of antioxidant content, moisture content and pH value. Alongside with that, the collection data for MSKC have been characterized and collected in term of antioxidant content, moisture content, water holding capacity and bulk density. Besides that, raw materials have been analysed and contain high reading in antioxidants content but low range reading in moisture. Then, the pH value for raw materials is slightly acidic. Alongside that, all 12 formulations were also analysed in term of antioxidant content, moisture content, water holding capacity and bulk density. Between all formulations, highest antioxidant content is in formulation 10 and the lowest antioxidant content is in formulation 1. Next, the highest moisture content is in formulation 12 and the lowest moisture content is in formulation 10. Then, the water holding capacity range reading is in between 15.53 ± 1.52^{a}. and 24.20 ± 2.00^{c} which is from formulation 10 the lowest and formulation 4 is the highest. Other than that, the highest reading for bulk density is formulation 8 and the lowest is formulation 6. Overall, the best formula is formulation 10 which contain the best characteristics in terms of antioxidant, moisture content and water holding capacity.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Athirah Mustafa Kamal, Zalilah Murni Yunus;* ***data collection:*** *Nur Athirah Mustafa Kamal;* ***analysis and interpretation of results*** *Nur Athirah Mustafa Kamal,* ***draft manuscript preparation:*** *Nur Athirah Mustafa Kamal, Zalilah Murni Yunus. All authors reviewed the results and approved the final version of the manuscript.*

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