Short Communication

Flour Properties of Whole and Dehulled Mung Beans (*Vigna radiata*) and Development of Food Gels Incorporated with Kithul (*Caryota urenus*) Flour

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Abstract

In the present study, proximate and flour properties including thermogravimetric (TGA/DSC) and X-ray defraction (XRD) analysis of whole and dehulled mung bean (*Vigna radiata*) flours were studied. Moreover, food gels were developed from whole and dehulled mung bean flours with incorporating Kithul palm (*Caryota urenus*) flour without adding sugar and artificial food additives. According to the proximate analysis, whole Mung bean flour contains (%, dry weight basis); carbohydrates 62.67±0.23, and proteins 29.39±1.52 while hulled mung bean contains (%); carbohydrate 66.27±0.75, and proteins 28.0±4.61 proteins. The TGA/DSC and XRD resulted similar pattern for both whole and hulled mung bean flours. The food gels developed from hulled mung bean flour resulted higher syneresis (18%) than gels from whole mung beans (7%). However, food gels from hulled mung bean flour with incorporated Kithul flour were ranked the highest organoleptic acceptance according to the sensory evaluation. Collectively, the results of the current study suggested that local mung bean flour could be a potential ingredient to develop food gels with incorporating Kithul flour as novel functional foods. The compositional analysis of developed mung bean food gels is in progress.

Keywords: food gels, mung bean flour, value-addition, Vigna radiata

1. Introduction

Mung bean (*Vigna radiata*) is a legume belongs to the Family: Fabaceae. The edible part is the dicotyledonous seeds and they are called as pulses. Mung bean is accounting for 79.89% of the world pulse production (Zhong et al., 2018). Further, it has been consumed since more than several thousand years. In point of view of nutrition, mung bean protein could be used as a lysine source for cereal products which contains minute amount of lysine. The addition of pulse flour to wheat flour is a modern trend in developing flour composites (Zhang et al., 2019). Moreover, mung bean seed contains about 20-31% protein and it's nearly two times than cereal seed maize and significantly higher than the conventional root crops. They play an important role as a source of dietary protein for large segment of the world population specially in the tropics where the consumption of animal protein is restricted either due to non-availability, affordability, customs or religious habits (Sharma et al., 2017). However, low methionine content and presence of trypsin inhibitor cause for low protein efficiency ratio (Yi-Shen, Shuai, & Fitzgerald, 2018). In health wise, mung bean contains compounds which can reduce fat accumulation and those compounds are vitexin, triacontanol, sitosterol and stigmasterol (Zhang et al., 2017). In addition, mung bean has been also shown several pharmacological benefits such as antitumor, antioxidant, and antifungal effects. Sri Lankan farmers in the dry zone currently cultivate mung bean and this crop needs value-addition to develop and introduce novel food products.

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Due to high protein and starch contents mung bean has ability to make food gels (Mun et al., 2015). Therefore, in the present study, whole and hulled mung beans were tested to develop food gels. Moreover, Kithul flour from *Caryota urenus* palm considered as a healthy and nutritious source since a long time in Sri Lankan traditional foods. The Kithul flour was incorporated in Mung bean gels to introduce more healthy food gel with high gel strength. Currently, there is a leading food trend for more natural foods by the consumers and an attempt was taken to develop food gels from local Mung beans without adding any artificial food additives such as food colors, flavours, and chemical preservatives.

2. Materials and Methods

2.1 Preparation of whole and dehulled Mung bean flours

The whole and hulled Mung beans samples were purchased from local supermarket at Kadawatha, Sri Lanka during April 2019. Initially, mung beans were cleaned thoroughly to remove dirty particles and weighted. Thereafter, both Mung beans types were soaked for 10 hours in water. Then, they were sun dried and grinded separately until it becomes a fine powder. The flours obtained were sieved through the 90 micrometer sieve and sealed in separate polythene bags until further use.

2.2 Proximate analysis of Mung bean flours

The moisture, crude protein, crude fat, and ash contents of whole and dehulled Mung bean flours were determined according to the standard AOAC official analytical methods. In addition, the total phenolic content was measured by Folin-Ciocalteu method and result was expressed mg gallic acid equivalent per 100 g of flour (mg GAE/100 g).

2.3 Microscopic analysis of Mung bean starch granules

The microscopic observation and photograph of a slurry of whole Mung bean flour were performed under a light microscope (OPTIKA B-292©, Ponteranica BG, Italy), after staining with Iodine solution.

2.4 Thermogravimetric analysis (TGA) and differential scanning colorimetry (DSC)

The TGA and DSC analysis of Mung bean flours were carried out according to manufacturer's guidelines. A SDT 650 (TA Instruments©, New Castle, DE, USA) simultaneous TGA/DSC instrument at Instrument Center, Faculty of Applied Sciences was used for the analysis.

2.5 XRD analysis of Mung bean flours

The crystalline structure of Mung bean flours were analysed using X-Ray Defractometer (Rigaku©, Ultima IV) with following conditions; scan rate=4.0 degree/min and scan range=5.0-7.0 degree. The sample was tightly packed in a rectangular glass cell with 0.2 mm depth.

2.6 Preparation of Mung bean food gels added with "Kithul" flour

In this study, two types of Mung bean food gels (either from whole or hulled Mung bean flours) were prepared and incorporated with "*Kithul*" flour (at the rate of 25% dry weight basis) (Table 1).

Table 1: Formulation of Mung bean gels added with "*Kithul*" flour.

Ingredients	Whole mung bean flour gel	Hulled mung bean flour gel
Whole Mung bean flour	15 g	-
Hulled Mung bean flour	-	15 g
Kithul flour	5 g	5 g
Salt	0.57 g	0.57 g
Water	160 mL	160 mL

First, the whole or hulled mung bean flours were mixed with water followed by the addition of salt and Kithul flour. The combined mixtures were heated to 75° C using a heating mantel. The gels were packed in transparent PVC cups and kept at 4° C until further analysis. Moreover, another two types of gels from each Mung bean flour (20 g) without adding Kithul flour were prepared as controls for the sensory evaluation.

2.7 Syneresis of Mung bean food gels

The syneresis of prepared food gels were assessed according to a modified method (Andrabi et al., 2016).

2.8 Sensory evaluation of Mung bean food gels

Randomly selected 20 semi-trained panelists were used to organoleptically assess the Mung bean food gels for taste, after taste, texture, aroma, appearance, and overall acceptability and rank the gels. The sensory assessors scored their preference from 1 (Extremely dislike) to 5 (Extremely like) to inform their respective opinions on the test parameters.

2.9 Statistical analysis

All analysis was carried out in triplicates and was reported as mean±standard deviation. The collected data was finally analysed by using, Minitab 17 package. For the parametric data analysis, One-way ANOVA was used at 95% confidence interval and for the pair wise comparison of the means Turkey's Analysis was used and MS Office Excel 2010 was used for the graphical representation of the data.

3. Results and Discussion

3.1 Proximate analysis of Mung bean flours

The proximate analysis results of mung bean flour are presented in Table 2 and all values are based on dry weight basis. The moisture content of flour was 11.35±0.13 and 13.57±0.19% and generally, both whole and dehulled Mung bean flours were nutritious with carbohydrate and proteins, a potential source for the gels to feed malnutrition in children.

Table 2: Proximate analysis of whole and hulled mung bean flours.

Constitute	Composition (%, dry weight basis)	
	Whole	Hulled
Moisture	11.35±0.13	13.57±0.19
Carbohydrate	62.67±0.23	66.27±0.75
Protein	29.39±1.52	28.00±4.61
Ash	3.53±0.34	3.17±0.07
Fat	2.27±0.26	2.45±0.61

Moreover, the Folin-Ciocalteu analysis resulted that the total phenol content of whole mung bean flour (33.67±2.20 mg GAE/100 g) was greater than the dehulled Mung bean flour (29.82±1.05 mg GAE/100 g).

3.2 Morphology of Mung bean starch granules

The Mung bean starch granules were shown in oval to round shape according to the light microscopic observation results (Figure 1). The gel properties are controlled by the volume of starch granules (Park et al., 2012).

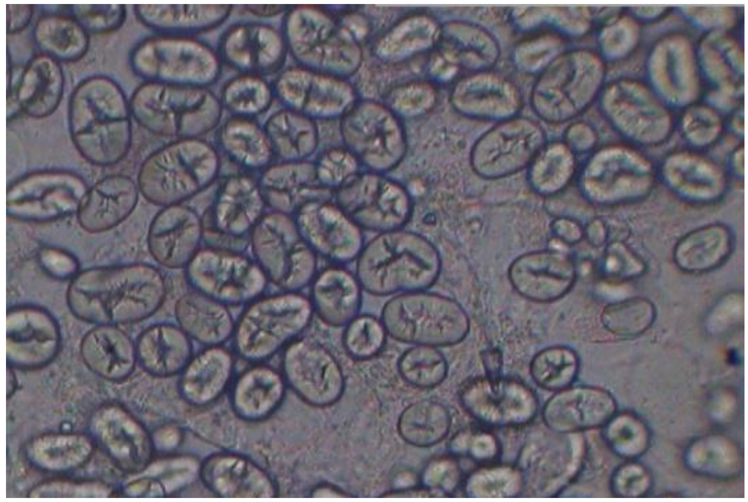

Figure 1. Morphology of Mung bean starch granules under light microscope (40×).

3.3 TGA and DSC analysis of Mung bean flours

In the TGA analysis the mass loss is measured as a function of temperature (Yokesahachart & Yoksan, 2011). The purpose of the TGA analysis of this study was to evaluate how far the manufacturing temperature would accept by the Mung bean flour without undergoing a considerable thermal degradation. The yielded data (Figure 2) confirmed that Mung bean flours could be easily used for high temperature cooking. In addition, DSC is a method to find the gelatinization temperature of a particular flour or starch. The result revealed that the onset gelatinization temperature for whole Mung bean flour was 54.03° C.

3.4 XRD analysis of Mung bean flours

The XRD pattern analysis is one of the fundamental methods for examining the microstructure and physico-chemical makeup of unknown solid material. According to (Jiang et al., 2020) XRD reveals polysaccharide structures and a technique used for analysis of the crystalline structure of the material. A bun shape crystallinity pattern mean low crystallinity and sharp peaks means high crystallinity. According to the results (Figure 3), the whole Mung bean flour XRD pattern strong intensities were almost same as hulled Mung bean flour XRD pattern strong intensities. It indicated moderate level of crystallinity.

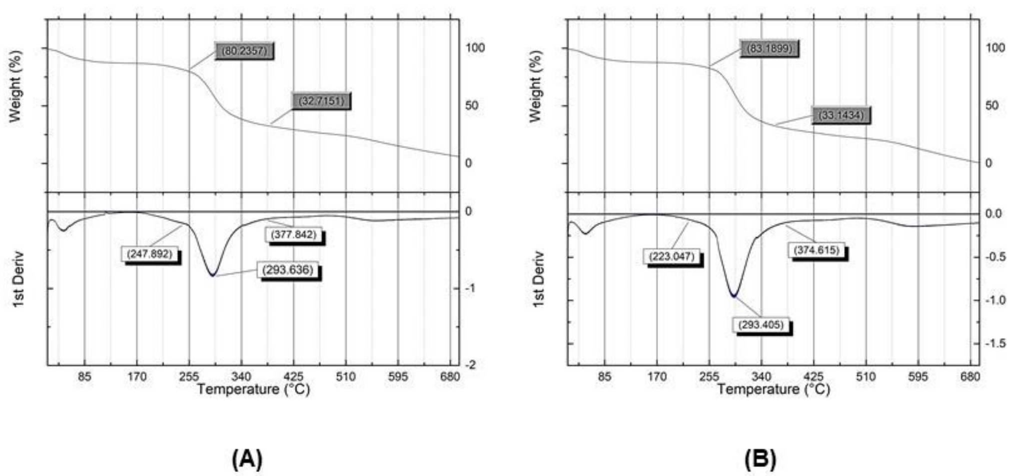

Figure 2. TGA results of whole (A) and dehulled (B) Mung bean flours.

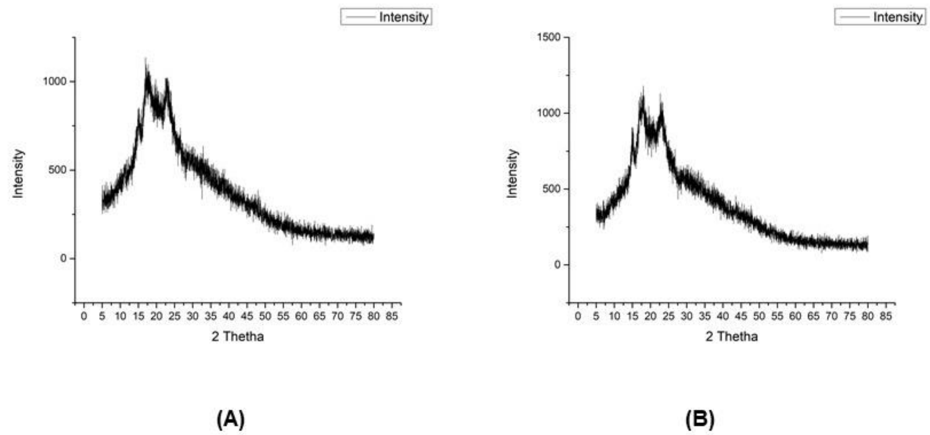

Figure 3.XRD analysis of whole (A) and dehulled (B) Mung bean flours.

3.5 Syneresis of Mung bean food gels

The syneresis values of developed two types of Mung bean food gels incorporated with "*Kithul*" flour were determined. The syneresis or weeping is known as reducing the water holding capacity and the syneresis of food gels made out of hulled Mung beans (18%) were greater than that of whole Mung beans (7%). A previous study has reported that the excellent gels can be made from Mung bean starch but syneresis is the major drawback (Kim et al., 2007). Therefore, in the commercial scale whole Mung beans can be used to develop strong food gels with incorporating "*Kithul*" flour.

3.6 Sensory evaluation of Mung bean gels

Four types of food gels such as whole Mung bean with "*Kithul*" flour (708), whole Mung bean without "*Kithul*" flour (606), hulled Mung bean with "*Kithul*" flour (905), and hulled Mung bean without "*Kithul*" flour (503) were developed for the sensory evaluation. The developed food gels were organoleptically assessed for appearance, aroma, texture, taste, after taste, and overall acceptability. The web diagram of the average rank of the four types of food gels is presented (Figure 4). The hulled Mung bean gels incorporated with "*Kithul*" flour was the highest ranked among all gels tested in terms of overall acceptability.

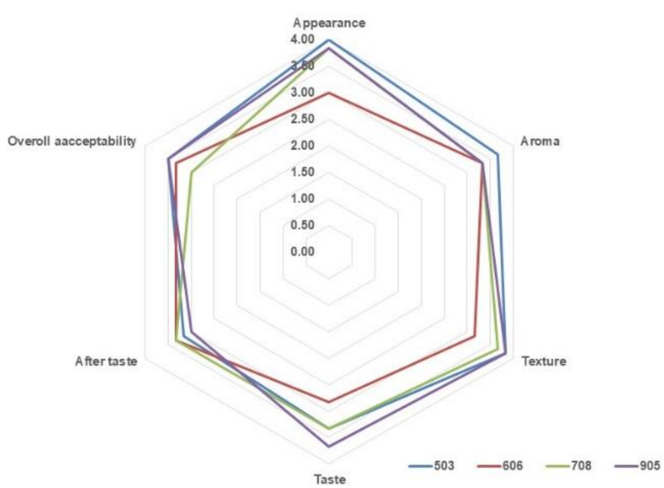

Figure 4. Web diagram of the sensory analysis of developed Mung bean food gels (708-"*Kithul*" flour added whole Mung bean flour,905-"*Kithul*" flour added hulled Mung bean flour, 606-Whole Mung bean flour without "*Kithul*" flour, and 503-Hulled Mung bean flour without "*Kithul*" flour).

4. Conclusion

The Mung beans are mainly cultivated in the dry zone of Sri Lanka and need value-addition to develop new food products. The current study revealed that the Mung bean flour can be used to develop food gels with incorporating "*Kithul*" flour without no added sugar and no added artificial food additives. The sensory evaluation has concluded the food gel made from hulled Mung bean with incorporating "*Kithul*" flour was the most acceptable than whole Mung beans. Collectively, it can be concluded that Mung bean flour can be used to develop no added sugar food gels with incorporating "*Kithul*" flour. Further, the compositional and nutritional analysis of developed Mung bean food gels are in progress.

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