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Does processing have a considerable effect on the nutritional and functional properties of Mung bean (*Vigna radiata*)?

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Abstract

Mung bean is an important grain legume which is rich in nutrients and other bioactive compounds with many beneficial physiological effects. However, the effect of processing on properties of mung bean has not been widely studied in Sri Lanka. In the current study, effect of processing (boiling and sprouting) on some nutritional and functional properties of mung bean was investigated in comparison with raw mung bean. Mung bean seeds (*Vigna radiata*), varity MI6 were obtained from the Government Seed Center, Dambulla, Sri Lanka. Proximate composition, gross energy, insoluble dietary fibre (IDF) and soluble dietary fibre (SDF) contents,total phenolic content (TPC), total flavonoid content (TFC), α-amylase inhibition capacity, DPPH and ABTS scavenging activities were determined. Crude Protein (CP) content of boiled mung bean was significantly (p<0.05) lower than that of raw mung bean while it was significantly (p<0.05) higher in sprouted mung bean than raw mung bean. Crude fat content (CF) was significantly (p< 0.05) lower in sprouted mung bean when compared to raw mung bean. IDF contents in raw mung bean was significantly (p<0.05) higher than that in sprouted and boiled mung bean whereas, SDF content in boiled and sprouted mung bean were significantly (p<0.05) higher than that in raw mung bean.processing significantly (p<0.05) reduced antioxidant activity and total phenol content compared to raw mung bean. However, flavonoids could only be detected in sprouted mung bean. Further, α-amylase inhibition in sprouted mung bean was significantly (p<0.05) higher than that in boiled mung bean. In conclusion, processing (boiling and sprouting) influences the CP content, CF content, dietary fibre content, antioxidant capacity, α-amylase inhibition and fermentation ability in mung bean.

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Main text

1. Introduction

Mung bean [*Vigna radiata* (L.)Wilczek] is one of the important legume crops widely cultivated in Asia[1]. From the 5.5 million ha of world mung bean production, about 90% is in Asia and among that, India is the biggest producer where about 2.99 million ha are cultivated[5]. Although mung bean is widely known for its fibre, mineral and protein, at present it is considered not only as a rich source of nutrients but also a source of other bioactive compounds with many beneficial physiological effects such as antioxidant, antidiabetic, anticholesteromic and anticancer effect in controlling and preventing various metabolic diseases[2].Previous studies have shown that processing alters the nutritional and functional properties of food[2].Some processing methods can increase and some can decrease the nutritional and functional properties of food. Therefore a great attention should be paid not only on what is eaten but also on the way of preparing it. Mung bean is processed into various forms such as sprouted, cooked and boiled before consumption.However, the effect of processing on nutritional and functional properties of mung bean has not been widely studied in Sri Lanka. Thus, the present study was carried out to investigate the nutritional and functional properties such as antioxidant effect, α- amylase inhibitory activity, dietary fibre and fermentation ability of boiled mung bean (BMB) and sprouted mung bean (SMB) in comparison with raw mung bean (RMB) using *in vitro* techniques.

2. Materials and methods

Mung bean(*Vigna radiata*) seeds, variety MI6 were obtained from the Government Seed Center, Dambulla, Sri Lanka, which was cultivated in *Yala* season, 2014. The seeds were then cleaned and soaked overnight at room temperature (28°C) before preparing boiled (BMB) and sprouted (SMB) mung beans. Beans were boiled for 30 minutes at 60°C for the preparation of BMB and to prepare SMB, beans were germinated for 48 h in folded papers. Raw, boiled and sprouted seeds were air dried and oven dried at 60°C until a constant weight wasobtained and ground to get a fine consistency. Powders were stored in sealed air-tight plastic containers in a refrigerator at 5°C until analysis.

Proximate composition of mung bean was analyzed according to the AOAC procedure and gross energy content was determined using the bomb calorimeter. Insoluble dietary fibre (IDF) and soluble dietary fibre (SDF) contents were also determined on dry matter basis[3]. Water extract of dried mung bean samples were prepared and antioxidant capacity was determined using DPPHand ABTSassays and total phenolic content (TPC) and total flavonoid content were determined by Folin-ciocalteu and Aluminium chloride method, respectively. Antidiabetic effect was determined by α-amylase inhibitory assayand microbial fermentation characteristics were measured using unadapted microorganisms obtained from swine caecum. In the present study, hydrogen and carbondioxide gases were measured which are by products of microbial fermentation to determine fermentation characteristics of mung bean.

Data were analyzed by one-way analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS. Significant differences among means were separated by the Duncan’s Multiple Rang Test (DMRT). Differences at $p<0.05$ were considered as significant.

3. Results,discussion, conclusion and recommendation

The gross energy in RMB, BMB and SMB samples were not significantly different ($p> 0.05$). Crude Protein (CP) content in SMB was significantly higher ($p< 0.05$) than that in RMB whereas it was significantly lower ($p< 0.05$) in BMB. Further, the crude fat content (CF) was significantly lower ($p< 0.05$) in SMB compared to RMB (Table 1). Insoluble dietary fibre content in RMB powder was significantly ($p<0.05$) higher than that of BMB and SMB powder whereas, soluble dietary fibre content in BMB and SMB powder was significantly ($p<0.05$) higher than that in RMB powder (Table 1). Total phenolic content (TPC) in RMB was significantly higher ($p< 0.05$) than that in BMB and SMB while Flavonoids could only significantly be detected in SMB and the value was 0.62mg CE/g. A significantly higher ($p < 0.05$) DPPH radical scavenging activity and ABTS radical quenching activity were observed in RMB extracts which was reduced to half after processing. Further, there was no significant ($p > 0.05$) difference between the antioxidant activities in BMB and SMB. However, α-amylase inhibitory activity was significantly high in RMB ($p < 0.05$) than that in BMB and SMB whereas it was significantly higher ($p < 0.05$) in SMB than BMB (Table1). There was a significantly high ($p < 0.05$) hydrogen and carbon dioxide production in RMB than boiled and sproutedgroups in the microbial fermentation analysis.

Table 1: Gross energy content, proximate composition, dietary fibre, total phenolic content, total flavonoid content, antioxidant capacity and α-amylase inhibitory activity, in raw (RMB), boiled (BMB) and sprouted mung bean (SMB) powder

		RMB	BMB	SMB
Proximate	Moisture Content (%)	4.76 ± 0.12^{a}	4.43 ± 0.27^{a}	3.84 ± 0.06^{b}
	Crude protein (CP) (%)	30.64 ± 0.86^{b}	22.93 ± 1.21^{c}	36.13 ± 0.90^{a}
	Crude Fat (CF) (%)	2.58 ± 0.47^{b}	5.22 ± 0.85^{a}	0.69 ± 0.25^{c}
	Crude Fibre (%)	8.47 ± 0.61^{a}	5.88 ± 0.68^{c}	7.28 ± 0.79^{b}
	Ash (%)	4.55 ± 0.02^{b}	4.26 ± 0.02^{c}	4.71 ± 0.08^{a}
	NFE* (%)	52.06 ± 0.04^{c}	61.71 ± 0.13^{a}	55.01 ± 0.07^{b}
Energy (KJ/g)		16.18 ± 0.96^{a}	16.72 ± 0.11^{a}	16.96 ± 0.32^{a}
Dietary fibre	Insoluble Dietary Fibre (%)	27.85 ± 0.35^{a}	17.15 ± 0.03^{b}	11.04 ± 0.23^{c}
	Soluble Dietary Fibre (%)	0.11 ± 0.03^{c}	0.49 ± 0.07^{a}	0.32 ± 0.03^{b}
Total Phenolic Content (TPC)**		6.03 ± 0.02^{a}	5.17 ± 0.06^{b}	5.21 ± 0.06^{b}
Flavonoid (Catechin equivalent (CE) mg/g of sample]		0.06 ± 0.03^{b}	0.02 ± 0.02^{b}	0.40 ± 0.22^{a}
Antioxidant capacity	DPPH (IC_{50} - mg/mL)	4.12 ± 0.36^{b}	11.58 ± 1.34^{a}	10.23 ± 0.17^{a}
	ABTS (Trolox Equivalents (TE) mg/100mg)	51.81 ± 0.30^{a}	26.12 ± 0.12^{b}	26.61 ± 0.10^{b}
α- Amylase inhibition (IC_{50}- mg/mL)		36.09 ± 0.02^{c}	77.02 ± 0.12^{a}	48.39 ± 0.17^{b}

Values are expressed as means ± SD
Mean values within a column with different superscript letters are significantly different ($p<0.05$)
*Calculated by difference from protein, fat, ash, fibre and dry matter.
** Values express as gallic acid equivalents (GAE) mg/ g of sample

The results of this study reveal that, boiling decreases CP content in mung bean and it may be due to the removal of CP with water during boiling. However, CP content was increased with sprouting in the present study and it is probably due to increasing non-protein nitrogen content during the germination process by releasing the bound nitrogenous compounds (e.g.-tannin-protein complexes)[4]. Further, the energy consumption during the germination process has reduced the CF content in sprouted mung bean. Mung bean has shown a reduction of IDF during boiling and sprouting. In line with that,a significant reduction was observed in insoluble dietary fiber after boiling by Mahadevamma and Tharanathan[5]. The reason for rapid reduction of dietary fibers in SMB may be due to hydrolyzing of dietary fibers while sprouting. However, the SDF content has increased with boiling and sprouting because of the solublilizing of dietary fibers. Results of the study reveal that processing causes (boiling and germination) decrease in TPC in mung bean and a similar result has been observed for pinto and kidney beans[2]. Further, the antioxidant capacity determined by DPPH and ABTS methods was significantly correlated ($p < 0.05$) each other. In addition the TPC was significantly correlated with antioxidant capacity determined by ABTS method, correlation coefficient being 1.0($p < 0.05$). Thus, it can be mentioned that phenolic compounds may contribute to free radical scavenging activity of mung beans. Dietary fibers are resistant to digestion and absorption in the human small intestine, but they are fermented in the colon. The fermentation of dietary fibers results in gasses and short chain fatty acids (SCFA) which have various health benefits. According to hydrogen production data, fermentation and sprouting have reduced the fermentation ability of mung bean.

The study proved that sprouting is a good method for obtaining a healthy diet by maximizing crude protein and minimizing crude fat levels. Boiling and sprouting had a significant impact on both dietary fiber fractions, promoting an improvement of soluble dietary fiber to insoluble dietary fiber ratio, which is important for dietary value and also for functional characteristics. Thus, according to result of present study processing has improved the nutritional and functional properties of mung bean.

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