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Effect of germination time duration and processing method (cooking, pressure cooking and microwave cooking) on crude protein content of Mung bean (*Vigna radiate*)

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Abstract
Germination is one of promising technique in food industry as it improves the nutritional quality while reducing anti-nutritional factors which affect for human nutrition. The aim of this study is to determine the variation of crude protein content of germinated Mung beans (*Vigna radiate*) with time and to determine the effect of three different processing techniques. This process depicted a significant effect on the crude protein content as it increased with the germination time duration. The crude protein content in 6 h, 12 h, 18 h and 24 h germinated Mung beans were 27.98 g, 29.82 g, 31.32 g and 33.02 g respectively. Further, cooking, pressure cooking and microwave cooking reduce the protein content and there's no significant difference between those three methods while they contained much higher protein content than raw sample as 27.44 g, 27.39 g and 27.41 g respectively.

Keywords: mung beans, germination, crude protein, cooking

1. Introduction
Legume is known as a fruit by edible seeds belongs to Fabaceae or Leguminosae family. This is an important source of protein, carbohydrate, dietary fiber and minerals. However the presence of anti-nutritional factors limits the consumption of legumes as a main protein source [1, 2]. The legumes generally contain large quantities of proteinase inhibitors such as trypsin, phytohemagglutinins, lathyrogens, chymotrypsin and elastase [3, 4].
Legumes are not generally consumed as it is because some processing techniques can make desirable changes in the composition of seeds. Soaking, cooking, fermentation and germination improve the quality of legumes by removing some anti-nutritional factors. Germination is one of the promising technique which improves the nutritional quality by increasing protein content, dietary fiber, vitamin, bioavailability of trace elements and reduce the concentration of anti-nutritive compounds [5, 6].
Mung bean (*Vigna radiata*) is one of an important pulse belong to legumes which is widely grown in Southeast Asia, Africa, South America and Australia. This is a very important source of protein while it contains some anti-nutritional factors which can cause gastro-intestinal discomforts and non-availability of nutrients in biological systems [7].
The aim of this study is to determine the changes in crude protein content in germinated Mung beans with time. Further, this explains the effect of different cooking methods such as cooking, pressure cooking and microwave cooking on the crude protein content.

2. Materials and Methods
2.1 Sample collection
The samples were purchased from the market, Nugegoda, Sri Lanka. They were manually cleaned from impurities and stored in airtight bottles in desiccators for analysis.

2.2 Germination of Mung bean seeds
The seeds were soaked in distilled water in glass containers for 24 h at room temperature. The 5 samples of 300g of Mung beans were measured and 4 of them were soaked. After soaking the seeds were filtered and the adherent moisture removed by gently rolling them on thick absorbent cloth.
The germination experiment was carried out by keeping the soaked Mung bean in petri dishes and they were covered with wet cotton cloths. They were kept inside an incubator which was maintained at 27^0C (room temperature). Periodically distilled water was sprayed during germination process. The soaked seeds were dried in an air oven at 70°C before the analysis and 105°C to a constant weight, ground to pass through a 40 mesh sieve and stored for further analysis.

2.3 Processing techniques
Cooking/ Boiling
This is the most common method used to cook for human consumption. The 100g of 12 hours sprouted Mung beans were added in to distilled water (1:2 v/v) and boiled for 1h.

Pressure cooking
The 100g of 12 hours sprouted sample was steamed in a pressure cooker for 10 minutes. The time was measured once the pressure cooker attained maximum pressure or when it was stared to release steam. Then steamed beans were dried at 60^0C for 6 h and then milled into flour prior to analysis [8].

Microwave cooking
The 100g of 12 hours sprouted sample was cooked in a domestic microwave (1.9 cu. ft. countertop microwave, Samsung) oven for 10 minutes by dipping in distilled water (1:5 w/w) [9].

2.4 Analysis of crude protein
The crude protein content was measured according the AOAC method (2006) [10] in raw, soaked, germinated (6 h, 12 h, 18 h

and 24 h), cooked, pressure cooked and microwaved Mung beans [10].

3. Results and discussion

There's a significant difference in crude protein content with respect to sprouting duration ($p < 0.05$). The Figure 1. clearly depicts that the crude protein content sharply increased with the sprouting time and the highest protein content was obtained in the sample of sprouts which was germinated for 24 h. According to the previous studies total nitrogen, total non-protein nitrogen, protein nitrogen, true protein nitrogen increased with germination [11]. Proteins in legumes consist of storage proteins, structural proteins, and biologically active enzymes which storage proteins can be categorized into globulins, albumins, prolamins and glutelines. As the plant uses the storage proteins as the source of nitrogen and carbon for bio-molecule synthesis, protein is gradually broken down during the process of germination. It is reported that high molecular weight proteins may have broken down to short chain peptides and amino acids [12]. Previous studies have reported that germination can increase the protein content due to biosysnthesis of enzymes and proteins or compositional changes following the degradation of other components. Further, concentration of some types of amino acids increases during this process [13].The Table. 1 describes the crude protein content with respect to the germination duration. There's a significant increment in crude protein content 6 h germinated Mung beans compared to raw Mung beans. Further, soaking step does not make any effect on the protein content.

Table 1: Crude protein content with respect to germination duration

Germination duration (h)	Crude protein content / g (per 100g)
Raw	26.40±0.01^{e}
0	26.28±0.01^{f}
6	27.98±0.00^{d}
12	29.82±0.00^{c}
18	31.32±0.01^{b}
24	33.02±0.01^{a}

Mean values in a column superscripted by different letters are significantly different at $P < 0.05$.

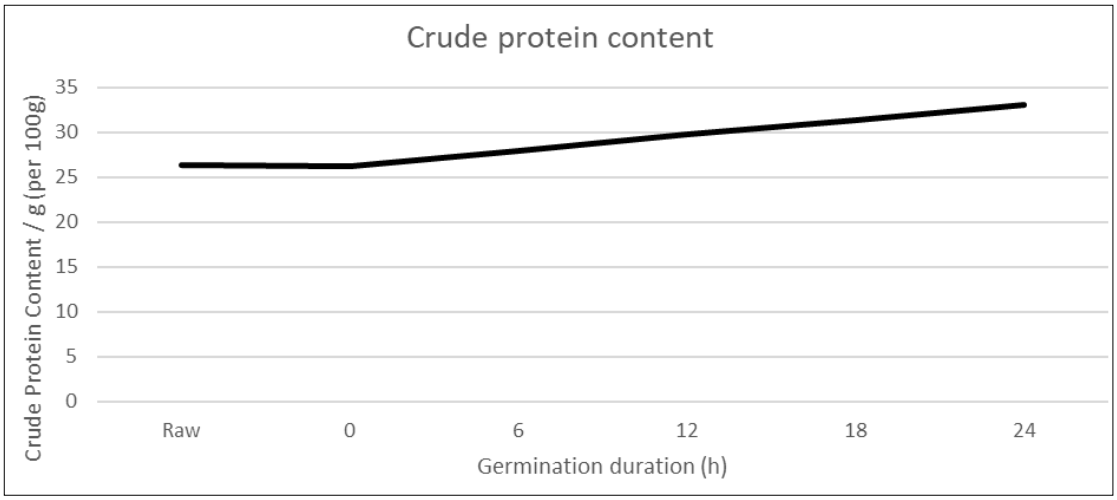

Fig 1: Variation of crude protein content with germination duration

Soaking is an initial step for number of processing techniques. This mainly hydrates the seeds within particular period when seeds are dipped in water. Studies have proved that soaking can reduce the levels of minerals, phytic acid and proteolytic enzyme inhibitors. Conversely, this does not make any effect on the protein content and raw sample contained 26.40 g and soaked sample contained 26.28 g per 100 g of sample.

Three different cooking methods together with soaked Mung bean were used to analyze. There's no significant difference between cooking, pressure cooking and microwave cooking on behalf of crude protein content ($p < 0.05$). But they have higher content than raw Mung beans as those were germinated before the processing or cooking step. Cooking or boiling is the oldest method for making legumes edible. As in the experiment, this involved a pre-soaking step to make them tender. However, both soaking and cooking can cause considerable loss in some nutrients which are water soluble [9].

Microwave energy can heat deeply within the food and this is a promising technique in the world as it yields better quality products than that obtained by convention cooking methods. Considering the crude protein content, there's no significant difference between cooked or boiled, pressure cooked and microwaved samples ($p < 0.05$) even though microwave cooking enhance the quality of legume. The studies have been proved that cooking method can improve the protein digestibility due to inactivation of trypsin inhibitors. Further, research studies have found that pressurized cooking can make beneficial effect on protein digestibility than other cooking methods [14].

Table 2

Method	Crude protein content/g (per 100g)
Raw	26.40±0.01^{c}
Soaked	26.28±0.01^{c}
Germinated (12 h)	29.82±0.00^{a}
Cooked	27.44±0.01^{b}
Pressure cooked	27.39±0.01^{b}
Microwaved	27.41±0.00^{b}

Mean values in a column superscripted by different letters are significantly different at $P < 0.05$.

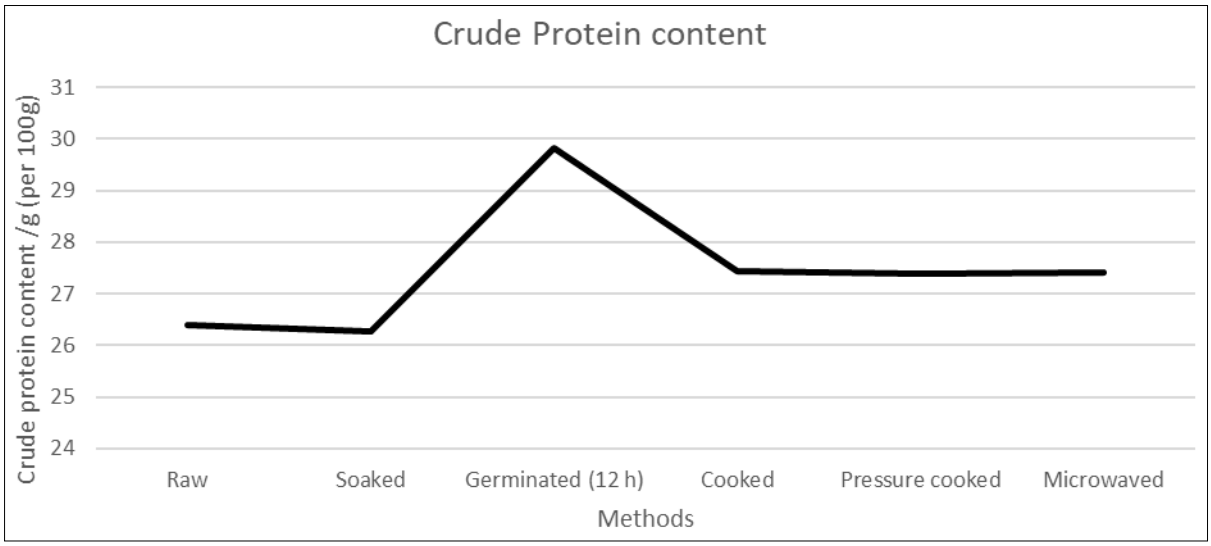

Fig 2: Crude protein content with different processing conditions

The Fig. 2 clearly depicts that germinated Mung beans contained the highest crude protein content that any other sample. Mung beans which were germinated for 12 h (only one type) were selected for processing conditions in order to determine whether there's any detrimental effect on protein content by germination process. Moreover, previous studies have proved that increase in crude protein content during germination may not be due to increment in true protein and non-protein nitrogen also accounted for that. 14.

4. Conclusion

The crude protein content in Mung beans increases with germination time and germinated beans have high protein content than raw Mung beans. Cooking, pressure cooking and microwave cooking reduce the crude protein content while there's no significant difference in protein content between those three methods.

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