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Nutrient composition and sensory evaluation of nutritious supplementary high fiber Laddoo from whole green gram

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Abstract
Protein, carbohydrates, minerals, and B-complex vitamins are all found in good amounts in pulses. Green gram (*Vigna radiata* L.) is one of the pulses that is renowned for its high protein content and ease of digestion. When the green gram's seed coat is dehusked, the amount of fiber it contains decreases. Both the insoluble dietary fiber (IDF) (38.9-65.7 percent) and total dietary fiber (TDF) (34.9-59.6 percent) are significantly reduced when the whole pulses are dehusked to dal. Thus, the husk might offer a substantial quantity of dietary fiber, which is important for managing chronic illnesses. The goal of the current study is to prepare high-fiber laddoo by adding whole green gram in different amounts to make it nutrient-dense and fiber rich. It also aimed to determine the product's acceptability and analyze the dietary fiber content, mineral composition, and proximate composition of laddoo, whole green gram and wheat flour. Results of proximate analysis showed that the moisture, crude fat, crude protein, total ash, crude fiber, carbohydrate, and energy values of wheat and whole green gram flour are comparable to those found in previous researches and published literature. Comparable outcomes were observed for calcium, phosphorus, and total iron levels. Laddoo made with whole green gram also contained good amounts of nutrients. Laddoo containing whole green gram has a high mineral content. Significant amounts of dietary fiber were discovered in the case of laddoo, demonstrating that adding whole pulses to food products can raise their nutrient level and dietary fiber content. Therefore, it was found that adding whole pulses, such as green gram, to food products can improve their nutritional value.

Keywords: Whole green gram, supplementary food, Laddoo

Introduction
Pulses have come to occupy a special place in human nutrition. These are second only to cereals as a source of protein, carbohydrates, minerals and B-complex vitamins. Among the pulses, green gram (*Vigna radiata* L.) is known for its easy digestibility, low flatulence potential and high protein content. Green gram is a pulse crop, grown principally for its protein rich edible seeds and has many common names viz. mung, moong, mungo, golden gram. In India, the name green gram/mung bean is more commonly used. Green gram is a good source of many nutrients including many minerals and various B complex vitamins. They are high in protein, resistant starch and dietary fiber (Singh *et al*., 2017) [13]. Its seed coat is high in crude fiber which is lowered when the seed coat is dehusked. So, the husk may provide a large amount of dietary fiber which plays a significant role in controlling chronic disorders like diverticulitis, bowel cancer, cardiovascular disease, diabetes, constipation etc. Plant foods are the only sources of dietary fiber (Raghuramulu *et al*., 2003) [9].
Mung bean is used in India for the preparation of different food products like dal, sweets, snacks and savoury products. The frequency of consumption of different mung bean products is very high, thus offering the possibility for improved products to contribute significantly to the nutritional status of the local people (Dahiya *et al*., 2013) [2]. In India, mung bean is deshusked and split to produce a food product locally known as dal. Dehusking of the work grain pulses to dal brings a significant reduction in total dietary fiber (TDF) (34.9-59.6%) as well as in insoluble dietary fiber (IDF) (38.9- 65.7%). The fiber present in the husk of whole grain pulses is mainly IDF. The amount of IDF as percentage of TDF constitutes 85-89% in whole grain pulses (Rao and Ramulu, 1998) [10]. "Dietary fiber" refers to the non- digestible residue in foods. Dietary fibers, composed of celluloses, hemicelluloses, pectins, lignins and

other non- digestible materials in the food not amenable to the action of alimentary enzymes of human beings, play a multifaceted role in preventing a number of health disorders through their influence in the gastrointestinal tract (Singh *et al*., 2000) [12]. So, keeping in view the dietary fiber content in pulses, they could be used as a supplementary food in day-to-day food items and provide health benefits.

Objectives of the study are

- To incorporate whole green gram in wheat flour laddoo in varied proportion and assess the acceptability.
- To evaluate the high fiber laddoo for their sensory characteristics.
- To evaluate the proximate composition, mineral composition and dietary fiber content of laddoo, whole green gram and wheat flour.

2. Materials and methods

Source of material

The whole green gram was procured from local market of Pantnagar. Other ingredients of Laddoo i.e. wheat flour, jaggery and ghee were also procured from local market of Pantnagar.

Product formulation

Three types of laddoos were prepared at different levels of ground whole green gram in combination with wheat flour.

Type A: 75:25 i.e. 75 g ground whole green gram and 25 g wheat flour.

Type B: 50:50 i.e. 50 g ground whole green gram and 50 g wheat flour.

Type C: 25:75 i.e. 25 g ground whole green gram and 75 g wheat flour.

In all these three types prepared, 75 g of jaggery and 15 g of ghee per 100 g of total ingredients were used.

Method of preparation: Whole green gram was slightly roasted. After cooling it was then ground in a kitchen mixer. Ghee was heated in a kadhai and wheat flour was roasted and then the ground whole green gram added to it. Then jaggery syrup was prepared which was added to the roasted mixture of wheat flour and whole green gram and mixed thoroughly. Round laddoo were prepared from this mixture.

Sensory quality

Sensory evaluation for all the three types of laddoo was done using sensory score card with parameters color, taste, texture, after taste and overall acceptability by ten voluntary subjects.

Chemical analysis

Chemical analysis of whole green gram, wheat flour and laddoo (most acceptable type selected after sensory evaluation) was done by estimating proximate composition, minerals and total dietary fiber. Among mineral estimation total iron by Wong's method (1928), phosphorus by Fiske and Subba Row method as given in Ranganna (1986) [8] and calcium by method of A.O.A.C. (1975) were done. Total dietary fiber was estimated by method of Asp and.

Statistical analysis

The data obtained was analyzed using general statistical methods viz. computation of percentage, mean and standard deviation. One way ANOVA was used to find out significant difference among various sensory characteristics of laddoo prepared with different level of whole green gram incorporation.

3. Results and discussion

The present study was undertaken with a view to prepare high fiber laddoo by incorporating whole green gram which makes the laddoo nutrient dense and fiber rich. The results obtained are given below:

Sensory evaluation of Laddoo

The acceptability of three types of laddoo prepared was evaluated for sensory attributes by sensory score card.

Table 1: Mean sensory scores of Laddoo (A, B and C).

Type of Laddoo	Color	Texture	Flavour	After taste	Overall acceptability
Type-A	4.1	4.2	4.5	4.5	4.3
Type-B	3.6	3.8	4.0	4.0	3.8
Type-C	3.3	3.3	3.4	3.5	3.1
sem*	.165	.185	.181	.181	.130
cd**(at 5%)	.480#	.538#	.526#	.526#	.378#

*Standard error of mean
**Critical difference
Significant difference
Note: Values are mean of ten observations

On the basis of sensory evaluation it was found that there was significant difference among different parameters like color, texture, flavour, after taste and overall acceptability among three types of laddoo. Type a Laddoo with 75% incorporation of whole green gram was found to be most acceptable one. So it was selected for further nutrient composition and dietary fiber content analysis.

Nutrient composition of Laddoo, Wheat flour and whole green gram

Proximate composition

Moisture

The moisture content of whole green gram was found to be 9.45±0.11%. Slightly higher values reported by Paul *et al*., 2011 [7] of 12.07±0.25g/100g. However, almost similar values were reported by Mubarak, 2005 [6] (9.75%) and Bhatty *et al*., 2000 [1] (8.25%).

Moisture content of wheat flour was found to be 12.15±0.28 %. Comparable values were reported by Gopalan *et al*., 1999 [4] i.e. 12.20 % and Sharma and Prasad, 2002 [11] i.e.12.00%.The moisture content of Laddoo was found to be 10.675±0.11%.

Crude fat

The crude fat content of whole green gram was found to be 1.235±0.02%. Gopalan *et al*., 1999 [4] and Paul *et al*., 2011 [7] quoted crude fat content of whole green gram as 1.3% and 1.53% respectively which are comparable to the results of this study.

Crude fat content of wheat flour was found to be

1.425±0.29%. David *et al*., 2015 [3] quoted the crude fat content of soft wheat as 1.33%. The crude fat content of Laddoo was found to be 15.82±0.39%. Addition of ghee in preparation of Laddoo accounts for higher level of crude fat content in it.

Crude protein

The crude protein content of whole green gram was found to be 21.656±2.16%. Almost similar values were reported by Paul *et al*., 2011 [7] of 21.57±0.18g/100g. Slightly higher values were reported by Mubarak, 2005 [6] (27.5%) and Bhatty *et al*., 2000 [1] (25%).

Crude protein content of wheat flour was found to be 11.131±0.51%. David *et al*., 2015 [3] quoted crude protein content of wheat as 10.23% which is slightly lower than the findings. The crude protein content of Laddoo was found to be 26.135±0.77%. High levels of crude protein seen in laddoo is may be due to incorporation of whole green gram.

Total ash

The total ash content of whole green gram was found to be 3.55±0.07%. Gopalan *et al*., 1999 [4] quoted total ash content of whole green gram as 3.5% which is similar to the findings. Total ash content of whole green gram as quoted by Paul *et al*., 2011 [7] is 3.85±0.05%.

Total ash content of wheat flour was found to be 1.9±0.28%. Gopalan *et al*., 1999 [4] reported the total ash content of wheat flour as 2.7% which is higher than the results. However David *et al*., 2015 [3] quoted the total ash content as 1% in wheat. The total ash content of Laddoo was found to be 2.45±0.07%.

Crude fiber

The crude fiber content of whole green gram was found to be 4.125±0.31%. Gopalan *et al*., 1999 [4] quoted crude fiber content of whole green gram as 4.1% which is similar to the findings. Very low total ash content of whole green gram was quoted by Paul *et al*., 2011 [7] is 0.63±0.01%. The crude fiber value reported by Mubarak, 2005 [6] was 4.63% and Bhatty *et al*., 2000 [1] was1.68%.

Crude fiber content of wheat flour was found to be 1.225±0.11%. Gopalan *et al*., 1999 [4] reported the crude fiber content of wheat flour as 1.9% which is slightly higher than the results. The crude fiber content of laddoo was found to be 2.335±0.41%.

Table 2: Proximate composition of whole green gram, wheat flour and Laddoo

	Moisture (%)	Crude fat (%)	Crude protein (%)	Total ash (%)	Crude fiber (%)	Carbo-hydrate (%)	Energy (Kcal)
Whole green gram	9.475±0.11	1.235±0.02	21.656±2.16	3.55±0.07	4.125±0.31	59.77±2.56	339±2.44
Wheat flour	12.15±0.28	1.425±0.29	11.131±0.51	1.9±0.28	1.225±0.11	72.36±0.98	345±1.73
Laddoo	10.675±0.11	15.82±0.39	26.135±0.77	2.45±0.07	2.335±0.41	40.51±0.21	409±1.33

Note: Values are mean±SD.

Carbohydrate

The total carbohydrate content of whole green gram was found to be 59.769±2.56%. Gopalan *et al*., 1999 [4] quoted carbohydrate content of whole green gram as 56.7%. However slightly higher value reported by Paul *et al*., 2011 [7]; 60.35%, Mubarak, 2005 [6]; 62.3% and Bhatty *et al*., 2000 [1]; 65.86%.

Total carbohydrates content of wheat flour was found to be 72.358±0.98% which is lesser than David *et al*., 2015 [3] i.e. 83.6%. The carbohydrate content of laddoo was found to be 40.51±0.21%.

Energy

The energy value for whole green gram was found to be 339±2.44Kcal. Gopalan *et al*., 1999 [4] and Paul *et al*., 2011 [7] quoted energy value for whole green gram as 334 Kcal and 342.71 Kcal respectively which are comparable to the findings. Energy value for wheat flour was found to be 345±1.73 Kcal which is comparable to Gopalan *et al*., 1999 [4] i.e. 341Kcal. The energy value for laddoo was found to be 409±1.33 Kcal. High level of energy in laddoo was found due to high level of fat content.

Mineral Estimation

Total iron

Total iron in whole green gram was found to be 5.722±0.2 mg/100g. Gopalan *et al*., 1999 [4] quoted total iron of green gram as 7.3mg/100g. Paul *et al*., 2011 [7] quoted the iron content in green gram as 5.04 mg/110g which is comparable to the study findings.

Total iron in wheat flour was found to be 6.162±0.42mg/100g.Total iron content of wheat was reported as 5.30 mg/100g by Gopalan *et al*., 1999. [4] Mallick *et al*., 2013 [5] found the iron content in ten different varieties of wheat in a range from 3.82 to 4.45 mg/100g. The total iron of laddoo was found to be 12.365±0.58mg/100g. Results showed that total iron content is high in laddoo due to addition of jaggery in it.

Phosphorus

Phosphorus content in whole green gram was found to be 298±11.31 mg/100g which is lower than the value quoted by Paul *et al*., 2011 [7] i.e.315.30mg/100g. Phosphorus content in wheat flour was found to be 290±15.5mg/100g.

Calcium

Calcium content in whole green gram was found to be 116±5.65 mg/100g. Dahiya *et al*., 2013 [2] found the calcium content of different mung bean varieties in the range of 81 to 114 mg/100g which are comparable to the findings of this study.

Calcium content of wheat flour was found to be 46.5±2.12 mg/100g. The calcium content of laddoo was found to be 218±2.82mg/100g. High level of calcium found in laddoo as calcium content of green gram is also high.

Table 3: Mineral composition (mg/100g)

	Total iron	Phosphorus	Calcium
Green gram	5.722±0.2	298±11.31	116±5.65
Wheat flour	6.162±0.42	290±15.5	46.5±2.12
Laddoo	12.365±0.58	316.5±9.19	218±2.82

Note: Values are mean±SD.

Dietary fiber estimation

Table 4: Dietary fiber content (%)

	Total dietary fiber	Insoluble dietary fiber	Soluble dietary fiber
Green gram	26.041±0.2	20±0.3	6.041±0.1
Wheat flour	9.382±0.4	6.625±0.1	2.757±0.6
Laddoo	7.892±0.7	6.125±0.9	1.767±0.4

Note: Values are mean±SD.

The total dietary fiber (TDF) content of whole green gram was found to be 26.041±0.2% of which insoluble dietary fiber (IDF) is20±0.3% and soluble dietary fiber (SDF) is 6.041±0.1%. Sudhakaran and Bukkan, 2021 [14] quoted dietary fiber content by different researchers as; 13% IDF 3.21% SDF, 16.21% TDF, 13.93% IDF 0.64% SDF, 14.57% TDF by Lin and Lai (2006), 26.9% IDF 4.8% SDF, 31.7% TDF and 14.59% IDF 2.44% SDF, 17.03% TDF. Result showed that majority of fiber in green gram is insoluble dietary fiber that contributes to its health benefits.
The TDF content of wheat flour was found to be 9.382±0.4% of which IDF is 6.625±0.1% and SDF is2.757±0.6 %. The TDF content of laddoo was found to be 7.892±0.7%, of which IDF is 6.125±0.9% and SDF is 1.767±0.4%.

4. Summary and Conclusion

The present study was undertaken with the objective to prepare high fiber laddoo by incorporating whole green gram in varied proportion and assess the acceptability and to evaluate the proximate composition, mineral composition and dietary fiber content of laddoo, whole green gram and wheat flour. On basis of sensory evaluation, laddoo with maximum level of whole green gram incorporation i.e. 75% level of incorporation, found to be most acceptable. Results of proximate analysis have shown comparable levels of moisture, crude fat, crude protein, total ash, crude fiber, carbohydrate and energy values of whole green gram and wheat flour with the values reported in literature and earlier findings. Similar results were found for values of total iron, calcium and phosphorus. Good amounts of nutrients were also found in laddoo incorporated with whole green gram. A high level of minerals found in laddoo with whole green gram incorporation. Appreciable amounts of dietary fiber also found in laddoo. So, it was found that whole pulses like green gram can be used to enhance the nutritional quality and dietary fiber content by incorporating them in food products.

5. Recommendation

Further more food products could be developed with supplementation of green gram. Analysis of different nutrients and antinutritional factors could be done of green gram and supplemented food products.

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