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Physico-Chemical Characteristics of Legume Seed Coat Fibre

Mamata Mannuramath[1], Jamuna K. V[2]

Department of Food Science and Nutrition, University of agricultural Sciences, Bengaluru, India

Abstract: ***Six different legume samples were selected for the study. Legumes were dehusked, processed and used for further experiment. The husk percentage of greengram, bengalgram, blackgram, redgram, soy bean and dolichos was 6.16, 9.90, 6.30, 9.32, 8.40 and 17.2 respectively. The SDF in present study ranged from 1.08 to 12.82 per cent. IDF content was observed in the range of 63.01 to 77.61 per cent. The TDF ranged from 64.82 to 85.99 per cent. A significant difference between treated and untreated samples (P ≤0.05) in the TDF content of the seed coat samples was observed. Total phenols content of samples ranged from 0.013 to 0.510 per cent. The phytic acid content of seed coat samples in present study ranged from 1.13 to 4.13 g/100g. Highest solubility index was observed in acid treated samples (11.62%) and lowest in alkali treated (7.32). Swelling power was highest in raw samples (5.93%) than the treated samples. The highest water absorption capacity was observed to be 3.8 g/g in the raw blackgram and dolichos seed coat. Fat absorption capacity was observed to be highest in the raw samples (4.03 g/g) than the treated samples followed by acid treated (3.76 g/g). Results revealed that seed coats are rich source of fibre.***

Keywords: Legume Seed Coat, Fiber, total phenols, phytic acid, swelling capacity, water absorption capacity

1. Introduction

Legumes, the edible portion of leguminous crops, are rich food source of dietary fibres that promote various beneficial physiological effects for human health [1]. The most common legumes for human consumption are chick pea, redgram, greengram, pea, soybean, blackgram etc. They are consumed after simple processing, as dhal, cooked grains etc. Seed coats and brans which are the by-products of dhal mills are used as animal feed or discarded as a waste but these can be effectively used as potent source of dietary fibre for human consumption. Dietary fibre has protective effect against a range of diseases, as constipation, diverficular disease, large bowel cancer, diabetes, coronary heart disease, obesity and gallstones. Hyper-cholesterolemia has moved to the forefront as a major risk factor for coronary heart disease which is emerging as the world's major health problem. Pectin, cellulose, some fruits and vegetables have been studied for their hypolipidemic properties but unconventional sources like grain husks still need exploitation. Compared to legume seed coats, cereal brans are high in protein and fat content. The dietary fibre content of cereal bran and legume seed coat is almost similar, which varies according to the species, the variety and processing of legume seeds. Legumes contain dietary fibre in the range from 8 to 27.5 percent, with soluble fibre in the range 3.3-13.8 percent. The present study was undertaken to know the physico-chemical characteristics of different legume seed coats.

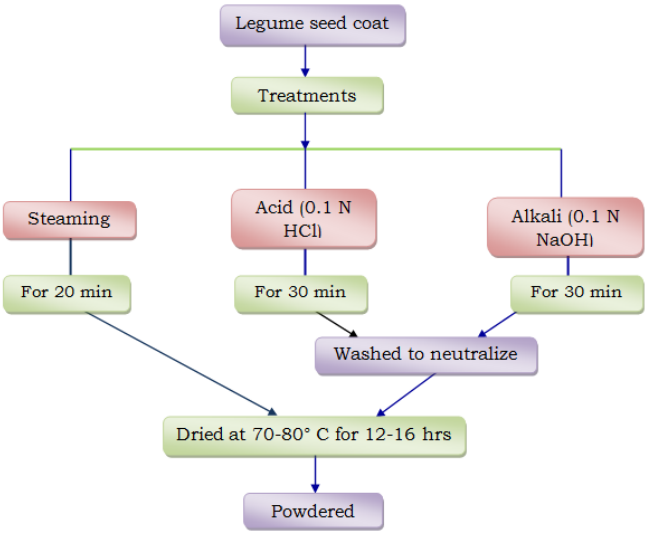
2. Materials and Methods

Six different legume samples namely Greengram (*Phaseolus aureus*), Redgram (*Cajanus cajan*), Bengalgram (*Cicer arietnum*), Blackgram (*Vigna mungo Roxb*), Soybean (*Glycine max merr*) and Dolichos (*Dolichos lablab*) were selected for the study. Redgram, soy bean and dolichos were procured from the AICRP Schemes, GKVK, UAS, Bengaluru and greengram, bengalgram and blackgram were procured from local market.

Dehusking of the legumes: The legumes were soaked for 5-6 hr and dried in sunlight. Dried samples were dehusked in dhal milling machine at the Department of Food Science and Nutrition. The seed coat was separated, cleaned and collected for further experiment. Husk percentage was calculated as follows;

$$\text{Husk percentage} = \frac{\text{Weight of the Husk}}{\text{Weight of the legume sample}} \times 100$$

2.1 Processing of Legume Seed Coat



2.2 Analysis of Chemical Composition of Processed Seed Coat Samples

The legume seed coat samples were subjected to chemical analysis namely: moisture, protein, fat [2]. Total phenols and phytic acid by [3] and total dietary fibre by [2].

2.3 Functional Properties

Water absorption capacity, oil absorption capacity, swelling power and solubility index were studied for both processed and unprocessed legume seed coat samples.

Water and oil absorption capacity was carried out using method given by [4]. One gram sample was mixed with 10ml of either distilled water or in 15 ml oil for 30minutes. The contents were allowed to stand at 30°C in a water bath for 30 minutes and then centrifuged at 3000 – 5000rpm for 20 – 30 minutes. After centrifuging the volume of the supernatant was recorded and used for determination of water absorption and the results were expressed as g/g sample.

Swelling power and solubility index was carried out using method given by [5]. About 500 mg (dry basis) (db) of sample was cooked in about 20 ml of water at about 100°C for 30 min. They were weighed and made equivalent to 25 g by the addition of water. They were centrifuged at 3000 rpm for 15 min. Supernatant was decanted carefully and kept, and residue was weighed for swelling power determination. 10 ml of the supernatant was pipetted out to a wide-mouth Petri dish (of known weight) and kept on a boiling water bath for evaporation. Afterwards, the dish was dried at 105 °C for 3 h, cooled, and weighed. Solubility and swelling power was estimated with the following

$$\text{Swelling power} = \frac{\text{Wt of the wet residue — Wt of the dried sample}}{\text{Wt of sample on db (mg)}}$$

$$\text{Solubility index} = \frac{\text{Wt of the dry residue (mg) X 2.5X 100}}{\text{Wt of sample on db (mg)}}$$

All the analysis was carried out in duplicates. Statistical analysis was done using one way ANOVA.

3. Results and Discussion

The husk percentage of different legumes has been presented in the Fig 1. The husk percentage of greengram, bengalgram, blackgram, redgram, soy bean and dolichos was 6.16, 9.90, 6.30, 9.32, 8.40 and 17.2 respectively. A husk percentage of 8 in legumes namely redgram *(Cajanus cajan*), greengram *(Vigna radiate)* and blackgram (*Vigna mungo*) which is found to be on par with the present study has been reported by [6].

In the present study moisture content of legume seed coats of greengram, bengalgram, blackgram, redgram, soy bean and dolichos was observed to be10.73, 13.88, 8.61, 9.55, 9.20 and 11.21 per cent respectively. The per cent total dietary fibre (TDF), soluble dietary fibre (SDF) and insoluble dietary fibre (IDF) has been presented in Table 1. The SDF in present study ranged from 1.08 to 12.82 per cent. The highest SDF was observed in acid treated samples and lowest in raw. The highest SDF was observed in acid treated bengalgram and lowest was observed in untreated blackgram seed coat. Generally it is observed that the treatments had positive effect on SDF content of legume seed coat. Treatments (steaming, acid and alkali) might have led to an increase in SDF values due to the redistribution of IDF into fibre fractions due to increased solubility. In soybean seed coat SDF content was not affected by treatments. IDF content was observed in the range of 63.01 to 77.61 per cent. The highest IDF was observed in raw bengalgram seed coat than treated samples and lowest in acid treated blackgram sample. Increase in IDF content was observed to be high in steaming (1.33 to 11.11%) than the raw. The total dietary fibre content in bengalgram and greengram seed coat was observed to be 84.2 and 74.7per cent respectively [7]. Similar trend was observed in the present study. The TDF ranged from 64.82 to 85.99 per cent. A significant difference between treated and untreated samples ($P \leq 0.05$) in the TDF content of the seed coat samples was observed. The highest TDF content was observed in steamed greengram seed coat (85.99%) and lowest was observed in alkali treated blackgram seed coat (64.93%). Generally, treatments had positive effect on TDF. Acid treatment increased the TDF content than the other two treatments.

Per cent total phenol and phytic acid content of legume seed coat samples has been presented in the Table 2. Total phenols content of samples ranged from 0.013 to 0.510 per cent. Phenol content of raw samples (0.199) was higher compared to treated samples. Phenol content of legume seed coat samples decreased due to the treatments. The highest reduction of phenols was observed in the alkali treated (84.3%) samples followed by acid treatment (73.0%). The lowest reduction was observed in the steam treated samples (55.5%). The greengram seed coat showed lowest phenol content and blackgram seed coat showed highest phenol content followed by redgram seed coat.

The phytic acid content of seed coat samples in present study ranged from 1.13 to 4.13 g/100g. The phytic acid content was lower in treated samples compared to the untreated samples. The results of the present study are in agreement with the reported values. The lowest phytic acid content was observed in the bengalgram seed coat sample (1.31-1.69 g/100). The highest was observed in the redgram (3.18 - 4.13g/100g) followed by greengram seed coat. The highest reduction of 21 per cent was observed in the alkali treated samples followed by acid treated (20%). The lowest reduction was observed in the steam treated samples (6%).

The per cent protein and fat content of legume seed coat samples has been presented in Table 3. The protein content of the legume seed coats ranged from 2.87 to 14.53g percent of the seed coat. Soy bean seed coat contained highest protein (10.48-14.53%) followed by blackgram seed coat and bengalgram lowest (2.87-3.49%) than the other samples. The fat content of seed coat ranged from 0.05 to 1.79 per cent. The fat content of the steam treated samples had increased to 0.89 per cent followed by 0.73 per cent in the acid treated samples. The highest fat content was observed in the soy bean seed coat samples

which may be attributed to the higher fat content in the grain itself (19.5%).

Solubility index ranged from 6.30 to 15.86 per cent (Table 4). Highest solubility index was observed in acid treated samples (11.62%) and lowest in alkali treated (7.32). The highest solubility index was observed in blackgram seed coat (12.75%) as it is low in fibre content than the other seed coats. The lowest was observed in the dolichos seed coat (8.73%) followed by greengram seed coat (9.62%). Swelling power was highest in raw samples (5.93%) than the treated samples (Table 5). Swelling power decreased due to treatments. It was observed to be highest in the untreated blackgram seed coat (6.74%) and lowest was observed in acid treated bengalgram seed coat (4.15%). Per cent water absorption capacity of legume seed coat samples has been presented in Table 6. It may be observed that raw samples had high water absorption capacity than treated samples.

The highest water absorption capacity was observed to be 3.8 g/g in the raw blackgram and dolichos seed coat. Lowest was observed in the steamed greengram seed coat (3.0 g/g). The variation in the water absorption capacity may be attributed to their granule size and structure. Bengalgram seed coat was found to have a high water absorption capacity followed by dolichos. Greengram had the lowest water absorption capacity. It is evident from Table 7 that fat absorption capacity was observed to be highest in the raw samples (4.03 g/g) than the treated samples followed by acid treated (3.76 g/g). Lowest was observed in alkali treated seed coat samples (3.46 g/g). The highest was observed in raw soy bean sample (4.8g/g) and lowest was observed in alkali treated greengram seed coat (2.9 g/g).

4. Conclusion

The findings of the present study revealed that legume seed coat which is a good source of dietary fibre can be successfully incorporated in the products and further confirm through ethical clinical studies.

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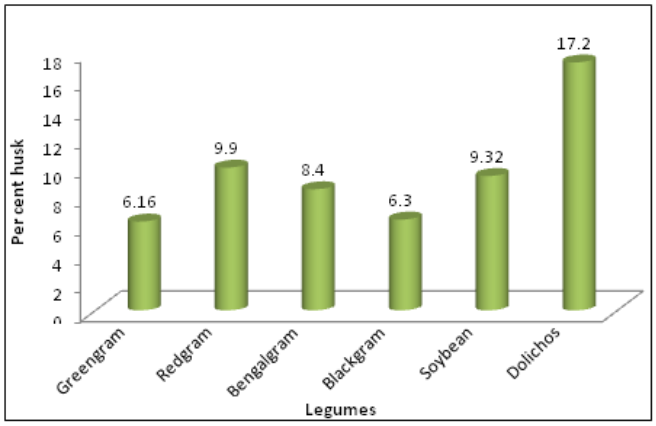

Figure 1: Husk percentage of legume samples

Table 1: Total, Soluble and Insoluble Dietary Fibre content of legume seed coat samples

Legume seed coat samples	Total Dietary Fibre (TDF) per cent				Soluble Dietary Fibre (SDF) per cent				Insoluble Dietary Fibre (IDF) per cent			
	Treatments				Treatments				Treatments			
	Raw	Steam	Acid	Alkali	Raw	Steam	Acid	Alkali	Raw	Steam	Acid	Alkali
Greengram	77.35	85.99 (11.1)	85.91 (11.00)	85.353 (10.3)	05.56	09.35 (68.32)	09.60 (72.82)	07.83 (40.99)	71.79	76.64 (6.76)	76.30 (6.28)	77.53 (8.00)
Bengalgram	84.18	85.24 (1.33)	84.43 (0.37)	83.617 (0.60)	06.50	08.79 (35.23)	12.82 (97.29)	10.01 (53.92)	77.61	76.45 (1.50)	72.51 (6.58)	73.61 (5.15)
Blackgram	70.86	65.82 (7.12)	64.98 (8.30)	64.930 (8.37)	01.08	01.28 (18.52)	01.97 (82.41)	01.82 (68.70)	69.78	65.05 (6.79)	63.01 (9.70)	63.11 (9.56)
Redgram	79.01	83.38 (1.4	79.62 (1.4	81.72 (0.0	6.12	08.19	07.06 (13.	06.73 (17.	72.89	75.19 (3.1	72.56 (0.46)	74.99 (2.8

		4)	8)	5)			8)	86)		6)		9)
Soy bean	75.77	77.72 (2.57)	77.92 (2.83)	77.726 (2.58)	05.62	05.18 (7.83)	05.64 (0.30)	05.23 (7.03)	70.07	72.54 (3.53)	72.28 (3.16)	72.50 (3.47)
Dolichos	74.87	79.30 (2.39)	79.07 (2.67)	78.031 (3.95)	04.80	05.74 (19.67)	04.29 (10.63)	06.03 (25.52)	70.07	72.28 (3.16)	74.78 (6.72)	72.01 (2.77)
Mean	78..40	79.39	78.70	78.47	5.29	6.23	6.84	06.17	72.04	73.03	71.91	72.29
F value	*				*				*			
SEm±	0.250				0.024				0.235			
CD (P=0.05)	0.711				0.067				0.668			

*significant at P≤0.05

Table 2: Per cent total phenols and phytic acid content of legume seed coat samples

Legume seed coat samples	Total phenol				Phytic acid			
	Treatments				Treatments			
	Raw	Steam	Acid	Alkali	*Raw*	*Steam*	Acid	Alkali
Greengram	0.095	0.070 (26)	0.028 (70)	0.022 (77)	3.19	2.44 (6)	2.63 (18)	3.00 (24)
Bengalgram	0.170	0.028 (84)	0.030 (82)	0.034 (80)	1.69	1.50 (11)	1.31 (22)	1.31 (22)
Blackgram	0.510	0.225 (56)	0.040 (92)	0.013 (97)	2.81	2.63 (7)	2.25 (20)	2.63 (17)
Redgram	0.300	0.079 (74)	0.095 (68)	0.006 (99)	4.13	3.94 (5)	3.19 (23)	3.38 (19)
Soy bean	0.080	0.089 (11)	0.049 (39)	0.018 (77)	2.63	1.88 (7)	2.25 (14)	2.44 (29)
Dolichos	0.230	0.040 (82)	0.030 (87)	0.048 (79)	2.44	2.44 (0)	1.88 (23)	2.06 (15)
Mean	0.199	0.120 (55.5)	0.045 (73.0)	0.24 (84.8)	2.81	2.47 (6)	2.25 (20)	2.54 (21)
F value	*				*			
SEm±	0.001				0.008			
CD (P=0.05)	0.003				0.022			

*significant at P≤0.05
Values in parenthesis indicates per cent reduction

Table 3: Per cent protein and fat content of legume seed coat samples

Legume seed coat samples	Protein				Fat			
	Treatments				Treatments			
	Raw	Steam	Acid	Alkali	*Raw*	*Steam*	*Acid*	*Alkali*
Greengram	08.05	10.32	12.25	09.63	00.24	00.73	00.73	00.21
Bengalgram	02.87	03.49	02.96	03.32	00.05	00.16	00.30	00.08
Blackgram	10.65	11.19	13.12	11.02	00.53	00.96	00.41	00.61
Redgram	05.40	07.16	05.76	05.76	00.83	01.23	01.40	01.00
Soy bean	10.65	14.53	13.09	10.48	01.33	01.79	1.26	00.94
Dolichos	08.11	09.73	08.23	07.87	00.40	00.47	00.28	00.38
Mean	7.62	9.40	9.24	8.01	0.56	0.89	0.73	0.53
F value	*				*			
SEm±	0.049				0.031			
CD (P=0.05)	0.138				0.088			

*significant at P≤0.05

Table 4: Per cent solubility index of the legume seed coat samples

Legume seed coat samples	*Solubility index*			
	Treatments			
	Raw	*Steam*	*Acid*	*Alkali*
Greengram	10.39	11.03	10.29	06.81
Bengalgram	10.32	09.69	12.49	08.80
Blackgram	13.02	15.86	14.74	07.68
Redgram	13.04	10.09	10.37	07.22
Soy bean	12.99	10.03	12.82	07.44
Dolichos	08.81	10.77	09.08	06.30
Mean	11.42	11.23	11.62	7.32
F value	*			
SEm±	0.031			
CD (P=0.05)	0.089			

*significant at P≤0.05

Table 5: Per cent swelling power of the legume seed coat samples

Legume seed coat	*Swelling power*			
	Treatments			
	Raw	*Steam*	*Acid*	*Alkali*
Greengram	5.26	5.47	5.81	5.53
Bengalgram	5.57	4.83	4.15	4.53
Blackgram	6.74	6.11	5.82	6.01
Redgram	5.31	5.37	5.38	5.94
Soy bean	6.51	5.34	6.20	5.63
Dolichos	6.24	6.26	6.46	6.10
Mean	5.93	5.56	5.63	5.61
F value	*			
SEm±	0.056			
CD	0.016			

*significant at P≤0.05

Table 6: Water absorption capacity of the legume seed coat samples

Legume seed coat samples	*Water absorption capacity (g/g)*			
	Treatments			
	Raw	*Steam*	*Acid*	*Alkali*
Greengram	3.4	3.0	3.2	3.2
Bengalgram	3.7	3.4	3.6	3.5
Blackgram	3.8	3.6	3.2	3.0
Redgram	3.7	3.6	3.1	3.6
Soy bean	3.6	3.5	3.6	3.1
Dolichos	3.8	3.3	3.3	3.6
Mean	3.7	3.4	3.3	3.4
F value	*			
SEm±	0.041			
CD (P=0.05)	0.1174			

*significant at P≤0.05

Table 7: Fat absorption capacity of the legume seed coat samples

Legume seed coat samples	Fat absorption capacity (g/g)			
	Treatments			
	Ra	Stea	Acid	Alkali
Greengram	3.6	3.2	3.5	2.9
Bengalgram	4.3	4.1	4.2	3.6
Blackgram	3.9	3.7	3.4	3.7
Redgram	4.2	3.3	4.0	3.3
Soy bean	4.8	4.4	4.6	4.2
Dolichos	3.4	3.2	2.8	3.1
Mean	4.0	3.7	3.8	3.5
SEm±				
CD (P=0.05)	0.026			
	0.074			

*significant at P≤0.05