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Effect of Germination Periods and Heat Treatments on Fiber Fractions in Germinated Legumes

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Abstract

The effect of germination time and heat treatments on fiber fractions was studied in three legumes i. e. mungbean, chickpea and cowpea. Optimized germination time was 12, 16 and 20 h for mungbean; 36, 48 and 60 h for chickpea and 16, 20 and 24 h for cowpea. Germination periods resulted in a greater increase i. e. 20.2-52.1 5 in the neutral detergent Fiber (NDF) fraction comprising cellulose, hemicellulose and lignin. The NDF content increased significantly with an increase in germination periods in all the three legumes. Both cellulose and hemicellulose increased after germination, the percent for cellulose being 16.4 to 47.6%. Increase in hemicellulose on germination ranged between 22. 3 to 51.2% in three legumes. Cellulose content after pressure cooking increased by 6.1 to 13.0% for three legumes. Hemicellulose increased by 8.7, 1.9 and 15.5% after pressure cooking the raw sproutsof mungbean, chickpea and cowpea, respectively. The corresponding values for microwaving were 15.6, 7.1 and 14.4%. The lignin content decreased after soaking and germination. The lignin content reduced from 8.1 to 27.5% during germination. A significant reduction in lignin was observed with an increase in germination periods. A non-significant difference in the lignin content of three legumes was observed when raw sprouts were compared with pressure cooked and microwaved sprouts. The results concluded that longer germination periods i.e. 20h for mungbean, 60 h for chickpea and 24h for cowpea followed by pressure cooking for optimized time enhanced the cellulose and hemicelulose to a significant level.

Key words : Germination period, Heat treatments, Fibre fractions, Leguminous sprouts.

Legumes have always been an integral part of Indian dietary system and contribute valuable nutrients. Legumes not only add variety to human diet, but also serve as an economical source of supplementary proteins for a large human population in developing countries like India where majority of the population are vegetarian (1). Legumes are good source of proteins, minerals, B-vitamins, dietary fiber and complex carbohydrates. Legumes are high in both soluble and insoluble dietary fiber. Soluble fiber slows the absorption of glucose, reduces blood cholesterol levels and decreases rates of heart disease. Insoluble fiber prevents digestive problems, helps in weight management, decreases constipation and may lower the risk of colon and rectal cancers, heart diseases and type II diabetes (2). Therefore, health promoting effect of dietary fiber present in legumes has generated interest in legumes. Nutritional quality of legumes can be enhanced by three approaches viz., biotechnology, processing and fortification. Processing technologies should help to transform raw grains into useful products with maximum nutritional value to ensure nutrient security of population for developing countries. With the aim of improving the nutritive value of legumes, preparation techniques have been developed to significantly raise the bioavailability of nutrients. Such techniques include germination. Germination is simple, inexpensive and improves the palatability, digestibility and availability of certain nutrients. However, the effect of germination depends on the type of legume and on the conditions and duration of the germination process (3).The legume sprouts is a popular vegetable in China and Southeast Asia and is often used in meals. They have become increasingly popular in restaurant salad bars and US kitchens particularly with health enthusiasts as these are rich in vitamins and low in carbohydrates (4), however sprouts are not well known in India where a vast potential for its commercial production, consumption and export exists. Sprout production is a simple germination process that requires neither sunlight nor soil. It has no season limitation. The process is completed in short period. The sprout production is extremely inexpensive, requiring only

Table 1. Optimized germination periods for legumes.

Legumes	Weight of sample (g)	Size of petri dish, (m/m)	Temperature ^{0}C	Soaking period (h)	Germination period (h) 1	2	3
Mungbean	100	200	25	10	12	16	20
Chickpea	100	200	25	12	36	48	60
Cowpea	100	200	25	8	16	20	24

seeds, sprouting containers and water as inputs. It can therefore, be practical even by poor farmers in augmenting their meager resources. It has a potential of being introduced as a vegetable and as a method of product diversification. The legume sprouts serve as a good alternative vegetable and source of income. This is especially true during the hot summer and rainy seasons when there is acute shortage of fresh vegetables. While several kinds of legumes may be eaten as sprouts, mungbean, chickpea and cowpea are commonly used and preferred beans for sprouting. Keeping in view the health benefits of sprouts, establishing optimal germination period followed by appropriate heat treatment to improve fiber content of commonly consumed legumes holds a great significance.

Table 2. Optimized heat treatments for legumes.

Legume	Weight of sprouts (g)	Time heat treatment (min) Pressure cooking at 15 lb pressure	Microwave cooking at 800W	Sprout : Water ratio Pressure cooking and microwave cooking
Mungbean	250	1	7	1 : 0.24
Chickpea	250	5	15	1 : 0.60
Cowpea	250	1	7	1 : 0.20

Methods

Mungbean, chickpea and cowpea seeds were procured from the Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana,

Table 3. Effect of germination period on fiber fractions in legumes (g/100g dry matter). Values in parentheses are percent change in comparison to raw samples. NDF : Neutral detergent fiber, ADF : Acid detergent fiber. NS = Non-significant.

Germination period	NDF	ADF	Lignin	Cellulose	Hemicellulose
Mungbean					
Raw	20.75	9.30	0.91	8.39 (9.6)	11.45
Soaked	22.7 (4.3)	10.60 (13.9)	0.81 (–10.9)	9.65 (15.1)	12.15 (6.1)
Germinated (h)					
12	24.95 (20.2)	10.95 (17.7)	0.76 (–16.5)	10.19 (21.4)	14.00 (22.3)
16	26.95 (29.8)	11.75 (26.3)	0.68 (–25.3)	11.07 (31.9)	15.50 (32.7)
20	28.95 (39.5)	12.60 (35.4)	0.66 (–27.5)	11.93 (42.2)	16.35 (42.8)
CD at 5%	1.14	0.88	0.07	–	–
Chickpea					
Raw	18.40	7.65	0.84	6.81	10.75
Soaked	19.65 (6.7)	8.45 (10.4)	0.83 (–1.2)	7.62 (11.9)	11.20 (4.2)
Germinated (h)					
36	23.10 (25.5)	9.00 (17.6)	0.77 (–8.3)	7.93 (16.4)	14.40 (33.9)
48	25.25 (37.2)	8.70 (13.7)	0.67 (–20.2)	8.24 (21.0)	16.25 (51.2)
60	28.0 (52.1)	9.25 (20.9)	0.65 (–22.3)	8.58 (25.9)	18.75 (74.4)
CD at 5%	0.99	0.68	0.07	–	–
Cowpea					
Raw	19.15	8.05	0.86	7.23	11.10
Soaked	21.15 (10.4)	9.00 (11.8)	0.82 (–4.6)	8.14 (12.6)	12.15 (9.4)
Germinated (h)					
16	24.15 (26.1)	10.05 (24.8)	0.79 (–8.1)	9.26 (28.1)	14.10 (27.0)
20	25.15 (31.3)	10.75 (33.5)	0.78 (–9.3)	9.9 (37.9)	14.40 (29.7)
24	27.05 (41.2)	11.40 (41.6)	0.73 (-15.1)	10.67 (47.6)	15.65 (40.9)
CD at 5%	1.15	0.58	0.03	–	–

Table 4. Effect of heat treatment on fiber fractions of legume sprouts (g/100g dry matter). Values in parentheses are percent change in comparison to raw samples. NDF : Neutral detergent fiber, ADF : Acid detergent fiber. NS = Non significant.

Heat treatment	NDF	ADF	Lignin	Cellulose	Hemicellulose
Mungbean					
Raw	26.95 ± 1.87	11.80 ± 0.85	0.76	11.1	15.15
Pressure cooking	26.88 ± 1.94	10.40 ± 0.84	0.72	9.68	16.48
	(0.3)	(11.8)	(5.2)	(12.8)	(8.7)
Microwaving	27.42 ± 1.95	9.90 ± 0.50	0.75	9.15	17.52
	(1.7)	(16.1)	(–1.3)	(17.5)	(15.6)
CD at 5%	NS	1.59	NS	–	–
Chickpea					
Raw	25.45 ± 2.24	9.0 ± 0.38	0.74	9.56	15.15
Pressure cooking	25.15 ± 0.82	10.30 ± 0.55	0.72	8.98	15.45
	(1.2)	(21.1)	(–2.7)	(6.1)	(1.9)
Microwaving	25.22 ± 0.90	9.70 ± 0.86	0.69	8.31	16.22
	(0.9)	(7.7)	(–6.7)	(13.0)	(7.1)
CD at 5%	0.99	1.33	NS	–	–
Cowpea					
Raw	25.45 ± 1.47	10.70 ± 0.66	0.77	9.80	14.75
Pressure cooking	26.65 ± 0.92	9.60 ± 0.73	0.72	8.78	17.05
	(4.5)	(10.2)	(–6.5)	(10.4)	(15.5)
Microwaving	26.57 ± 1.48	9.70 ± 0.56	0.75	8.80	16.87
	(4.4)	(9.3)	(–2.6)	(9.9)	(14.4)
CD at 5%	NS	1.39	NS	–	–

Punjab, India. The seeds were germinated in seed germinator and then subjected to heat treatments under optimized conditions (Tables 1 and 2).

The samples were dried in hot air oven at 60C. The dried samples were ground into fine powder form and preserved in zip-lock bags for chemical analysis. Neutral detergent fiber (NDF), Acid detergent fiber (ADF) and lignin were estimated by the method given by Goering and Van Soest (5). Neutral detergent solution (NDS) solublizies all the components except neutral detergent fiber (NDF) of food. Neutral detergent fiber gives cellulose, hemicelluloses and lignin. Acid detergent fiber is treated with acid detergent solution (ADS) in which hemicellulose is solublized. The residue (ADF) is consisting of cellulose and lignin, the ADF is treated with 72% H_2SO_4. Lignin is obtained as residue.

Hemicellulose = NDF-ADF
Cellulose = ADF-Lignin

The average and standard deviation were computed from nine replications, three each of raw, pressure cooked and micro waved sprouts. Analysis of variance was used to determine the variation between samples of different germination periods and heat treatments. Critical difference (CD) at 5% was calculated where *F*-ratio was significant.

Results and Discussion

Effect of germination periods and heat treatment on fiber fractions of legume sprouts is shown in Tables 3,4 and 5 Neutral detergent fiber (NDF) fraction comprising of cellulose, hemicellulose and lignin was 20.75, 18.40 and 19.15g/100g in mungbean, chickpea and cowpea, respectively. Soaking resulted in an increase of 4.3 to 10.4% while germination periods resulted in a greater increase i.e. 20.2 to 52.1%. The NDF content increased significantly ($P \leq 0.05$) with an increase in germination period in all the three legumes. No significant ($P \leq 0.05$) change was observed when two heat treatments were given to raw sprouts.

Cellulose fraction calculated from difference between acid detergent fiber (ADF) and lignin was found to be 8.39, 6.81 and 7.23g in mungbean, chickpea and cowpea, respectively. The corresponding values for hemicellulose calculated from the difference between NDF and ADF were 11,45, 10.75 and 11.10g. Cellulose increased after soaking, the increase being 11.9 to 15.1%. Both cellulose and hemicellulose increased after germination, the percent increase for cellulose being 16.4 to 47.6%. Increase in hemicellulose on germination ranged between 22.3 to 51.2% in three legumes. The results revealed that as the germination progressed, the insoluble dietary fiber fraction cellulose and partially soluble fraction hemicellulose increased. Cellulose content after pressure cooking increased by 6.1 to 13.0% for three legumes. Hemicellulose increased by 8.7, 1.9 and 15.5% after pressure cooking the raw sprouts of mungbean, chickpea and cowpea, respectively. The corresponding values for microwaving were 15.6, 7.1 and 14.4%.

The insoluble fraction lignin content was highest in mungbean (0.91g) followed by cowpea (0.86g) and chickpea (0.84 g). The lignin content decreased after soaking and germination in three legumes, the percent decrease during soaking was between 1.19 to 10.98. The lignin content reduced from 8.1 to 27.5% during germination. A significant ($P \leq 0.05$) reduction in lignin was observed with an increase in germination period. A non-significant difference in the lignin content of three legumes was observed when raw sprouts were compared with pressure cooked and microwaved sprouts. NDF contents of 12.7 g/ 100g was observed in chickpea which was increased by 25% in open pan and 17.3% in pressure cooking (6). An increase in NDF was probably due to formation of new components such as millard products formed from condensation of protein and tannins which might be isolated as fiber. Kawale et al. (7) observed an increae in insoluble dietary fiber by 3.8 to 4.5% when kidney beans and horsegram were boiled and stained. Barakoti (8) and Deol (9) reported that NDF content increased with germination and cooking. The results of present study are in line with those reported in literature.

The results concluded that longer germination periods i.e. 20h for mungbean, 60 h for chickpea and 24h for cowpea followed by pressure cooking for optimized time enhanced the cellulose and hemicellulose to a significant level.

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