ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 6, December 2014

Development of High Protein Biscuits Using Pigeon pea Brokens Flour

Silky, M.P. Gupta and Avinash Tiwari
Ph.D. Food Technology Scholar, Jiwaji University, Gwalior, M.P.
Dr. M.P. Gupta, Red. Prof. (Dairy Technology) D.D. Upadhyay Veterinary University, Mathura, U.P.
Dr. Avinash Tiwari Prof. (Botany), Jiwaji University, Gwalior, M.P.

Abstract - High protein biscuits were developed form the blends of refined flour and pigeon pea brokens flour for human consumption. The incorporation of pigeon pea brokens flour increased the contents of proximate compositional constituents of refined flour. The results of sensory evaluation showed that the incorporation of pigeon pea brokens flour in blends of refined flour upto 20 percent for developing high protein biscuits was found most suitable. It was found that 20 percent inclusion of pigeon pea flour in refined flour increased 25 percent protein, 3 fold crude fibre and 2 fold in ash content of biscuits.

I. INRODUCTION

Cereal grains are a major component of man's diet throughout the world. On a world wide scale, about 70 per cent of the protein available for human consumption is derived from plant sources, whereas for India, the figure is about 90 per cent [1]. Moreover, cereals proteins are deficient in essential amino acid lysine and those of legumes in sulphur containing amino acids. Besides economic concern, the flour undergoes a substantial reduction in nutritional value as nutrients rich bran and germ are separated out from the starchy endosperm. However, by blending pigeon pea broken flour with refined flour, a nutritionally balanced blend can be prepared as the cereals and pulses supplement the protein quality of each other. Almost all of the legumes specially pigeon pea go to milling industry before they are utilized. On this basis, it is estimated that roughly 0.82 million tonnes of dhal mill by-products (broken) are produced annually. In recent years, there has been a considerable shift in the consumer's perception of foods due to changing lifestyle, modernization, increased woman empowerment, increased per capita income and newer marketing strategies employed by major food manufacturer. Most consumers demand convenience food, ready to eat snacks or food which add bulk and satisfy appetites without taking up preparation times. On the other hand consumers have increasingly shown interest in a trend of healthy life-styles which has created demand for health oriented convenience foods and products. Global Industry Analysts, Inc., (GIA) in a recently concluded off-the-shelf market research stated that the global baking industry is currently facing opportunities as well as changes created by the economic crisis. Demand for bakery products have always been growing over the years worldwide. Cookies are ready to eat, convenient, inexpensive and one of the most popular and widely consumed processed food products in India. However, the information on utilization of pigeon pea brokens to prepare biscuits is very scanty. In the present investigation, therefore, the composites of pigeon pea broken flour and refined four were baked to develop highly acceptable biscuits.

II. MATERIAL AND METHODS

Fine pigeon pea flour and refined flour were procured from the wheat flour, Victoria Foods Private Limited, B-32, Lawrence road, Industrial area, Delhi-110035. All other ingredients were purchased from local market. Pigeon pea brokens were thoroughly cleaned by removing dust, dirt and admixture of other grains. The cleaned pigeon peas broken were ground in a domestic grinder (Philips). Fine pigeon pea flour were sieved through an 80-100 mesh sieve.

Preparation of biscuits

Sweet biscuits were prepared using the traditional creamery method described by [2]. Refined Flour/ blends 64gm, Sugar Powder 18gm, Vegetable oil/ Shortening 16gm, Skim milk powder 1gm, Glucose 1gm, Ammonium bicarbonate 0.5gm, Common salt 0.4gm, Baking powder 0.3gm, Sodium bicarbonate 0.2gm, Vanilla flavour 0.02ml, Fine wheat bran 25gm, Water as required for proper consistency. Sugar, fat and flavor (vanilla) were creamed in a mixer. To this, a well-mixed blend of white flour, skim milk powder and baking powder was added along with water containing glucose, common salt, ammonium bicarbonate and sodium bicarbonate. The contents were mixed further for 2 minutes to make the dough. Using a wooden rolling pin, the dough was sheeted on a specially fabricated aluminium platform to a uniform thickness of 2.5 mm. Circular biscuits of 6 cm diameter were cut and baked for 8-9 minutes at 200 ^{0}C in a baking oven. Biscuits were prepared from white flour (control) and blends of white flour and wheat bran using the following proportions. Wheat bran was included 0, 5, 10, 15, 20, 25 and 30 percent in refined flour to prepare blends. All composites were sifted through 60 mesh sieve to obtain uniform mixing.

Proximate Composition

The moisture content, protein content, fat and ash were determined by [3] method. The carbohydrates were calculated by subtracting the sum of moisture, protein,

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 6, December 2014

fat, ash and fiber from 100. The crude fiber was estimated using [4] method. The calcium content was determined by [4] procedure. The phosphorus and iron content were estimated according to the procedures described by [5].

Physical Characteristics

Diameter (D): The diameter of biscuits was measured by laying six biscuits edge-to-edge and measuring to the nearest mm [4]. The biscuits were rotated at 90° and their diameter was re-measured as a check determination. The average value was reported in mm.

Thickness (T): Thickness or height of the biscuits was measured by stacking six biscuits one above the other and the average value was expressed as mm [4].

Spread ratio (D/T): The spread ratio was calculated by dividing the average value of diameter (D) by the average value of thickness (T) of biscuits [4].

Per cent spread factor: The per cent spread factor was calculated by the following formula:

$$\% \text{ Spread Factor} = \frac{\text{Spread ratio of biscuits prepared from blend}}{\text{Spread ratio of biscuits prepared from control}} \times 100$$

Density of biscuits: Density of biscuit was calculated by dividing weight by volume. Weight of 6 biscuits at a time was measured from which, weight of single biscuit were calculated. Volume of the biscuit was determined by rapeseed displacement method [6].

Hardness: Hardness of biscuits was measured by Stable Micro-System Texture Analyzer (TAXT 2i). The hardness was measured in terms of maximum force used to break the biscuit. The biscuits were placed under 2 mm diameter cylindrical probe and the texture analyzer settings were fixed (return to start option, pre test speed 2.0 mm/sec, test speed 0.5 mm/sec, post test speed 10 mm/sec, distance 4.0 mm/sec, load cell 50 and 200 points per second for graph). The maximum force was expressed in gram or Newton's.

Sensory evaluation of biscuits

Different biscuits prepared were subjected to sensory evaluation by using untrained laboratory panel. The biscuits were evaluated between 11:00 am and 12:00 noon or from 02:00 pm to 03:00 pm. The panellist were presented the samples and requested to record their ratings for appearance, colour, texture, flavour and overall acceptability on a 9 point Hedonic scale using numerical values ranging from 01 to 09, were 01 represented disliked extremely and 09 represented like extremely. The data obtained were analysed statistically on a completely randomized design using analysis of variance technique [7] to find if the differences were significant or not at 05 percent level of significant.

III. RESULTS & DISCUSSION

Blends of refined flour and pigeon pea brokens flour.

Proximate composition

Table 1 - Proximate Composition Refined flour & Pigeon pea flour

Proportion of pigeon pea flour	Protein %	Fat %	Ash %	Crude Fiber %	Carbohydrate %
0	11.6	0.98	0.78	0.58	86.07
5	12.31	1.02	0.97	0.88	84.76
10	13.03	1.05	1.15	1.18	83.53
15	13.74	1.09	1.34	1.48	82.3
20	14.45	1.12	1.52	1.78	81.07
25	15.17	1.16	1.71	2.08	79.84
30	15.88	1.19	1.89	2.38	78.61
Mean	13.74	1.08	1.33	1.48	82.31
C.D. at 5%	0.32	0.05	0.07	0.08	0.93

From the results presented in Table 1 it can be revealed that wheat flour and broken pigeon pea flour contained 11.6 percent and 25.87 per cent protein, respectively. The protein content of raw blends varied proportionately and the variation was significant ($p \leq 0.05$). The above value for protein content indicated that the blends of refined flour with broken pigeon pea flour will have higher amount of protein content than refined flour. The values for protein content in pigeon pea flour are in close confirmation to the values reported by [8] **and** [9]. [10] reported protein content in red gram; *dhal* was 22.3 per cent whereas [11] reported protein content of 23.1 per cent in pigeon pea brokens. The protein content in pigeon pea brokens was reported by [10] in the range 19.72 to 24.44 per cent in different varieties of pigeon pea. The values of fat content in refined floru and pigeon pea brokens obtained in the present investigation were 0.98 percent and 1.75 percent, respectively. The variation in fat content of raw blends was found to be proportionate and the variation was significant ($p \leq 0.05$) because of blending of wheat bran with refined flour. In the present investigation, a value of 0.78 per cent and 4.51 per cent for ash content, in refined flour and pigeon pea brokens flour, respectively were obtained. The ash content of blends was found to vary proportionately with the amount of refined flour and pigeon pea brokens flour in the blends. The variation in ash content was significant ($p \leq 0.05$) because of blending of pigeon pea brokens flour with refined flour. [11] Also reported crude fat and ash content of pigeon pea brokens as 1.7 and 4.7 per cent respectively. These values are very close to the value of present investigation. A range of 51.55 to 56.85 per cent carbohydrate was reported by [12] in red gram dhal whereas she reported crude fiber in the range of 5.59 to 7.03 per cent in five varieties of pigeon pea. Almost the similar values have been reported in the present

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 6, December 2014

investigation. The carbohydrate content varied proportionately in raw blends made from refined flour and pigeon pea brokens flour and the variation due to blending was significant ($p \leq 0.05$). Results presented in Table 1 showed that blending of pigeon pea flour diluted the carbohydrate content significantly ($p \leq 0.05$) and concentrated the protein, fat, ash and crude fiber significantly ($p \leq 0.05$). Hence it enhanced the proximate compositional constituents in biscuits. It was noted from the result of present investigation that the blending of pigeon pea flour enhanced the level of protein and ash 25 and 95 per cent. The increase in crude fiber content because of inclusion of 20 percent pigeon pea flour was 2 fold as compared with refined flour.

Mineral Composition

The calcium, phosphorous and iron contents in pigeon pea broken flour were found 151.500 mg, 298.60 mg and 6.18 mg per 100 g, respectively. [11] Reported mineral content as calcium 237.3 mg, phosphorous 457.2 mg, iron 8.2 mg per 100 gram of pigeon pea broken whereas [10] reported mineral content of pigeon pea as calcium 73 mg, phosphorous 304 mg, iron 2.7 mg per 100 gram. The variations between the results of present investigation and the findings of earlier workers may be due to the varietals differences region of cultivation and climatic conditions.

Table 2 - Mineral composition (mg/100g) of raw blends of refined flour and pigeon pea flour

proportion of wheat bran	ash %	calcium (mg/100g)	Phosphorus (mg/100g)	Iron (mg/100g)
0	0.78	71.30	142.80	4.48
5	0.97	75.31	150.59	4.57
10	1.15	79.32	157.6	4.66
15	.134	83.31	165.4	4.75
20	1.52	87.30	173.2	4.84
25	1.71	91.32	181.0	4.93
30	1.89	95.30	188.8	5.02
Mean	1.16	83.31	165.63	4.75
C.D at 5%	0.3	1.19	2.56	0.59

The results presented in Table 2 shows the mineral composition of raw blends of refined flour and broken pigeon pea flour. From the results it can be revealed that the content of calcium, phosphorus and iron increased significantly ($P \leq 0.05$) from 71.3, 142.8 and 4.48 mg per 100g to 95.3, 188.8 and 5.02 mg per 100g, respectively, by increasing the proportion of pigeon pea broken flour from 0 to 30 per cent in blends. The increase in iron content was proportionate but was non- significant. Results indicated that the blending of pigeon pea broken flour enriched the blends with calcium, phosphorus and iron which enhanced the above minerals in biscuits. Biscuits thus obtained were evaluated for weight, volume, density, diameter, thickness, spread ratio, per cent spread factor and hardness. The data obtained are given in Table 3. The results shows that the water requirement for dough formation increased from 15 to 16.3 ml per 100 g as the pigeon pea brokens flour content in the formulation increased from 0 to 30 per cent. The increase in the water requirement was probably due to the presence of high amount of protein which is present in the pigeon pea flour [8] reported that by increasing the amount of pigeon pea flour in the formulation for biscuits making, the weight, density, spread ratio, per cent spread factor and hardness increased significantly ($p \leq 0.01$). Whereas volume, diameter and thickness of biscuits decreased significantly ($p \leq 0.01$) with an increase in the proportion of pigeon pea in the biscuits formulation. The hardness of biscuits in the present investigation increased from 21.49 to 22.95 Newton's by increasing pigeon pea incorporation from 0 to 30 per cent Similar results were reported by [8] and [9]. [8] Reported that increase of pigeon pea resulted in reduction of spread ratio. It has been reported that hydrophilic starches have a negative elation with the spread ratio of cookies. During baking hydrophilic starch granule absorb moisture, become swollen and gelatinized. This gelatinization increases dough viscosity and thus reduces cookie spread. This suggests that the starches of pigeon pea flour were more hydrophilic in nature than those of cocoyam flour. These finding are more or less similar to the findings of the present investigation.

Table 3 – Effect of incorporation of pigeon pea flour in formulation (Rf) on physical characteristics of biscuits

proportion of pigeon pea flour	Water added ml	Weight of biscuit Gm	Volume of biscuits CC	Density g/cc	Diameter mm	Thickness mm	Spread ratio d/t	% Spread factor	Hardness n
0	15.0	8.02	15.73	0.510	58.95	7.14	8.26	100	21.49
5	15.2	8.00	15.70	0.509	58.85	7.12	8.25	100	21.54
10	15.5	7.95	15.60	0.510	58.65	7.08	8.28	100.24	21.75
15	15.7	7.93	15.20	0.522	58.40	7.00	8.34	100.97	21.98
20	15.9	7.88	14.70	0.536	58.10	6.91	8.41	101.82	22.30
25	16.1	7.80	14.30	0.545	57.75	6.83	8.46	102.42	22.65

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 6, December 2014

30	16.3	7.75	14.05	0.551	57.30	6.75	8.49	102.78	22.95
Mean	15.67	7.90	15.04	0.53	58.29	6.98	8.36	101.18	22.09
CD at 5%	NS	NS	0.73	NS	NS	0.31	0.57	0.57	0.21

* NS: Non Significant

Table 4 – Sensory score for colour and appearance of biscuit made from the blends of refined flour and pigeon pea flour

panelists	Proportion of Pigeon pea percent						
	0	5	10	15	20	25	30
1	8.0	8.0	8.0	8.0	8.0	8.0	7.0
2	8.0	9.0	8.0	8.0	8.0	7.0	7.0
3	8.0	8.0	8.0	7.0	7.0	6.0	7.0
4	8.0	8.0	8.0	8.0	8.0	7.0	7.0
5	8.0	8.0	7.0	7.0	7.0	7.0	7.0
6	8.0	7.0	8.0	8.0	8.0	7.0	7.0
7	8.0	8.0	8.0	8.0	7.0	7.0	6.0
8	8.0	8.0	8.0	8.0	8.0	7.0	7.0
9	8.0	8.0	8.0	8.0	8.0	7.0	7.0
10	8.0	8.0	8.0	8.0	8.0	7.0	7.0
mean	8.0	8.0	7.9	7.8	7.7	7.0	6.9

CD at 5% = 0.46

Table 5 – Sensory score for body and texture of biscuit made from the blends of refined flour and pigeon pea flour

panelists	Proportion of Pigeon pea percent						
	0	5	10	15	20	25	30
1	8.0	8.0	8.0	8.0	8.0	8.0	7.0
2	8.0	8.0	8.0	7.0	7.0	7.0	7.0
3	8.0	8.0	8.0	8.0	8.0	7.0	7.0
4	8.0	8.0	8.0	8.0	7.0	7.0	7.0
5	8.0	8.0	8.0	8.0	8.0	7.0	6.0
6	8.0	8.0	7.0	7.0	7.0	7.0	7.0
7	8.0	7.0	7.0	7.0	7.0	7.0	7.0
8	8.0	8.0	8.0	8.0	7.0	7.0	7.0
9	8.0	8.0	8.0	8.0	8.0	7.0	7.0
10	8.0	8.0	8.0	8.0	8.0	7.0	7.0
mean	8.0	7.9	7.8	7.7	7.5	7.1	6.9

CD at 5% = 0.44

Sensory characteristics

The biscuits made from the blends obtained by blending pigeon pea flour with refined flour were subjected to sensory evaluation. The sensory attributes namely color and appearance, body and texture, taste and flavor, and over all acceptability were evaluated on 9-point hedonic scale. The results of mean sensory scores are presented in Table 4 to 7for various sensory attributes. The mean sensory scores for colour and flavor of biscuits made from the blends pigeon pea flour with refined flour are presented in Table 4. The inclusion of pigeon pea flour upto 20 percent did not vary the colour and appearance significantly with respect to control sample. Thereafter the variation was significant ($P \leq 0.05$). However biscuits made from the sample containing 30 percent pigeon pea flour were ranked in acceptable range on 9 point hedonic scale by the panelists. The mean sensory scores for body and texture of biscuits made from the blends pigeon pea flour with refined flour are presented in Table 5. The results showed that the mean scores decreased significantly ($P \leq 0.05$) after the inclusion of pigeon pea flour at 20 percent and more proportion of pigeon pea flour in refined flour as ranked by the panelists. The biscuits made from refined flour score maximum but the biscuits made from the blends containing pigeon pea flour upto 20 percent did not vary significantly. However the biscuits made from the blends containing 20, 25 and 30 percent bran were reported in acceptable range on 9 point hedonic scale of sensory evaluation by the panelists.

Table 6 – Sensory score for taste and flavor of biscuit made from the blends of refined flour and pigeon pea flour

panelists	Proportion of Pigeon pea percent						
	0	5	10	15	20	25	30
1	8.0	8.0	8.0	8.0	8.0	8.0	7.0
2	9.0	8.0	8.0	8.0	8.0	7.0	7.0
3	8.0	8.0	8.0	8.0	8.0	7.0	7.0
4	8.0	8.0	8.0	8.0	7.0	7.0	7.0
5	7.0	7.0	7.0	7.0	7.0	7.0	7.0
6	8.0	8.0	8.0	8.0	8.0	7.0	6.0
7	8.0	8.0	7.0	7.0	7.0	7.0	7.0
8	8.0	8.0	8.0	8.0	8.0	7.0	7.0
9	8.0	8.0	8.0	8.0	8.0	7.0	7.0
10	8.0	8.0	8.0	8.0	8.0	7.0	7.0
mean	8.0	7.9	7.8	7.8	7.7	7.1	6.9

CD at 5% = 0.47

The results of sensory score for taste and flavor presented in Table 6 revealed that the mean sensory score was highest for the biscuits made from wheat flour, however the variation in mean sensory score in the biscuits made from the blends upto 20 percent inclusion of pigeon pea flour was non-significant. The biscuits made from the blends upto 25 percent level of pigeon pea flour scored in acceptable range by the panelists on 9 point hedonics scale. The biscuit made from the blend with 30 percent pigeon pea flour was scored in acceptable range on 9 point hedonics scale. The mean sensory scores

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 6, December 2014

for over all acceptability of biscuits made from the blends of pigeon pea flour and wheat flour are presented in Table 7.

Table 7 – Sensory score for overall acceptability of biscuit made from the blends of refined flour and pigeon pea flour

panelists	Proportion of Pigeon pea percent						
	0	5	10	15	20	25	30
1	8.0	8.0	8.0	8.0	8.0	8.0	7.0
2	8.0	8.0	8.0	8.0	8.0	7.0	7.0
3	8.0	8.0	7.0	7.0	7.0	7.0	6.0
4	8.0	8.0	8.0	8.0	8.0	7.0	7.0
5	9.0	8.0	8.0	8.0	8.0	7.0	7.0
6	8.0	8.0	8.0	7.0	8.0	7.0	7.0
7	8.0	8.0	8.0	8.0	7.0	7.0	7.0
8	8.0	8.0	8.0	8.0	8.0	7.0	7.0
9	8.0	8.0	8.0	8.0	7.0	7.0	7.0
10	8.0	8.0	8.0	8.0	7.0	7.0	7.0
mean	8.1	8.0	7.9	7.8	7.6	7.1	6.9

CD at 5% = 0.39

The biscuits made from control had highest mean score followed by the biscuits made from the blends containing 5, 10, 15 percent pigeon pea flour. The biscuits made from the blends containing 20, 25 and 30 percent pigeon pea flour portion were rated significantly ($P \leq 0.05$) lower than the control sample, however the biscuits made from the blends with 20 and 25 percent incorporation of pigeon pea flour were rated acceptable by the panelist on 9 point hedonics scale.

On the basis of the results of mean sensory score it was concluded that the pigeon pea flour may be included successfully upto 20 to 30 percent which increased the crude fiber, protein, minerals content and lowered the carbohydrate without affecting the sensory scores adversely. Further increase in the pigeon pea flour lowered the sensory attributes because of development of more pigeon pea flour tastes as well more hardness. Hence 20 percent inclusion of pigeon pea flour was selected for further studies.

Table 8 – Chemical Composition of biscuits made from the blends of refined flour and pigeon pea flour

proportion of pigeon pea flour	Moisture %	Protein %	Fat %	Ash %	Crude Fiber %	Carbohydrate %	Calcium (Mg/100g)	Phosphorus (Mg/100g)	Iron (Mg/100g)
0	3.30	6.46	15.90	0.45	0.32	73.57	46.01	89.23	2.80
5	3.35	6.86	15.92	0.56	0.49	72.82	48.59	94.01	2.86
10	3.40	7.26	15.94	0.66	0.65	72.09	51.19	98.40	2.91
15	3.46	7.65	15.96	0.77	0.82	71.44	53.78	103.42	2.97
20	3.50	8.05	15.98	0.88	0.98	70.61	56.37	108.43	3.03
25	3.54	8.44	16.01	0.99	1.15	69.87	58.96	113.44	3.08
30	3.60	8.84	16.03	1.09	1.31	69.13	69.55	117.83	3.14
Mean	3.45	7.65	15.96	0.77	0.82	71.36	54.92	103.54	2.97
C.D at 5%	NS	0.1	NS	0.7	0.4	0.5	1.07	2.21	0.23

Chemical Composition of Biscuits

The chemical composition of biscuits made from the blends of refined flour with pigeon brokens flour is presented in Table 8. The protein, ash and crude fiber calcium, phosphorus and iron showed a increasing trained with an increase in the level of pigeon pea flour in the blends. The increase in moisture was non-significant the biscuits made from the blends containing 20 percent pigeon pea flour increased the protein content about 25 percent while a 3 fold and 2 fold increases was observed in crude fiber and ash content, respectively. The increase in protein crude fiber, ash, calcium, phosphorus and iron is significant ($P \leq 0.05$) with respect to the biscuits made from refined flour. Hence protein rich biscuits are developed from the blends containing 20 percent pigeon pea flour.

REFERENCES

[1] FAO. 1979. Production Year Book. 33. 251 (FAO, Roma).

[2] Whitley, P.R. 1970. Biscuit manufacturer. Applied science Publisher Limited, London U.K.

[3] A.O.A.C. 1984. Official Methods of Analysis .14th ed. Association of Official Agricultural Chemist .Inc Arlington ,V.A.

[4] A.A.C.C. 1976. Approved Methods of American Cereal Chemist, U.S.A.

[5] Ranganna S. 1986 Handbook of Analysis and Quality Control for Fruit and Vegetable Products Second Ed Tata McGraw Hill Publication Co. New Delhi,

[6] Haridas Rao P, Shurpalekar, S.R. 1976. Utilization of milo in bakery products. J.Food Sci. Tech. 13: 298-299.

[7] Snedecor, G.N and Chochran, W.G. 1968. Statistical methods. Oxford and IBH Publishing Co. New Delhi.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 6, December 2014

[8] Mamta Shankar (2008) Incorporation of Makhana flour in wheat flour to develop value added biscuits Ph.D. Thesis Food Technology, Bundelkhand University, Jhansi.

[9] Rana Parmendar (2006) Development of high fiber biscuits using wheat bran and pigeon broken thesis food technology G.B. Pant Uni. of Agr., Pantnagar.

[10] Narasinga Rao, B.S.; Deosthale, Y.G. and Pant, K.C. 1989.Nutritive Value of Indian Foods. National Institute of Nutrition, ICMR, Hyderabad.pp:26, 47-48.

[11] Singh D. 1993. Development of extruded snacks from composites of rice, dhal and wheat milled by-products. Ph. D. Thesis, (Food Technology). G. B. Pant University of Agriculture and Technology, Pantnagar.

[12] Vinita, 1982. Evaluation of improved varieties of pigeon pea (Cajanus Cajan): proximate composition, protein fraction and trypsin inhibitor activity. MSc. Thesis (Foods and Nutrition). G. B. Pant Univ. of Agri. And Tech., Pantnagar.