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Nutritional evaluation of Pigeon pea and development of food product incorporating it

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Abstract

Generally seed products are considered of low nutritional quality due to the presence of anti-nutritional factors. Many processing like malting are helpful to overcome these types of problems. Therefore a study was conducted to see the effect of malting on composition of Pigeon pea seeds and on the developed food products after its incorporation. The study comprises of three phases which involved 1). Proximate profile determination (moisture, ash, protein, fat, crude fiber, carbohydrate), 2). Food product development and 3). Sensory evaluation. Soaked Pigeon pea flour was used in different proportions ranging from 10% to 60% to prepare food product (khakhra) and its organoleptic evaluation was done by 5 point hedonic test. It was found that proximate composition of the soaked flour contained significantly higher content of protein on dry weight basis ($P \geq 0.05$) in comparison of raw flour. Incorporation of 10% and 20% soaked flour in developed products depicted significantly higher acceptability. Therefore, soaked Pigeon pea seeds can be beneficial to overcome malnutrition, diabetes, cardiovascular diseases and may other diseases.

Keywords

Pigeon pea, proximate composition, sensory evaluation, product development, value addition, malting

Introduction

People in ancient times ate only for satisfying their hunger and prolonging life. They used to partake what they liked in terms of appearance, flavor and taste without realizing the healthy or ill effects of those foods. Masses in developing countries have been following the same pattern of consuming traditional foods till now. However, non-conventional food stuffs, the proverbial treasure trove of nutrients and phytochemicals, have been waiting in the margins for making to the dietary mainstream on account of their being abound in

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nutrients, medicinal, flavoring and physical qualities in addition to their nutritional worth. But they also have off-beat to extreme flavors, like pungent and an assay of anti-nutrients, the stumbling blocks stymieing their utilization. It's also a time when developing countries are brimming with teeming millions as a result of population explosion; and thus need non-conventional foods processed through appropriate technology to develop acceptable, nutritive and health enhancing food products without any side effects. Out of a long list of non- conventional food stuffs, pigeon pea stands out needing focus and attention of food scientists and nutritionists keeping in view its awe inspiring nutritive and therapeutic attributes, it was selected as the subject of research endeavor. Malnutrition has been documented in many developing countries due to inadequate protein intake. In Nigeria, lack of protein nutrition is a prominent health related issue in <5 years age group (UNICEF, 1996).

Nutritive value of pigeon pea flour is quiet rich in many minerals and vitamins. It's protein content and quality is also comparable to soybean (Apata & Ologhobo, 1994). It has the protective effects against malnutrition. Children below 5 years of age come under vulnerable group in India due to malnutrition that is clear from the fact that India has greatest number of underweight kids below 5 years all over the world. Malnutrition causes yearly 23 Lakhs deaths of 6 months - 5 years children that accounts for 41% mortality (Schroeder & Brown, 1994).

Maintaining normal body weight is very crucial not only to maintain normal health but also to avoid many disorders. Body weight includes the weight of bones, muscles, organs, body tissues and adipose tissue. Fluctuations in body weight occur due to imbalance in many neural, hormonal and chemical mechanisms. While the problem of excess body weight is confronting more and more people in the only rampant in the less privileged sections of the society but also occurs as a result of eating disorders or psychological problems (Khanna et al., 2017).

Different types of pulses are grown all over the world. Grams are known to be originated in South West Asia, while Pigeon pea has been originated from Africa. Pulses are mainly consumed as Daal/ khaman/ cheela/ sprouts/ roasted forms and many more types of dishes. These are good protein source for vegetarian population as well as have medicinal

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properties also. By products can be used as animal's fodder. Pulses are also used to enrich soil quality by improving its nitrogen content (Singh, 1988).

Pulses are largely produced and consumed in India. Protein deficiency is very common in Indian population among all age groups (Reddy, 2009). Economically backward classes should be educated to consume more pulses for a more balanced diet as it is the cheapest protein source (Gowda et al., 2013). A major cultivated area in India is covered by Chickpea and pigeon pea (53%) (Sharma et al., 2002).

Pigeon pea (*Cajanus cajan*), part of the *Leguminosae* family. It is also called as red gram in English, and *Arhar* or *Tur dhal* in Indian name (Wu et al., 2009). Pigeon pea seed may vary for size and shape and may be of different colours. It contains protein (20-22%), fat (1.2%) and carbohydrate (65%) and ash content (3.8%) (FAO, 1982). It is an excellent source of energy and protein for hypertensive patients being rich in protein, complex carbohydrate and long shelf life (Grover et al., 2002).

Pigeon pea is a produce of climates that are arid and semi-arid topography with soil fertility as poor (Kanwar 1976; Sanchez and Cochrane 1979). In India, mainly pigeon pea is grown on Alfisol and Vertisol types of soils (Kampen and Burford, 1979). These types of soils are deficient in all micronutrients except molybdenum as their organic content is low and lime content is quiet high (Katyal et al., 2001).

Okpala and Okoli (2011) have shown in their study that protein content of pigeon pea enriched cookies was comparable to minimum recommended values as per FAO/ WHO.

Significance

Pigeon pea is a good resource of protein, carbohydrates, fat, minerals and B-complex vitamins; calcium, iron, magnesium, zinc, and phosphorus

- It also contains unsaturated fatty acids, phytochemicals and phytoestrogens
- It has the protective effects against malnutrition
- Keeping all the points in mind, it can be used for the development of food products effective against malnutrition

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Objectives

- To assess proximate composition of Pigeon pea flour after applying processing treatments
- To prepare products suitable for diabetic patients using Pigeon pea flour
- To evaluate acceptability of the prepared food products using 9 point hedonic rating scale

Research Methodology

The study was conducted into 3 phases -

1. **Phase 1**

a. Selection and procurement of legumes

Pigeon pea were obtained from the local marketplace of Jaipur (city in India). The flour was geared up by malting technique; soaking, germination and kilning.

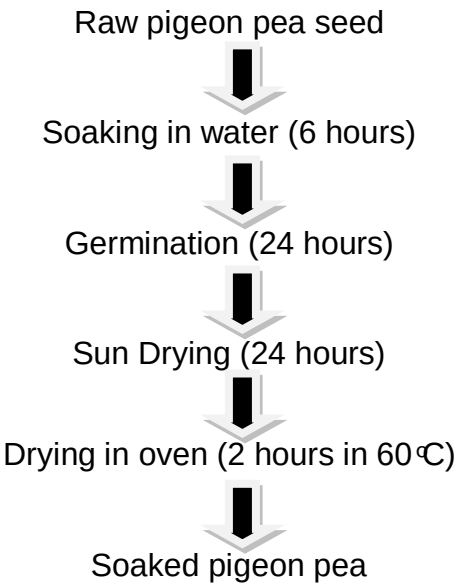
Preparation of raw flour of pigeon pea:

Pigeon pea (500 g) was weighed and dried in an oven at 60 degree Celsius for 20 hrs. The dried pulse was milled, then sieved through 150 wire mesh and packed in polyethylene and stored in covered container at normal temperature for proximate analysis.

b. Preparation of malted pulse flour using household processing methods

Preparation of soaked pigeon pea flour:

500 grams of pigeon pea was soaked for 3 hrs. in distilled water and then drained. It was then germinated and dried in an oven for 7-8 hours at 60 degree Celsius. Then these were milled and stored in airtight containers after sieving.



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c. Analysis of proximate composition

Proximate composition analysis was done by estimation of moisture, crude fibre, crude fat, protein, ash while carbohydrates were calculated by the difference method.

Proximate Composition of Pigeon Pea Seeds

Estimation of moisture content (*AOAC, 1993*)

Procedure:

8-10 g sample was taken in an weighted dry, tarred and evaporated dish and dried in an oven at 70-100 ˚C for 3- 4 hrs in an oven and 4-6 hrs. in a vacuum oven. Then the sample was cooled in desiccators and weighted accurately. Drying, cooling and weighing were done until the weight of the sample turn out to be constant.

Moisture content of the sample in g/100g of the sample was calculated by the formula:

$$\text{Moisture (g/ 100g)} = \frac{\text{Initial weight (W1)} - \text{Final weight (W2)}}{\text{Weight of the sample (g)}} \times 100$$

Estimation of mineral ash content (*NIN, 2008*)

Procedure

10 ml of sample was weighed in a crucible and charred at 600 degree Celsius in a furnace for 4 hours. Then it was cooled and weighed till 2 consecutive weights are obtained.

Following formula was used to calculate the ash content -

$$\text{Ash content (g/100g sample)} = \frac{\text{Weight of the Ash (g)}}{\text{Weight of the sample taken (g)}} \times 100$$

Estimation of fat content *(*Raghuramulu et al, 1983*)*

Generally the fat content estimation is done in dry sample after moisture removal.

Procedure: The procedure involved a 15 hours extraction of fat by soxhlet method in a weighed sample. Obtained ether extract of fat was dried by evaporation.

Fat content of 100 g sample was weighed

Fat content was determined by the formula:

$$\text{Fat (\%)} = \frac{W2 - W1}{\text{Initial Weight}} \times 100$$

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Estimation of Crude Fiber (AOAC, 1993)

5 gram of moisture free sample was weighed to estimate crude fibre content. It was boiled with concentrated sulphuric acid for 30 minutes followed by boiling with 0.313N sodium hydroxide solution to digest its acid and alkali soluble fragments. After boiling for 30 minutes in both the solutions, it was washed with distilled water frequently to make it acid or alkali free, then residue was cooled and weighed till two consecutive weights. Formula is as follows:

$$\text{Crude fibre} = \frac{(\%)\, W^3}{w} \times 100$$

Estimation of Protein content (Kjeldahl method)

Protein content was estimated by Kjeldahl method.

It is divided into 3 groups:

1. **Digestion:** Sample was mixed with 3 - 4 g catalyst and digested with Sulphuric acid. After becoming transparent, the sample was cooled
2. **Distillation:** Diluted digested sample was taken into distillation assembly and loaded with equal volume of alkali. The evaporated ammonia was condensed and collected into boric acid solution containing indicator.
3. **Titration:** As soon as the colour changes, the boric acid solution was titrated with known concentration of alkali.

Protein content was determined by the following formula:-

$$\text{Nitrogen N \%} = \frac{14.01 \times 0.1\ N \times (TV - BV)}{W \times 1000}$$

$$\text{Protein P\%} = \%\ N \times 6.25 \text{ (for food sample)}$$

Estimation of Carbohydrate:

It was calculated by difference method. The sum of the volume (g/100g) for fat, protein, moisture, ash, and crude fibre from 100 to get the carbohydrate content of sample. The formula is as following:

Carbohydrate (g/100g) =100 - (Moisture + Fat + Protein + Ash + Fibre)

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- **Phase 2**

a. Product Development: Development of product in order to select the recipes of present study various recipes based on home –made products with different proportions. The criteria for selection were:

- Easy availability of ingredients
- Consumed commonly by masses
- Easy and simple to make with little expenditure of time and energy.
- Product development and sensory evaluation

b. Sensory Evaluation: The ability of the panelist, motivation, general attitude and emotional state of the panelist may affect judgment. The panelists were provided an explanation about attributes they supposed to measure (Stone and Sidel, 2006).

Panel member's selection - Sensitivity threshold test

In this test, salty or sweet solutions are given to taste with minor changes in concentration. It depicts the sensitivity of candidates to find out the minor difference. Out of these, 10 members were selected as panelist who showed sharp discrimination and discretion capacity.

Format 1 - Sensitivity Threshold Test

Name:

Date:

Instructions:

1. You are provided with series of beakers and to continue different concentration of solutes (Sweet).
2. Start testing with left most beaker and to continue to taste solution in other beaker.

Express your result in terms of numerical scores given below.

S. No.	Salty Taste	
	Description	Scores
1.		
2.		
3.		

Table 1: Numerical scores calculation

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Intensity scale for different primary tests:

Scale of Scores **Description**

1. Weak taste
2. Medium taste
3. Strong taste

Sensory Evaluation of pigeon pea products using 5-Point composite rating scale

In composite rating scale test, the panelists had assigned score on a five points composite rating scale for colour, appearance, taste, texture; and after taste were measured. Rating was done as liked very much (5) to disliked very much (1).

Format 2: Five Point Composite Rating Scale

Sample	Appearance	Color	Taste	Texture	After taste	Overall acceptability	Overall mean score
Sample 1							
Sample 2							

1. Dislike very much, 2. Dislike, 3 Neither like nor dislike, 4 Like, 5 Liked very much

Table 2: Five Point Composite Rating Scale

Phase 3: Statistical Analysis Of The Data And Interpretation

The data gathered was analyzed statistically and presented after proper statistical analyses as shown following -

- **Mean (x bar)**

  It was calculated as -

  $\bar{X} = \sum X$

  Where:

  $\bar{X}$ = Mean

  X = Value of the variable

  N = Total number of panel members

  $\sum$ = Summation

- **T-test**

  The T test is used when sample size is < 30 and the standard deviation of the population is unknown (Gupta, 2000).

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Results And Discussion

Commencing with the collection of *Cajanus cajan* and preparation of flour and determining the proximate composition (moisture, ash, protein, fat, crude fiber, carbohydrate) and then Further, the study includes product development from the malted flour and assessing their acceptability through 5 point composite sore. At the end statistical analysis and report writing was done. The result will be discussed under the following heads:-

- Proximate Analysis of pigeon pea seeds powder
- Sensory evaluation of the food product developed through incorporation of malted flour

Nutritional Analysis

Parameters	Pigeon pea (*Cajanus cajan*) seeds	
	Unmalted flour	Malted flour
Moisture(g/100g)	8.45±0.95	13.32±2.69 (51%↑)*
Ash(g/100g)	4.58±0.40	3.61±2.09 (21% ↓)*
Crude Fat(g/100g)	4.78±0.22	1.68±0.44 (64% ↓)*
Crude Fiber(g/100g)	5.79±1.2	7.48±0.22 (29.1%↑)*
Protein(g/100g)	17.46±0.32	22.65 ±1.89 (26% ↑)*
Carbohydrate(g/100g)	38.63±0.48	33.74± 2.38 (12.65%↓)*

Table 3: Nutritional composition of Malted and Un-malted Pigeon pea seeds (*Cajanus cajan*) on dry weight basis

Proximate compositions of un-malted and malted *Cajanus cajan* seeds (on dry weight basis) are articulated as Mean ±SD of triplicate determination. * ($p \geq 0.05$) level shows significant difference; ($p < 0.05$) NS shows non-significant difference. Data in parenthesis is % increased (↑) and is also decreased (↓) due to processing.

Moisture content (g/100g) of soaked and raw pigeon pea seeds were 13.32±2.69 and 8.45±0.95 respectively. This makes it clear that the process of malting significantly

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enhanced (51%) the moisture content. However in order to protect the product from microbial spoilage the moisture content is kept low (Akonor *et al.,* 2016). Ash content (g/100g) of malted and raw pigeon pea seeds were 3.61±2.09 and 4.58±0.40 respectively. This shows that malted seeds contain significantly contain lower ash p ≥0.05 levels in comparison with raw seeds flour. This result showed that ash content of malted seeds was significantly decreased by 21%. The quantity to ash in any plant simple assumes importance as it determines the minerals composition.

Fat content (g/100g) of malted and soaked pigeon pea seeds were 1.68±0.44 and 4.78±0.18 respectively. This shows that soaked seeds contain significantly contain lower fat p ≥ 0.05 levels in comparison with raw seeds flour. This result showed that fat content of soaked seeds was significantly decreased by 64%. Crude fibre content (g/100g) of malted and raw pigeon pea seeds were 7.48±0.22 and 5.79±1.2 respectively. This shows that soaked seeds contain significantly higher fibre at p ≥ 0.05 levels in comparison with raw seeds. This result showed that fibre content of Malted seeds was significantly increased by 29.1%.

Protein content (g/100g) of malted and raw pigeon pea seeds were 22.65±1.89 and 17.46±0.32 respectively. This shows that malted seeds contain significantly higher protein at p ≥ 0.05 levels in comparison with raw seeds. This result showed that protein content of soaked seeds was significantly increased by 26%. Carbohydrate content (g/100g) of soaked and raw pigeon pea seeds were 33.74±2.38 and 38.63±0.48 respectively. This shows that soaked seeds contain significantly lower carbohydrate at p ≥ 0.05 levels in comparison with raw seeds. This result showed that carbohydrate content of malted seeds was significantly decreased by 12.65%. According to Vanderstoep *et al.,* 2015 stated that that these low carbohydrate and glucose levels make soaked seeds useful to those who are diabetic and individuals who are watching their weight.

Product Development

In the present study, one recipe was developed with variation in each recipe. There was standard (S) and its six variation were made by incorporating the soaked pigeon pea flour (PPF) with the concentration of 10%, 20%, 30%, 40%, 50%, 60% assigned as code 101, 102, 103,104,105,106 respectively.

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Sensory Evaluation

In this section of study evaluation of the recipes were carried out using triangle test for selection of panel and for judging the formulated recipes were tested on nine point hedonic rating scale with respect to various characteristics namely color, texture, taste, odor, appearance and overall acceptability of different product, the Mean and Standard

Deviation scores for different attributes are predicted below.

Attributes	Standard	(10%)	(20%)	(30%)	(40%)	(50%)	(60%)
Appearance	4.7±0.44	4.4±0.54	4.3±0.67	4.1±0.57	3.4±0.54	3.4±0.89	2.7±0.74
Colour	4.7±0.44	4.5±0.5	4.2±0.44	4±0.3	3.5±0.5	3.3±0.44	2.6±0.54
Texture	4.7±0.44	4.5±0.5	3.4±0.54	3.4±0.54	3±0.70	3.1±0.74	2.4±0.89
Taste	4.7±0.44	4.5±0.5	4.4±0.54	4±0.5	3.1±0.74	2.6±0.89	2.1±0.74
Overall acceptability	4.7±0.44	4.5±0.5	4±0.2	3.5±0.5	3.1±0.74	2.8±0.83	1.9±0.54
Overall mean score	4.7±0.44	4.48±0.50	4.02±0.34	3.8±0.28	3.22±0.58	2.98±0.61	2.34±0.55

Table 4: Acceptability Evaluation of food product (khakhara) by incorporating soaked pigeon pea seeds flour in the term of sensory attributes

Data are reported as MEAN ± SD group of twenty panels each. All test taste recipes group (10%, 20%, 30%,40%,50% and 60% compared to standard recipe. *P < 0.05 and NS- non significant.

Presentation of khakhara sample to assess acceptability at different levels of Pigeon pea assimilation

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Figure 1:Khakhra samples

Product: Khakhra

The product was prepared by the incorporation of soaked pigeon pea seeds in various levels of concentrations as shown in the above table. These samples were assigned as Variant 101, 102, 103, 104, 105 and 106 respectively which is compared with the standard recipe. The mean score obtained for the *appearance* varied from 2.7±0.77 to 4.4±0.54. Sample 101 with score (4.4±0.54) was very much similar to the standard. The mean score obtained for the *color* varied from 2.6±0.54 to 4.5±0.5. The mean score obtained for the *taste* varied from 2.2±0.74 to 4.5±0.5. Khakhra samples with 30% Pigeon pea incorporation were quite similar to the standard one in terms of taste, while overall acceptability and overall mean score of Pigeon pea incorporation at 20% level was found in consonance with the standard recipe. The mean score obtained for the *texture* varied from 2.4±0.89 to 4.5±0.5. The mean score obtained for the *overall acceptability* varied from 1.9±0.54 to 4.5±0.5.

Conclusion

Ever increasing world's population poses a greater demand for innovative protein sources. Cereal pulse combination is considered as one of the best preventable sources for the protein energy malnutrition. Role of nutrition in prevention of protein deficiency has been emphasized clearly in the present research. In present study, pigeon pea seeds were selected which is categorized under pulses and legumes. The study was undertaken to develop malted flour to compare the proximate analysis between raw and soaked flour and the last was to evaluate the acceptability of products. The salient features of the study along with conclusions are as follows:

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Pigeon pea samples were collected of *Cajanus cajan* seeds from the KVK (Krishi Viyan Kendra) of Jaipur (Rajasthan) and application of malting technique to prepare their flour.

- Proximate analysis of soaked and raw pigeon pea flour was done with standard AOAC method
- The analysis revealed that the amount of protein and crude fibre content were high in soaked seeds flour with a difference of 26% and 29.1% respectively in comparison with raw seeds flour
- Carbohydrate content of soaked pigeon pea, it was found by 12.65% as low carbohydrate content in comparison with raw seeds. These low carbohydrate and glucose levels make, useful to those who are diabetic and individuals who are watching their weight management.
- Thus, the data revealed that soaked seeds contain good content of crude Fiber, protein and low in carbohydrate and fat thus it can serve as potent nutritious food supplements to improve the health.
- Sensory evaluations of the recipe were conducted by 5 point composite score, food product such as khakhra were developed with different concentration of soaked flour (10%, 20%, 30%, 40%, 50%, 60%) assigned as Variant 101, 102, 103, 104, 105 and 106 respectively) in recipe.
- Sensory evaluation revealed that in terms of all sensory attributes that products developed at variant 101 (10%) and variant 102 (20%) were found highly acceptable. In terms of taste, 30% level of incorporation was found acceptable, therefore it is recommendable to incorporate Pigeon pea at 30% level as it provides maximum amount of protein and other macro and micro nutrients with taste as well.
- Thus the study indicates that soaking had significantly affect the proximate composition of seeds, thus seeds became richer in protein and fibre.
- The data also indicates that 10% and 20% soaked pigeon pea flour incorporated in recipe were acceptable and comparable to their standard products thus, khakhra showed the quality score in terms of sensory evaluation and overall acceptability.

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