Influence of Processing Techniques on the Nutritional and Anti-Nutritional Properties of Pigeon Pea (*Cajanus Cajan*)

Pele G.I., Oladiti E.O., Bamidele P.O., Fadipe E.A.

Abstract— **Pigeon pea is a perennial legume shrub often grown in a wide range of soil textures, from sandy soils to heavy clays. The study therefore investigated the effect of processing methods on the nutritional and anti-nutritional properties of pigeon pea. Pigeon peas were subjected to different processing methods which were sun drying and milling which serves as the control (sample A); soaking for 24 h, sun drying and milling (sample B); soaking for 12 h, de-hulling, sun drying and milling (sample C) and sprouting for 120 h, sun drying and milling (sample D). The proximate composition of pigeon pea showed that crude protein ranged from 16.74 to 38.43% with a significant increase in sample A, C and D while the crude fat that ranged from 11.80 to 24.61% showed significant difference in the samples. The moisture content which ranged from 7.91 to 13.65% is significantly highest in sample D. The anti-nutritional composition of the samples showed that phytic acid ranged from 5.27 to 7.61% with a significant decrease in sample D. The tannin content ranged from 11.52 to 14.72 mg/100g while protease inhibitor is 5.09 to 7.60%. The study however showed that traditional processing techniques significantly reduced the anti-nutritional properties.**

Index Terms— **de-hulling, *Cajanus cajan*, milling, proximate, sprouting, sun drying**

I. INTRODUCTION

Dietary quality is an important limiting factor to adequate nutrition in many resource-poor settings. One aspect of dietary quality with respect to adequacy of micro nutrient intake is bioavailability. Several traditional household food processing and preparation methods can be used to enhance the bioavailability of micronutrients in plant based diet [1]. These include: mechanical processing, soaking, de-hulling, fermentation, and germination/ malting. These strategies aim to increase the physicochemical accessibility of micronutrients, decrease the content of anti-nutrients such as phytate or increase the content of compounds that improve bioavailability [2]. A combination of strategies is probably required to ensure a positive and significant effect on micronutrient adequacy. A long term participatory intervention in developing countries that use a range of these strategies and the promotion on the intake of other micronutrient rich foods including animal source foods resulted in improvements in both haemoglobin and lean body mass and a lower incidence of common infections among intervention compared with control children. The suitability of these strategies and their impact on nutritional status and functional health outcomes need to be more broadly assessed [3]. In resource poor communities, it has become clear that malnutrition is attributable not solely to insufficient amounts of food, but also to the poor nutritional quality of the available food supply, particularly among plant based diets containing only small amounts of micronutrient dense animal source foods [4]. The low bioavailability of nutrients arising from the presence of anti-nutrients such as phytate, polyphenol and oxalate is another factor that limits the quality of predominantly plant based diets [5].

Legumes are important sources of protein, carbohydrates, dietary fiber and minerals. Only a few of the known legume species are extensively promoted and used. Pigeon pea is a marginally known legume, having the potential of reducing protein deficiency in developing poorer nations [5]. The young pods and unripe seeds of this plant are used as vegetables and the ripe seeds are used as pulse. It is a good source of protein, carbohydrate, dietary fiber and energy [6]. The young pods and dried seeds of the legumes contain 4.5% protein. In spite of its good nutritional qualities, legume consumption is declining worldwide. According [7], the necessity of extensive preparation and cooking time, and the occurrence of gastrointestinal distress after ingestion are contributing to the abstention of the use of legumes. In addition, anti-nutritional factors interfere with protein and carbohydrate digestibility by forming complexes with proteins and minerals [8]. Untreated pigeon pea has been reported to possess high level of anti-nutritional factors such as trypsin inhibitor, tannins and phytic acid. High trypsin inhibitor activity in legumes prevent protein metabolism while phytate phosphorus compromises mineral absorption. In order to utilize these legumes effectively as human food, it is essential to inactivate or remove these anti-nutritional factors. A better understanding of the effect of different processing techniques on the nutritive value and anti-nutritional factors may lead to wider use of pigeon pea in the food industries.

Pele G.I., Department of Food Science and Technology, Federal University of Technology, P.M.B. 704, Akure, Ondo State, Nigeria., Department of Food Science and Technology, Federal Polytechnic, P.M.B. 420, Offa, Kwara State, Nigeria. +2348034899527

Oladiti E.O., Department of Food Science and Technology, Federal University of Technology, P.M.B. 704, Akure, Ondo State, Nigeria.

Bamidele P.O., Department of Food Science and Technology, Federal Polytechnic, P.M.B. 420, Offa, Kwara State, Nigeria.

Fadipe E.A., Department of Food Science and Technology, Federal University of Technology, P.M.B. 704, Akure, Ondo State, Nigeria.

II. MATERIALS AND METHODS

2.1 Source of Materials

Pigeon pea was obtained from a local market in Ado-Ekiti, Nigeria. The peas were sorted and cleaned from extraneous materials. Reagents used are products of Eagle Scientific Limited, England and B.D.H. Limited, England. All glass wares were washed with detergent solution, rinsed and oven dried before used.

2.2 Production of pigeon peas flour

Pigeon peas were sorted, washed and four different processing methods were employed to produce pigeon pea flour. Sample A which serves as control, pigeon peas sundried and milled into flour while sample B, pigeon peas soaked in water at 12 ^{0}C for 24 h, sundried and milled into flour. Sample C, pigeon peas soaked for 12 h, de-hulled, sundried and milled into flour while sample D, pigeon peas sprouted for 120 h, dried and milled into flour. Sprouting of pigeon peas was done by soaking the seeds in water for 24h. The seeds were removed and germinated by spreading the seeds on the jute bags and covered with the same material. Water was sprinkled on the jute bags twice daily until the seeds began to sprout. The sprouted seeds were sundried for 4days and milled into flour.

2.3 Determination of Proximate Composition

Analysis of moisture content, crude protein, crude fat, ash and fibre were determined by method described by [9]. Total carbohydrate content was determined by subtracting the crude protein, fat, ash and crude fibre percentages from 100%.

2.4 Determination of anti-nutritional properties

Gravimetric determination of tannin was done according to the method of [10], while phytate was determined according to the method of Young and Greaves [11]. The determination of protease inhibitor was done according to method of [12].

2.5 Statistical Analysis

Data obtained from the experiment were subjected to statistical analysis using SPSS version 20, while the statistical analysis showed significant differences, the means were separated using the Duncan Multiple Range Test (DMRT).

III. RESULTS AND DISCUSSION

3.1 Effect of Traditional Processing Methods on the Proximate Composition of Pigeon Pea flour

The results of the effect of traditional processing methods on the proximate composition of pigeon pea are presented in Table 1. The crude protein (%) of the control (sample A), sample B, C and D were 25.03, 16.74, 21.47 and 38.43 respectively. The results showed that there is significant difference in crude protein of the samples, where sample D composed the highest protein. This highest crude protein content of sample D which was 38.43 affirmed that sprouting could have a significant increase on the bioavailability of the nutritional composition of pigeon pea, though a significant increase was also observed in the control. The lowest level of crude protein observed in sample B could be due to the hydrophilic property its crude protein exhibits which could have leached out while soaking in water for 24 h. The crude protein observed in sample B is also in contrast with the report of [13] who reported that steeping of pigeon pea for 24 h gives 22.1 of crude protein. The discrepancy in the results could be due to the fact that sample B was not dehulled, whereas the result is consistent with sample C, though soaked for 12 h, yet because it was dehulled gives a significant increase in crude protein. The results also showed that there is significant difference in crude fat (%) except in sample C and D. The crude fat of sample A is observed to be the highest which is 24.61, while sample C is the lowest. The increase in the crude fat of sample A could be due to the fact that the pericarp and seed coat of pigeon pea which composed of the fatty component was not affected by processing, however the lowest level of crude fat was observed in sample C, which could be due to de-hulling of pigeon pea which could have removed the seed coat that composes most of the crude fat. The moisture content of Sample A, B, C, and D were 7.91, 10.29, 9.54 and 13.65 respectively. Result showed that moisture content (%) was significantly highest in Sample D, which is as a result of sprouting; however Sample A had the lowest moisture content. It was however observed that there is no significant difference between Sample B and C which is consistent with the report of [14] who reported the moisture content of raw pigeon pea as 10.40.

Table 1. Proximate Composition of Processed Pigeon Pea Flours (%)

Parameter/Sample	A	B	C	C
Moisture Content	$7.91^c \pm 0.35$	$10.29^b \pm 0.02$	$9.54^b \pm 0.01$	$13.65^a \pm 0.04$
Crude Protein	$25.03^b \pm 0.16$	$16.74^d \pm 0.17$	$21.47^c \pm 0.01$	$38.43^a \pm 0.08$
Crude fat	$24.61^a \pm 0.12$	$18.41^b \pm 0.15$	$11.80^c \pm 0.02$	$12.83^c \pm 0.03$
Ash	$5.58^a \pm 0.01$	$5.08^a \pm 0.02$	$4.11^b \pm 0.11$	$5.41^a \pm 0.02$
Crude fibre	$8.93^a \pm 0.02$	$5.83^b \pm 0.05$	$5.34^b \pm 0.01$	$4.47^c \pm 0.02$
Carbohydrate	$35.85^c \pm 0.01$	$53.92^b \pm 0.12$	$57.28^a \pm 0.02$	$38.86^c \pm 0.08$

Values are means of 3 replications

Values along the same row followed by the same letter are not significantly difference ($p<0.05$).

The ash content of sample A, B, C and D were 5.58, 5.08, 4.11 and 5.41 respectively. Result showed that there is no significant difference in the ash content of sample A, B and D, whereas a significant decrease is observed in sample C. This may be due to the effect of dehulling which removed the seed coat that contains the ash content of the pigeon pea. The carbohydrate content of sample A, B, C and D were 35.85, 53.92, 57.28 and 38.86 respectively. Results showed that there is a significant increase in carbohydrate content of sample C, whereas there is significant decrease in carbohydrate content of sample A and D.

3.2 Effect of Traditional Processing Methods on the Anti-nutritional Properties of Pigeon Pea Flours.

The results of the effect of traditional processing method on the anti-nutritional composition of pigeon pea flour are presented in Table 2. The phytic acid (%) of the control (sample A), sample B, C and D were 7.61, 7.68, 7.00 and 5.27 respectively.

Table 2. Anti-nutritional Properties Processed Pigeon Pea Flour

Parameter/sample	A	B	C	D
Phytic acid (%)	7.61[a] ± 0.11	7.68[a] ±0.01	7.00[a] ± 0.20	5.27[b] ±0.90
Tannin (mg/100g)	14.72[a] ± 0.48	13.10[b] ± 0.70	13.82[b] ± 0.30	8.52[c] ±0.22
Protease inhibitor (%)	7.60[a] ± 0.35	6.78[b] ± 0.60	6.72[b] ± 0.05	5.09[c] ± 0.81

Values are means of 3 replications

Values along the same row followed by the same letter are not significantly difference ($p<0.05$).

Result showed that there is significant decrease in phytic content of sample D; this could be due to sprouting of pigeon pea which reduced the effect of Phytic acid that could compromise the mineral absorption. The tannin content (%) of sample A, B, C and D were 14.72, 13.10, 13.82 and 8.52 respectively. Results showed that there is significant decrease in tannin content of sample B, C and D; this could be due to the effect of soaking and sprouting which leached most of the tannin content. The protease inhibitory of sample A, B, C and D were 7.60, 6.78, 6.72 and 5.09 respectively. Results also showed that there is significant decrease of protease inhibitory in sample B, C and D, this could also be due to the effect of soaking and sprouting that leached most of the tannin content.

IV. Conclusion

The study has revealed the effect of traditional processing methods on the nutritional and anti-nutritional composition of pigeon pea. The results obtained have shown that traditional processing significantly improved the nutritional quality of pigeon pea and reduced the anti-nutritional composition of pigeon pea. Protein content of pigeon pea was significantly increased while the fat content was significantly decreased due to sprouting respectively. The phytic acid which compromises minerals absorption was also significantly reduced by sprouting. Fat content of pigeon pea was significantly highest in the control which could have a negative effect on rancidity.

References

[1] K.H. Brown. The importance of dietary quality versus quantity for weaning in less developed countries: A framework for discussion. Food Nutr Bull. 1991, 13: 86-94

[2] M.H.N. Golden. The nature of nutritional deficiency in relation to growth failure and poverty. Acta Paediatr Scand Suppl. 1991, 374: 95-110

[3] J.A. Duke. Handbook of legumes of the world economic importance. New York: Plenum Press. 1981, Pp 33-37

[4] B.O. Eggum and R.M. Beames . The nutritive value of seed proteins: Biochemistry, Genetics and Nutritive value. Gottschalk Muller HP. (eds). Martinus Nijhoff/ W. Junk Publishers, the Hague. 1983, Pp. 499-531

[5] R.S. Gibson. Zinc nutrition in developing countries. Nutr Ress Rev. 1994, 7: 73-151

[6] J.W. Erdman, A.G. Pneros-Schneier, M.E. Shils, J.A. Olson and M. Shile. Factors affecting nutritive value in processed foods: Modern nutrition in health and disease. Philadelphia. 1994, P. 1569.

[7] V. Lyer, D.K. Salunkhe, S.K. Sathe and L.B. Rockland. Quick cooking beans (*Phaseolus vulgaris L.)*. Phytates, oligosaccharides and anti-enzymes. Qual. Plant foods Hum Nutr. 1980, Pp 30-45

[8] D.B. Rodriquez-Amaya. Carotenoids and food preparation: The retention of provitamin. A carotenoid in prepared, processed and stored foods. Arlington: Opportunities for Micronutrient Intervention (OMNI). 1997.

[9] A.O.A.C. Official Methods of Analysis, 17th edition. Association Official Analytical Chemists. International, Gaithersburg, Maryland. 2000

[10] A.O.S. Makkar and A.V. Goodchild (1996). Quantification of Tannin: A laboratory Manual International Centre for Agricultural Research in Dry Areas (ICARDA). Aleppo, Syria. 1996, IV p 25

[11] S.M. Young and J.S. Greaves. Influence of variety and treatment on phytin content of wheat. Food Res. 1990, 5: 103-105

[12] J.N. Ladd and J.H. Butler. Short term assay on soil proteolytic enzyme activity using proteins and dipeptide substrate. Soil biology and biochemistry. 1972, 4: 19-39

[13] J.N. Nwosu, N.C. Onuegbu, N.O. Kabuo and M.O. Okeke (2010). The effect of steeping with cheimcals (Alum and Trona) on the proximate and functional properties of pigeon pea (*Cajanus cajan*) flour.

[14] P.N. Ghadge, S.V. Shewalkar and D.B. Wankhede. Effect of processing methods on qualities of instant whole legume: Pigeon pea (*Cajanus cajan*). Agricultural Engineering International. The CIGR e-journal manuscript FP FP 08004. 2008,Vol. X