International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 23, No. 2, p. 28-33, 2023

INNSPUB

RESEARCH PAPER

OPEN ACCESS

Proximate and phytochemical analyses of raw and differently processed pigeon pea seeds as potential animal feed

Adeolu Modupe Esther*, **Asolo Olayinka Hannah, Akinrinmade Bobola Philip**

Department of Animal Health and Production Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria

Article published on August 08, 2023

Key words: Pigeon pea seed, Proximate, Phytochemical processing, Animal feed

Abstract

Proximate and Phytochemical analyses of Raw and differently processed Pigeon pea seeds as potential Animal feed was conducted at the Nutritional Laboratory of Food Science and Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria. Pigeon pea (*Cajanus cajan*) as the test ingredient was obtained from local markets in Owo. The seeds were handpicked and winnowed to remove all the foreign materials, after which the seeds were processed using the following methods; soaking, boiling, and toasting at different times (24 hours, 48 hours, and 72 hours soaked; 15 minutes, 30 minutes, and 45 minutes boiled; 5 minutes, 10 minutes, and 45 minutes toasted). Proximate and phytochemical analyses were carried out using standard methods of analysis. The results revealed that the anti-nutritional factors in the processed pigeon pea seed meal (PPSM) had a lower range for oxalate (0.81-2.07mg/g), phytic acid (0.46-9.02mg/g), saponin (0.85-2.97mg/g), tannin (0.21-1.35%), and trypsin inhibitor (1.01-13.11%) as against 2.43mg/g, 10.71mg/g, 24.72mg/g, 4.17%, and 29.40% obtained for raw pigeon pea seed meal, respectively. It was concluded that processing (soaking, boiling, and toasting) of PPSM reduced the level of anti-nutritional factors (oxalate, phytate, saponin, tannin, and trypsin inhibitor), and thus the inclusion of processed pigeon pea seed meal is recommended as an ingredient in animal feed as it offers high nutritive value due to its high crude protein content. Also, processing by soaking, boiling, or toasting as analyzed in this study is recommended to reduce the content of its anti-nutritional factors.

* **Corresponding Author:** Adeolu Modupe Esther ✉ adeolumodupe2021@gmail.com

Introduction

The pigeon pea is a leguminous plant from the Fabaceae family that was introduced to America and East Africa about 3000 years ago from Asia. It is referred to as "Wake masa" by the Hausa, "Fiofio" by the Igbo, "Otili" by the Yoruba, and "Agwugwu" by the Igalas in Nigeria, where it is produced on a yearly basis in quantities of about 147 tonnes (Oke, 2014).

Pigeon pea seeds include various dietary components and comprise 85% cotyledons, 14% seed coat, and roughly 1% embryo (Singh *et al.*, 2020). In most markets throughout Nigeria, pigeon pea is readily available. Still, due to geographic location, cultivar, growth conditions, and storage conditions, there is a significant variation in the chemical makeup of the crop (Fatokimi and Tanimonure 2021).

One of the most popular legumes grown for its palatable seeds in tropical and subtropical regions is the pigeon pea (*Cajanus cajan* (L.) Mill.). the pigeon pea is drought resistant, tough, and quick to adapt (*Saxena et al.,* 2020). In areas where rain failures are common, drought resistance might be thought of as being of the utmost importance for food security (Semba *et al.,* 2021).

Despite being a significant legume, the pigeon pea (*Cajanus cajan*) has very little appeal to humans as a food source due to the availability and more palatable flavour of other, simpler-to-cook beans like cowpea. Right now in Nigeria, it serves no industrial purpose. Up to 30% of livestock have found it to be a suitable source of protein (Amaefule *et al.*, 2011). However, the presence of anti-nutritional elements such as trypsin inhibitors, chymotrypsin inhibitors, amylase inhibitors, haemagglutinins, tannins (polyphenols), saponins, cyanide, phytic acid, oxalate, etc. may make the use of pigeon pea seed in monogastric feeding problematic. (Duhan and others, 2001; Igene *et al.,* 2012), which affects the legume's bitter or unpleasant taste and reduces its ability to digest proteins and absorb divalent metal ions like Fe^{2+} and Zn^{2+} in the colon (Abdu *et al.,* 2008). In order to fully utilize pigeon pea seeds as a feed ingredient, it is crucial to remove these unwanted components. At this time, boiling, boiling and de-hulling, toasting, and roasting are the main procedures used to process raw pigeon pea seeds (Akintunde *et al.,* 2010; Yisa *et al.,* 2010).

Objective of the Research

The objective of this research is to determine the proximate and some phytochemical compositions of raw and processed pigeon pea seeds.

Marterials and methods

Experimental site

The study was carried out at the Nutritional Laboratory of Food Science and Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.

Source and preparation of test ingredients

The test component, pigeon pea (*Cajanus cajan*), was purchased at neighbourhood markets in Owo, Ondo State, Nigeria. The seeds were hand-selected, winnowed to remove any foreign materials, and then processed by soaking, boiling, and toasting them at various times (for example, for 24 hours, 48 hours, and 72 hours; for 15 minutes, 30 minutes, and 45 minutes; and for 5 minutes, 10 minutes, and 45 minutes, respectively).

Raw pigeon pea seed meal

After being cleaned, the raw pigeon pea seeds were ground into a meal known as raw pigeon pea seed meal (RPPM) using a hammer mill equipped with a 0.2mm sieve. RPPM was kept in an airtight container and then its proximate and phytochemical composition was determined.

Soaking of pigeon pea seeds

In order to create three different types of soaked pigeon pea seed meal (SPPM), 15kg of pigeon pea seeds were soaked in 75 litres of clean water for 24 hours, 48 hours, and 72 hours, respectively, in three different drums. After the water was drained off, the soaked seeds were sun-dried for 4 days during the dry season.

Boiling of pigeon pea seeds

On a gas cooker, 25 litres of cold, clean water were heated to boiling, and 15 kg of raw pigeon pea seeds were added. The water was then covered and allowed to boil for 15, 30, and 45 minutes, respectively. The instant the pigeon pea seed was added to the boiling water, the process of boiling began (Audu and Aremu, 2011). After the seeds had boiled for the specified amount of time, the water was drained out, and they were left to dry in the sun for 4 days. During the dry season, the sun-dried seeds were ground into 3 different kinds of boiled pigeon pea seed meal (BPPM).

Toasting of pigeon pea seed

The eroded fine sand was placed in a sizable frying pan over a fire, and pigeon pea seeds were added. The seeds were stirred continuously for 5 minutes, 10 minutes, and 15 minutes, respectively, to toast them until they were a golden brownish colour. To obtain three different varieties of toasted pigeon pea seed (TPPM), the toasted seeds were separated from the sand and allowed to cool for an additional 30 minutes.

Proximate analysis

Proximate analyses of the experimental samples were carried out according to AOAC (2012).

Phytochemical analyses

Standard analytical techniques were used for the phytochemical analyses; phytate was determined in accordance with Maga (1983), oxalates in accordance with Soetan *et al.,* trypsin inhibitor in accordance with Liener (1980), tannin in accordance with Makkar and Goodchild (1996), and saponin in accordance with Brunner (1984).

Statistical analysis

Using a completely randomized design and analysis of variance (ANOVA), the data were acquired (S.A.S., 2012). Duncan's Multiple Range Test (Duncan, 1955) distinguished between significant means. The overall confidence threshold for testing statistical significance was set at 5%.

Result

Table (I) lists the chemical make-up of the test components (raw and processed pigeon pea seed meal). Crude protein (28.10 to 30.51%), ether extract (2.10 to 2.21%), crude fiber (7.49 to 10.11%), ash (4.81-5.61%), nitrogen-free extract (44.42 to 50.11%), and dry matter (86.61 to 91.96%) are the ranges of proximate composition. All the parameters evaluated revealed that there were significant ($p<0.05$) differences. Oxalate, phytic acid, saponin, tannin, and trypsin inhibitor levels were each reduced by roughly 95.32% as a result of processing pigeon pea seed meal (PPSM), which also decreased the other anti-nutritional elements evaluated.

Table I. Chemical and Phytochemical compositions of the raw anddifferently processed pigeon pea seed meal.

Parameters	Soaking time					Boiling time					Toasting time				
	Raw	24hrs	48hrs	72hrs	SEM	Raw	15min	30min	45min	SEM	Raw	5min	10min	15min	SEM
Crude protein (%)	28.10^{b}	28.30^{b}	28.47^{ab}	30.51^{a}	0.29	28.10^{d}	28.40^{c}	28.62^{b}	29.37^{a}	0.14	28.10^{d}	30.17^{a}	29.22^{b}	29.01^{c}	0.22
Ether extract (%)	2.10	2.14	2.15	2.21	0.02	2.10^{b}	2.12^{b}	2.11^{b}	2.20^{a}	0.01	2.10^{b}	2.21a	2.13^{ab}	2.14^{ab}	0.01
Crude fibre (%)	7.49^{d}	7.61^{c}	7.84^{b}	10.11^{a}	0.32	7.49^{d}	7.52^{c}	7.69^{b}	9.88^{a}	0.30	7.49^{d}	10.00^{a}	8.01^{c}	8.97^{b}	0.29
Ash (%)	4.81^{b}	4.83^{b}	4.86^{ab}	5.23^{a}	0.05	4.81^{b}	5.00^{a}	5.14^{a}	5.17^{a}	0.24	4.81^{b}	5.54^{ab}	5.55^{ab}	5.61^{a}	0.10
Nitrogen Free extract (%)	50.11^{a}	49.12^{b}	48.80^{c}	44.42^{d}	0.66	50.11^{a}	49.07^{b}	48.54^{c}	45.60^{d}	0.50	50.11^{a}	44.95^{d}	47.99^{b}	47.23^{c}	0.56
Dry matter (%)	86.61^{d}	87.00^{c}	87.12^{b}	87.48^{a}	0.09	86.61^{b}	88.11^{ab}	88.10^{ab}	88.22^{a}	0.20	86.61^{d}	88.87^{c}	89.90^{b}	91.96^{a}	0.58
Phytochemicals															
Oxalate (mg/g)	2.43^{a}	1.71^{b}	1.54^{c}	1.20^{d}	0.14	2.43^{a}	2.07^{b}	1.53^{c}	0.90^{d}	0.17	2.43^{a}	1.08^{ab}	1.06^{ab}	0.81^{b}	0.19
Phytic acid (mg/g)	10.71^{a}	9.02^{b}	5.06^{c}	1.71^{d}	1.01	10.71^{a}	8.24^{b}	4.89^{c}	2.24^{d}	0.97	10.71^{a}	1.06^{b}	0.89^{c}	0.46^{d}	1.30
Saponin (mg/g)	24.72^{a}	2.97^{b}	2.40^{c}	1.63^{d}	2.92	24.72^{a}	2.55^{b}	2.09^{c}	0.91^{d}	2.99	24.72^{a}	1.63^{b}	1.32^{c}	0.85^{d}	3.06
Tannin (%)	4.17^{a}	0.45^{b}	0.39^{c}	0.21^{d}	0.49	4.17^{a}	1.03^{b}	0.98^{c}	0.92^{d}	0.42	4.17^{a}	1.17^{d}	1.20^{c}	1.35^{b}	0.38
Trypsin inhibitor (%)	29.40^{a}	11.16^{b}	5.09^{c}	2.70^{d}	2.97	29.40^{a}	13.11^{b}	5.71^{c}	2.01^{d}	2.90	29.40^{a}	1.61^{b}	1.41^{c}	1.01^{d}	0.01

Discussion

Pigeon pea seed meal (PPSM) has a high crude protein and ether extract concentration, according to chemical analysis results. The range of protein values observed in this study (28.10–2.51%) was in agreement with the findings of Obioha (1992), Amaefule and Obioha (2001), and Onu and Okongwu (2006), who reported a range of 17.90–30.00%. Akubor (2017) reported a value of crude protein to be 24.90% for toasted pigeon peas and 22.00% for boiled pigeon peas; the value in this study, however, was not consistent with those reported in the literature (Aduku, 1993; Olomu, 2011). It also confirms the potential of the meal as a rich protein feedstuff in animal feed. Variations may result from different agro climatic conditions and seed and cultivar storage techniques (Arora *et al.,* 1983).

Pigeon pea seed meal (PPSM) that had undergone various processing methods had low levels of trypsin, oxalate, phytate, saponin, and other inhibitors. This was consistent with the findings of Sgwane *et al.* (2008), who claimed that all members of the Leguminoseae family still contain trace amounts of anti-nutrients. According to Al-Masri and Mardini (2013) anti-nutritional variables can have negative consequences and interfere with how well animals use their diet and produce. Before giving these drugs to the animals, they must be rendered inactive. In this study, the anti-nutritional factors in PPSM were reduced through processing. This finding was consistent with Akinmutimi's (2004) findings that anti-nutritional factors in legumes are typically reduced through soaking, sprouting, toasting, and cooking. When lentils were cooked, Wang *et al.* (2009) showed a similar outcome. Using dry heat to treat pigeon pea seeds resulted in a decrease in anti-nutritional factors, according to Egena *et al.,* (2007). Since anti-nutritional factors are known to influence monogastrics, this has a favorable impact. Animals' ability to absorb and use minerals has long been recognized to be inhibited by high levels of phytates and oxalates (Butler, 1989). Tannins lower the digestibility and palatability of protein, lowering its quality. When saponin concentrations are high, it damages cells by rupturing cell membranes, which stops cell proliferation (Mittal *et al.,* 2012). According to Farris and Singh (1990), trypsin inhibitors cause digestive losses by interfering with the activities of digestive enzymes. The test materials' concentrations of phytates, tannins, oxalates, saponins, and trypsin inhibitors were below the levels that would have a negative impact on their nutritional value or result in any harmful effects linked to these anti-nutritional components. Additionally, the current findings are consistent with those made by Akinmutimi (2004), who discovered that while hazardous compounds were reduced after processing, it was not possible to completely eradicate all traces of anti-nutritional components from feedstuffs.

Conclusion

The proximate analysis of raw and processed pigeon pea seed meal (PPSM) showed that it had a high amount of crude protein (between 28.1 and 30.51%). Oxalate, phytate, saponin, tannin, and trypsin inhibitor levels in PPSM were lowered as a result of processing (soaking, boiling, and toasting).

Recommendation(S)

Due to its high crude protein content and excellent nutritional value, processed pigeon pea seed meal is advised for use as an ingredient in animal feed. To lessen the content of its anti-nutritional components, processing pigeon pea seeds by soaking, boiling, or toasting is advised.

References

Abdu SB, Yashim SM, Kabir M, Musa A, Jokthan GE. 2008. Effect of Soaking medium on minerals and anti-nutritional factors in Baobab (*Adarnsonia digitata*) seeds. Proceedings of 33rd Annual Conference of the Nigerian Society for Animal Production (NSAP) at Olabisi Onabanjo University, Ayetoro, Ogun State, March, 2008 388-389.

Aduku AO. 1993. Tropical Feedstuff Analysis Table. Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Samaru, Zaria, Nigeria 196.

Akinmutimi AH. 2004. Evaluation of sword beans (*Canavalia gladiata*) as an alternative feed resources for broiler chicken. Journal of Poultry Science **4,** 453-496.

Akintunde AR, Omage JJ, Bawa GS. 2010. Effect of Allzyme Supplementation on the utilization of Differently Processed Pigeon Pea (*Cajanus cajan*) Seeds by Broiler chickens. Proceedings of 35th Annual Conference of the society for Animal production (NSAP) Ibadan, Nigeria 439-442

Akubor PI. 2017. Effect of processing methods on the chemical composition and functional properties of pigeon pea seed. Asian Journal of Advances in Agricultural Research **2(2),** 1-8

Al-Masri MR, Mardini M. 2013. Anti-nutritional components in leaves of some indigenous oak species at different growth stages. Livestock Research for Rural Development **25(2),** 301-307.

Amaefule KU, Obioha FC. 2001. Performance and nutrient utilization of broiler starters fed diets containing, boiled or de-hulled pigeon pea seeds. Nigerian Journal of Animal Production **28(1),** 31-39.

Amaefule KU, Oke UK, Obioha FC. 2011. Pigeon pea (*Cajanus cajan*) (L.) Mill. sp seeds meal in Laying Performance and Egg Quality Characteristics of Pullet fed Raw or Processed Pigeon pea Seed Meal Diets during Grower and Layer Stages of life. International Journal of Poultry Science **6,** 445-451.

Arora SP, Jaikihsan AA, Chopra RC. 1983. Nutritive value of Mesta cake for ruminant (Abstract). Indian Journal of Dairy Science **36,** 430-431.

Audu SS, Aremu MO. 2011. Effects of Processing on Chemical Composition of Red Kidney Bean (*Phaseolus vulgaris* L.) Flour. Pakistan Journal of Nutrition **10(11),** 1069-1075

Brunner JH. 1984. Direct Spectrophotometer Determination of Saponin. Journal of Animal Chemistry **34,** 1314-1326.

Butler LG. 1989. Effects of condensed tannin on animal nutrition in: "chemistry and significance of condensed tannin" Hemingway RW, Karchesy J.J., (Editor) Plenum Press New York, USA 391-402

Duhan A, Khetarpaul N, Bismoi S. 2001. Saponin content and trypsin inhibitor activity in processed and cooked pigeon pea cultivars, International Journal of Food Science and Nutrition **52(1),** 53-59.

Duncan DB. 1955. Multiple Range and F-test. Biometrics **11,** 1-24

Egena SSA, Yahaya SK, Shiawoya EI, Usman A. 2007. Effect of anaerobic fermentation/lye treatment and roasting of flamboyant seed on nutrient digestibility and carcass characteristics of broilers. International Journal of Tropical Agriculture and Food System **4,** 373-374

Fatokimi EO, Tanimonure VA. 2021. Analysis of the current situation and future outlooks for pigeon pea (Cajanus Cajan) production in Oyo State, Nigeria: a Markov Chain model approach. Journal of Agriculture and Food Research, 6, 100218. International Journal of Animal Science **6,** 88-94.

Igene FU, Isika MA, Ekundayo DA. 2012. Replacement value of boiled pigeon pea (*Cajanus cajan*) on growth performance, carcass and haematological responses of broiler chickens. Asian Journal of Poultry Science **6(1),** 1-9.

International AOAC, Guideline Working Group. 2012. AOAC INTERNATIONAL guidelines for validation of botanical identification methods. Journal of AOAC International **95(1),** 268-272.

Liener IE. 1980. Heat labile anti nutritional factors. In: Advances in Legume Science, (Eds. Summerfield, R.J. and Bunting, A.H.), Kew, London, Royal Botanic Gardens 157-170

Maga JA. 1983. Phytate: Its Chemistry, Occurrence, Food Interaction, Nutritional Significance and Methods of Analysis. Journal of Agriculture and Food Chemistry **30,** 1-9.

Makker HPS, Goodchild AV, El-Monein AA, Becker K. 1996. Cell constituents tannin levels by Biological Assays and nutritional value of some legumes foliage and straw. Journal of Science food Agric **71,** 129-136.

Matlala MV. 2020. Performance of elite pigeon pea (*Cajanus cajan*) varieties in Limpopo Province (Doctoral dissertation)

Mittal R, Nagi HPS, Sharma P, Sharma S. 2012. Effect of processing on chemical composition and antinutritional factors in chickpea flour. Journal of Food Science and Engineering **2(3),** p.180.

Obioha FC. 1992. A Guide to Poultry in the Tropics. Enugu, Nigeria, Acena Publishers.

Oke DG. 2014. Proximate and Phytochemical Analysis of Cajanus Cajan (Pigeon Pea) Leaves. Journal of Chemical Science **3(3),** 1172-1178.

Olomu JM. 2011. Monogastric Animal Nutrition, Principles and Practices. 2nd Edn., JAS Ventures Anyigba, Kogi State, Nigeria 80 - 98.

Onu PN, Okongwu SN. 2006. Performance characteristics and nutrient utilization of starter broilers fed raw and processed pigeon pea (*Cajanus cajan*) seed meal. International Journal of Poultry Science **5(7),** 693-697.

Saxena KB, Choudhary AK, Sultana R. 2020. Enhancement of rural income and nutrition by cultivating pigeon pea hybrids: Enhancement of Rural Income and Nutrition. Journal of Agric Search **7(4)**185-191.

Semba RD, Ramsing R, Rahman N, Kraemer K, Bloem MW. 2021. Legumes as a sustainable source of protein in human diets. Global Food Security **28,** 100520.

Sgwane TS, Teleni E, Gardiner CP. 2008. Kenaf seeds (*Hibiscus cannabinus* L) as a protein supplement to sheep. In: Proceedings of Australian Rangeland Society of 15th Biennial Conference. Charters Towers, QLD, Australia

Singh N, Rai V, Singh NK. 2020. Multi-omics strategies and prospects to enhance seed quality and nutritional traits in pigeonpea. The Nucleus **63,** 249-256.

Soetan KO, Akinrinde AS, Adisa SB. 2014. Comparative studies on the proximate composition, mineral and antinutritional factors in the seeds and leaves of African locust bean (*Parkia biglobosa*). Journal of Food Science and Technology **15(1)70.**

Wang N, Hatcher DW, Toews R, Gawalko EJ. 2009. Influence of cooking and dehulling on nutritional composition of several varieties of lentils (*Lens culinaris*). Journal of Food Science and Technology **42,** 845-848.

Yisa AG, Edache JA, Oyawoye EO, Diarra SS, Yakubu B. 2010. The effect of graded levels of boiled and dried pigeon pea seed meal on the carcass of cockerels. Journal of Environmental Issues and Agriculture in Developing Countries **2(2),** 125-131.