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Physical characteristics and effects of processing methods on pigeon pea varieties

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Abstract
Three varieties of pigeon peas (*Cajanus cajan*) were subjected to physical characteristics, cooking and sensory evaluation. Swelling capacity and cooking time ranged between 45.7 to 54.7% and 170–210 mins respectively. The red-brown coloured variety was the most acceptable among the varieties by sensory analysis. The effects of different processing methods were studied on the proximate, mineral and anti-nutritional factors of pigeon pea. Soaking and cooking method reduced cooking time but most of the processing methods reduced protein and mineral contents of pigeon pea. Roasted and fried seeds had higher protein, fat and ash contents than seeds from other processing methods. All processing methods significantly reduced the tannin, phytic acid and trypsin inhibitor contents of the seeds.

***Key words*:** Pigeon pea, processing, nutrients and antinutrients.

Introduction
Pigeon pea (*Cajanus cajan*) is one of the grain legume crops of the tropic and subtropics. It finds an important place in the farming systems adopted by small holder farmers in a large number of developing countries. It is ranked sixth in area and production in comparison to other grain legumes such as beans, pea and duck peas [1]. In Nigeria, pigeon pea is not usually consumed by the majority of the people because of the hard to cook phenomenon. Mature, dried, whole unsoaked seeds need to be cooked for hours by traditional processing methods. The hard seed coat of the pea constitutes to the longer cooking time. The seed coat when removed speeds cooking time. The seed coats are also high in fiber, low in nutrients and low in digestibility [1]. Apart from the long cooking time and fuel consumption encountered with peas, the presence of certain anti-nutritional factors also limit the utilization of the legume [1-4]. Since pigeon peas are well adapted to the tropical regimes [5, 6] and insufficient protein of good quality is limiting in many developing countries [7], there is a need to carry out research on processing methods that will improve the utilization of this legume. The effect of processing methods on phytic acid content in different legumes have been published in some studies [8]. This paper presents the physical cooking sensory properties of pigeon pea varieties in south-western Nigeria and the effect of processing methods on the nutritional and anti-nutritional properties of pigeon pea.

Material and Methods
Pigeon peas (mixed varieties) were collected from Iseyin, Oyo state, Nigeria. These were separated based on colour to have three varieties. The average grain weight of each variety was determined as the weight of fifty seeds [9]. The seed length and diameter were measured with a vernier caliper. Seed colour was determined by visualizing the seeds physically.

Seed density was determined according to the method of Alfonso et al. [10]. One hundred seeds were weighed and transferred into 100 ml measuring cylinder containing 50 ml of tap water. The seeds were allowed to soak for 10 mins for equilibration and the volume of water displaced was recorded. The mass and volume were used to calculate the density.

The swelling capacity was determined using the method of Alfonso et al. [10]. Swelling capacity was the difference between thousand grain weight before and after soaking for 18 hours.

Cooking time: Whole seeds were cooked to tenderness in boiling water (1:3 w/v). Tenderness was determined using the method of Njoku and Ofuya [11]. This was by feeling the beans between the fingers. The degree of tenderness was scored on 0 to 5 scale, with a zero rating very hard beans and a rating of 5 for very soft beans. The time required to achieve a rating of 4 (soft) was recorded as cooking time. Cowpea (Ife-brown) was used as control and for comparison.

Sensory analysis: The three varieties of cooked pigeon pea were presented to ten panelists as coded samples. Cooked cowpea (Ife-brown) was also used as control. The panelists were to taste and rinse their mouth with tap water between samples. They were asked to rate the samples by six sensory attributes namely, colour, appearance, flavour, texture, taste and overall acceptability. The most acceptable variety was subjected to other processing methods.

Processing of seeds: 1) *Soaking and cooking:* Whole seeds were soaked in water for 2 hours (1:5 w/v) and cooked in boiling water (1:3 w/v) until they were soft by hand feel. 2) *Cooking with water changes:* Seeds were cooked with water (1:3w/v). The water was changed at 30 minutes interval twice. 3) *Dehulling:* Whole seeds were soaked in warm water (40°C) for 30 minutes. The seeds were dehulled using a mortar and pestle. 4) *Roasting:* Seeds were roasted at 150°C for 5 minutes. 5) *Frying:* Seeds were deep-fried in soybean oil at 190°C for 5 minutes.

Chemical analyses: Proximate analysis of the samples were done according to AOAC [12]. Calcium (Ca) content was determined using atomic absorption spectrophotometer (Model Buck 2000) and phosphorus was determined colorimetrically [12]. Analysis of tannin [13], phytic acid [14] and trypsin inhibitor [15] were carried out.

Statistical analysis: Sensory results and other data were subjected to analysis of variance and means were separated by Duncan's multiple range test using SAS [16].

Results and Discussion

The physical and cooking properties of pigeon pea varieties are presented in Table 1. The pigeon pea varieties were light brown, red-brown and black. Grain weight of fifty seeds was in the range of 4.83 - 5.14 g. Seed density was in the range of 1.51 - 1.87g /cm^3.

Light brown variety had the highest swelling capacity of 54.7% among the varieties and the lowest cooking time of 170 mins. Ife-brown cowpea had a lower grain weight, size, density and cooking time (20 minutes) than the other varieties. Higher swelling capacity was also recorded for Ife-brown. Higher swelling capacity and reduced cooking time of Ife-brown cowpea could be attributed to its soft and rough skin that allows for easy migration of water into the seed unlike the pigeon pea varieties with hard seed coat, thereby undergoing the hard-to–cook phenomenon. Latunde-dada [9] recorded a swelling capacity of 43.9-94.5% for twelve varieties of cowpea.

The sensory properties of the cooked pigeon pea varieties are shown in Table 2. Among the varieties, the red-brown colored variety was the most acceptable in terms of colour, appearance, flavour, taste and overall acceptability. In comparison to cowpea (Ife-brown), Ife-brown was more acceptable than the pigeon pea varieties in all the sensory attributes tested (Table 2). Latunde-dada [9] also reported that seed coat colour greatly influences the choice and marketability of cowpea varieties in Nigeria. He reported that the brown coated cowpea varieties are more favoured above the white-coated beans. In this study, the red-brown pigeon pea was more acceptable than the light brown or black coloured varieties.

Table 3 shows the effect of processing methods (apart from cooking) on the chemical composition and anti-nutrients of the pigeon pea. The crude protein content of the red-coloured pigeon pea was 25.9%. This protein content did not differ from previous reports of other legumes [17-19]. Soaking and cooking reduced cooking time to 120 mins. Cooking with water changes did not change cooking time but improved the palatability of the seeds. All processing methods utilized reduced protein content of the seeds especially in the cooked seeds with water changes. For the soaked and cooked beans, enhanced permeability of seed coat as a result of the soaking process improved the cooking process which also had a limitation on increasing the leached solid into the boiling water, there by responsible for reduction in the protein content. Aletor and Ojo [20] also observed reduction in chemical composition due to loss of water soluble nutrients during cooking. Pigeon pea is very low in fat content. The process of frying increased the fat content of the peas due to absorption of the frying oil by the seeds. Ash, Ca and P contents of the pea were also reduced by the processing methods.

All the processes significantly reduced the phytate, trypsin inhibitor and tannin contents of the seeds (Table 4). The cooking method with water changes twice had the lowest trypsin inhibitor content. Generally, trypsin content was reduced within the range of 8.8–12.1 Tiu/g from 30.1 Tiu/g in the raw seed. Nehad [21] observed that presoaking reduced the antinutrient in faba beans.

Table 1. Physical and cooking properties of pigeon pea varieties in comparison with cowpea (Ife-brown).

Seed colour	Grain weight (g)	Grain length (cm)	Grain diameter (cm)	Seed density (cm^3)	Swelling capacity (%)	Cooking time (min)
Light-brown	5.14* ± 0.22	2.18 ± 0.02	2.11 ± 0.03	1.87 ± 0.01	54.7 ± 2.33	170
Red-brown	4.83 ± 0.06	2.21 ± 0.01	2.08 ± 0.02	1.70 ± 0.02	46.2 ± 3.67	200
Black	5.02 ± 0.14	2.18 ± 0.04	2.11 ± 0.02	1.77 ± 0.02	45.7 ± 2.22	210
Cowpea (Ife-brown)	4.02 ± 0.11	1.52 ± 0.03	1.63 ± 0.05	1.51 ± 0.01	70.9 ± 2.51	20

*Mean of three readings, ± standard deviation

Table 2. Sensory properties of cooked pigeon pea varieties in comparison with cowpea (Ife-brown).

Variety	Colour	Appearance	Flavour	Texture	Taste	Overall acceptability
Light-brown	5.63^c	4.75^c	3.00^c	3.88^b	4.80^a	4.63^c
Red-brown	5.88^b	5.40^b	4.82^b	3.92^b	5.60^{bc}	5.62^b
Black	4.88^c	4.63^c	3.63^c	3.66^b	5.00^b	4.92^c
Cowpea (IB)	7.50^a	6.88^a	7.00^a	6.75^a	7.38^a	6.99^a

*Means in the same column not followed by the same superscript are different p<0.05. IB= Ife brown

Table 3. Effect of processing methods on the proximate composition of pigeon pea.

Processing method	Protein (%)	Fat (%)	Ash (%)	Ca (%)	P (%)
Cooked seeds	8.30^d	1.1^c	4.41^a	0.13^d	0.21^d
Soaked and cooked seeds	10.64^c	0.54^{cd}	1.72^d	0.14^d	0.19^d
Seeds cooked with water changes	7.91^d	0.33^d	1.32^e	0.18^b	0.14^e
Dehulled seeds	9.84^c	0.72^{cd}	1.30^e	0.11^{de}	0.29^b
Roasted seeds	15.30^b	2.46^b	3.87^c	0.15^e	0.26^{bc}
Fried seeds	15.54^b	7.50^a	3.71^c	0.16^{bc}	0.15^e
Raw seeds	25.97^a	2.36^b	4.14^b	0.37^a	0.42^a

Means in the same column not followed by the same superscript are different at P<0.05.

Table 4. Effect of processing methods on anti-nutritional factors of pigeon pea.

Method	Tannin g/100 g	Phytate g/100 g	Trypsin inhibitor (Tiu/g)
Cooked seeds	4.14^b	1.94^b	11.65^{bc}
Soaked and cooked seeds	3.13^c	2.34^b	9.41^d
Seed cooked with water changes	2.17^c	1.85^{de}	12.16^b
Dehulled seeds	2.15^e	2.24^c	8.78^d
Roasted seeds	2.56^d	1.77^e	10.18^{cd}
Fried seeds	2.00^c	1.64^f	8.94^d
Raw seeds	4.60^a	4.80^a	30.27^a

*Means in the same column not followed by the same superscript are different at P<0.05.

In conclusion, the colour of the pigeon pea influenced the acceptability of the legume, so breeding of improved varieties should be towards such desirable traits as the red-brown pigeon pea with softer seed coat.The different processing methods the utilisation of the pigeon pea, however roasted and fried peas gave better nutrient compositional

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