

REGULAR ARTICLE

Effect of processing techniques on the overall quality attributes of cookies produced from jackbeans and wheat flour

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Abstract

The study was carried out to determine the effectiveness of heat processing on jackbeans, an underutilized legume. Raw and processed seed flour (roasted at 120°C for 10 mins and pressure cooked for 10 mins) produced from jackbeans were evaluated for its nutritional quality and antinutritional factors using standard methods. The nutritional qualities determined showed that sample with 20% pressure cooked jackbeans flour supplement has the highest amount of protein, fat, fibre and ash content, while the sample with 40% supplementation of pressure cooked jackbeans flour has the highest percentage of moisture content. The cookies produced from 100% wheat flour has the highest percentage of carbohydrate, while sample with 40% roasted jackbeans flour supplement has the highest percentage of concanavanine A. The antinutritional factors of the processed flours were found to be lower than the raw seed flour. Sensory qualities determined showed that sample with 20% of pressure cooked jackbeans supplement was rated high in terms of taste, aroma, texture, and overall acceptability, while cookies with 100% wheat flour was rated high 7.7 in term of colour. This study showed that thermal processing especially pressure cooking decreased the antinutritional contents of the jackbeans flour than other processing methods used.

Key words: Jackbeans; antinutritional factors; pressure cooked jackbeans; concanavanine A

Introduction

The demand for protein rich food is constantly increasing worldwide, especially in developing nations, due to the population increase and diminishing agricultural production. Although cereal grains served in this aspect, still the demand is not met with in most of the countries, which leads to the option of alternative high costly sources for energy nutrition (Sridhar and Seena 2006). Main sources of protein rich foods are leguminous plants (Bressani, 2002). Jackbeans (*Canavalia ensiformis*) is an important, but under exploited beans, the seed contains about

300g/kg crude protein and 600g/kg carbohydrate (Udedibia and Nkwocha, 1990). The intended use of Jack beans flour for the production of cookies is to increase the use of the beans and enhance food security in children and adults in tropical regions. Composite flour produced from cereals and legumes such as wheat flour and jackbeans flour have the advantage of improving overall nutrition (FAO, 1995). In selecting the components to be used preferably it should be readily available, culturally acceptable and provide increased nutritional potential (Akobundu *et al.*, 1998).

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The consumption of cereal based foods like cookies require the development of an adequate substitute that would be readily available, cheap, and able to replace wheat flour in terms of its functionality (Hussain et al., 2006). Cookies are mainly produced from hard wheat flour (*Triticum* spp) and different techniques are used for the production. These methods are either the mixing method, which is involves the sieving of flour, baking powder, and nutmeg (dry ingredients), sugar and margarine of a known weight together and mixed thoroughly, beaten eggs were added; and also the sifted dry ingredients were added and mixed together to produce batter. The batter is rolled out on a rolling board to 0.5cm height and cut into shape. The cookies are now baked in a pre-heated electric oven; cookies were produced from the composite flour of wheat flour and jackbeans flour.

Jackbeans flour cannot be used all alone in the production of cookies, because it lacks gluten which is responsible for risen up of flour in any pastry production; so wheat flour has to be added to produce composite flour which is used for cookies production and other baked products. In view of the above, the objectives of this study were to determine the effect of different processing techniques on the anti-nutritional factors and the proximate composition of jackbeans, and also to determine the overall quality attributes of cookies produced from composite flour of processed jackbeans and wheat flour.

Materials and method

The matured seeds were obtained from International Institute of Tropical Agriculture IITA, Ibadan and was planted in the Federal Polytechnic Offa, experimental farm in May 2014. The beans were matured and harvested in December 2015. Other ingredients for cookies production were obtained from Owode market, Offa, Kwara State.

Preparation of samples

Raw (Control) samples

The raw samples were dried in the sun and broken by the use of mortar and pestle to remove the seed coats. The seed were milled, sieved and packaged in an air tight container for further use.

Roasting method

The roasting method was carried out by the use of sand bath which was pre heated to temperature of 120° C and 1kg of jackbeans

seed was introduced which was roasted for 10 minutes. The jackbeans were removed and allowed to cool to room temperature, roasted seeds were dehulled, milled (attrition milling), sieved using 1mm mesh size and packaged in an air tight container until required for use.

Pressure cooking method

The pressure cooking was carried out by the use of household pressure cooker (Crown star) Master chef No MC-PC 7005 in 1:3 (w/v) distilled water. One kilogram of the jackbeans seeds was weighed and pressure cooked for 10 minutes, cooled, dehulled, dried in a hot air oven at 55°C for 6 hrs, milled using attrition mill, sieved and package in an air tight container until it is require for use.

Analysis for Jack beans flour

The proximate analysis (protein, moisture content, crude fibre, ash, crude lipid) was determined using the approved AOAC method (2000) while carbohydrate was calculated by difference.

Anti- nutritional content determination

Heamagglutinin activity of jack beans flour was determined based on Liner (1953) method, while trypsin inhibitor activity was done according to the procedure described by Kakade et al. (1974). Tannin content was determined according to AOAC (2000). Phenolics and concanavalin A contents were determined as described below.

Phenolics content

Phenolics content was analysed from sample by following AOAC (1984) and as described by Mako (2013).

Concanavalin A determination

1g of flour was weighed into a 50ml digestion tube, 20ml of 6MHCl was added and allow to digest by placing in the digestion hole of Tecator BD 30 digestion unit to homogenize the sample to clear filtrate. The digest was allowed to cool and was filtered into 100ml volumetric flask up to mark with double distilled water. 1ml of the filtrate was pipette into a 20ml test tube, 0.5ml of phosphate buffer and 0.5ml of aqueous sodium nitroprussiate solution were added. Working standard solution of concanavanine A of range of 0-5ppm were prepared from stock 25 ppm concanavaline a solution was treated similarly with phosphate buffer and sodium nitroprussiate solution. The mixture was stirred vigorously and stored in a dark cabinet

for 2hrs to a reddish colour indicating the presence of concanavaleine A was obtained. After 2hours the absorbance of sample extract and working standard against blank were read on a spectronic 21D spectrophotometer at a wavelength of a 520nm.

Cookies production

Cookies were produced based on AACC (2000) method with some modification. 250gm of flour (composite flour) sugar 125g, hydrogenated fat 12g, 1 egg (each 60g) and 5gm of baking powder. The cookies were produced by the process of weighing accurately the ingredients, whereby fat and sugar were mixed until fluffy, whole eggs was added and dry ingredient (baking powder, nutmeg) were added together and mixed thoroughly with the use of a dough mixer. The dough was rolled out using a 0.5cm height rolling board and cut into shape with aid of a cookie cutter. The oven was pre-heated at the temperature of 190°C for 3-4 min and baking was carried out at 185°C for 10 min. The cookies sample after production were allowed to cool to room temperature and stored in an air tight container. Cookies made from whole wheat flour serves as the control.

Cookies quality parameters

Physical analysis

The physical analysis of the cookies was determined based on AACC (2000) method includes the following: spread factor, diameter (width) and thickness (height).

Spread factor (SF) was determined from the diameter and thickness as following:
 Calculation

$$S.F = \frac{D \times CF \times 10}{T}$$

Where CF = correction factor at constant atmospheric pressure, is 1.0, D = diameter (width)

T = thickness. The diameter and thickness of cookies were determined in mm with venial caliper. This process was repeated thrice (3x) to get an average value of the result which was reported in mm.

Nutritional qualities of cookies produced

Proximate composition analysis

The proximate composition of cookies produced was carried out (moisture content, fibre, crude protein, fibre, and ash content) according to AOAC method 2000 and the carbohydrate was calculated by difference.

Statistical Analysis

All data were statistically analyzed using SPSS version 17.0 for analysis of variance, while Duncan multiple range test (DMRT) was used to separate means where there is a significant difference. For each sample, triplicate determinations were carried out.

Results and discussions

The data presented in Table 1 showed the proximate composition of jackbeans flour. The crude protein of roasted jackbeans flour was found to be higher (18.63) than the pressure cooked jackbeans flour (16.73). This may be due to the fact that roasting would concentrate the nutrients present in the food as the water molecule are evaporated or volatilized out; on the other hand, the pressure cooked seed has a reduced protein content which may be due to the breaking down of protein coupled with leaching effect of water on cooking. The crude fibre of the pressure cooked flour was found to be lesser (1.84) than that of raw and roasted flour (2.07 and 1.99). Low crude fibre is nutritionally appreciated because it traps less protein and carbohydrate (Balogun & Fetuga, 1986). The fat content was found to be higher in roasted jackbeans flour (1.96) than the pressure cooked and raw flour (1.70 and 1.88) respectively. The ash content of raw and roasted jackbeans flour were higher than the pressure cooked flour. This might be due to the leaching out of the micronutrient during pressure cooking time. The moisture content of pressure cooked flour was found to be higher (17.84) than the raw and roasted jackbeans flour (9.91 and 6.49), respectively. The crude carbohydrate of roasted jackbeans flour was higher than the raw and pressure cooked jackbeans flour.

Table 1. Proximate composition of raw and differentially processed Jack beans flour.

Sample	%Moisture	%Protein	%Fat	%Crude fibre	%Ash	%CHO
Raw	9.91±0.04 ^b	19.84±0.06 ^{bc}	1.88±0.02 ^a	2.07±0.02 ^{ab}	3.04±0.04 ^{ab}	63.26±0.05 ^b
Roasted	6.49±0.02 ^a	18.63±0.04 ^b	1.96±0.02 ^b	1.99±0.02 ^a	2.97±0.01 ^a	67.96±0.03 ^c
Pressure cooked	17.84±0.02 ^c	16.73±0.06 ^a	1.70±0.02 ^a	1.84±0.02 ^a	2.88±0.02 ^a	59.01±0.03 ^a

All values are expressed as mean ± SD of three replicate determinations. Mean values in the same column with different superscript are significantly different (p < 0.05).

Table 2. Effect of processing on the anti-nutritional activity of jackbeans flour.

Sample	Tannin (μm)	Hemmaglutini n (μm)	Trypsin Inhibitor (μm)	Phenolics (μm)	ConcanavalineA (μm)
Raw	0.41 \pm 0.02 ^a	38.72 \pm 0.03 ^c	19.19 \pm 0.02 ^c	0.93 \pm 0.02 ^c	0.79 \pm 0.001 ^c
Roasted	6.49 \pm 0.02 ^b	0.16 \pm 0.02 ^a	0.40 \pm 0.02 ^a	0.28 \pm 0.02 ^a	0.06 \pm 0.001 ^a
Pressure cooked	0.03 \pm 0.20 ^a	1.41 \pm 0.03 ^b	3.77 \pm 0.02 ^b	0.52 \pm 0.02 ^b	0.23 \pm 0.002 ^{ab}

All values are expressed as mean \pm SD of three replicate determinations. Mean values in the same column with different superscript are significantly different ($p < 0.05$).

Processing techniques alters the anti-nutritional constituents of jackbeans flour as showed in Table 2. The level of tannin content of jackbeans flour was found to be lower in pressure cooked flour (0.245) than roasted and raw flour (0.295 and 0.41) respectively. The level of total free phenolics compounds of jackbeans flour was found to be lower in roasted flour (0.277) than the pressure cooked and raw jackbeans flour (0.529 and 0.925). The hemagglutinins activity was found to be lower in the roasted jackbeans flour (0.155) than the pressure cooked and the raw jackbeans flour (1.41 and 38.72) respectively. The trypsin inhibitor activity of roasted jackbeans flour was found to be lower (0.395) than that of the pressure cooked and the raw flour (3.77 and 19.19) respectively. The concanavalin A content was found to be lower in roasted jackbeans flour (0.064) than the pressure cooked and the raw flour (0.233 and 0.79) and concanavalin A was reported as one of the most important anti-nutritional factors in *Canavalia ensiformis* seeds (Udedibie and Carlini, 1998). However, roasting and pressure cooking has a significant effect on the level of this anti-nutritional factor. It was reported that concanavalin binds to carbohydrates of intestine and resists digestion (Putsztai, 1989).

The result of Table 3 showed that the sample with 20% pressure cooked flour supplement has the highest percentage of

protein (12.53), fat (18.04), fibre (0.77) and ash content (1.45), respectively, while sample with 40% pressure cooked jackbeans flour supplement has the highest percentage of moisture content (4.12) and sample with 40% of roasted jackbeans flour has the lowest percentage of fat (17.53), fibre (0.575), and also sample with 100% wheat flour has the lowest percentage of protein (9.43) and highest percentage of carbohydrate.

Physical analysis and evaluation of Cookies Thickness

This result the thickness of cookies (Fig. 1) showed that the highest value (36mm) was found in the control cookie that is made from 100% wheat flour (T4). The lowest value of 30mm was found in both pressure cooked and roasted cookies; however, at 40% substitutions of both roasted and pressured cooked cookies the thickness was 31mm and 32mm respectively.

The diameter of the cookies showed that highest significant value (448mm) was observed for the cookies prepared from control (T2) while the lowest value was found for the cookies prepared from (To) (421mm) Fig. 2. The higher the amount of roasted jackbean flour supplementation, the higher the increase in diameter.

Table 3. Nutritional qualities of the cookies.

Parameters (%)	Sample A	Sample B	Sample C	Sample D	Sample E
Fibre	0.72 \pm 0.02 ^c	0.77 \pm 0.01 ^d	0.64 \pm 0.02 ^b	0.62 \pm 0.01 ^{ab}	0.58 \pm 0.02 ^a
Ash	1.32 \pm 0.01 ^a	1.45 \pm 0.02 ^c	1.29 \pm 0.02 ^a	1.36 \pm 0.02 ^b	1.44 \pm 0.01 ^c
Moisture content	3.80 \pm 0.01 ^{ab}	3.64 \pm 0.02 ^a	4.12 \pm 0.01 ^c	3.62 \pm 0.02 ^a	4.04 \pm 0.02 ^{bc}
Protein	9.43 \pm 0.06 ^a	12.53 \pm 0.04 ^c	11.82 \pm 0.07 ^b	11.70 \pm 0.08 ^b	11.43 \pm 0.06 ^b
Fat	17.74 \pm 0.02 ^a	18.04 \pm 0.01 ^{ab}	17.83 \pm 0.01 ^a	17.97 \pm 0.02 ^{ab}	17.53 \pm 0.02 ^a
Carbohydrate	66.99 \pm 0.03 ^c	63.62 \pm 0.04 ^a	64.31 \pm 0.05 ^a	64.73 \pm 0.03 ^{ab}	64.99 \pm 0.01 ^b

All values are expressed as mean \pm SD of three replicate determinations. Sample A: 100% Wheat; Sample B: 80:20 Wheat-jackbeans pressured cooked; Sample C: 60:40 Wheat-jackbeans pressured cooked; Sample D: 80:20 Wheat-jackbeans roasted; Sample E: 60:40 Wheat-jackbeans roasted.

Mean values in the same row with different superscript are significantly different ($p < 0.05$).

Spread factor

Highest spread factor (50.22 mm) was observed in the cookies prepared from 100% wheat flour (T4) (Fig. 3). Tsen (1976) showed fortified wheat flour with soy flour isolate up to the level of 50% diminished greatly the spread

factor thereby enhanced the thickness. Similar results were reported by Hoojat and Zebik (1984) in replacement of 20% and 30% navy bean, sesame seed flour decreased spread factor of the wheat flour cookies.

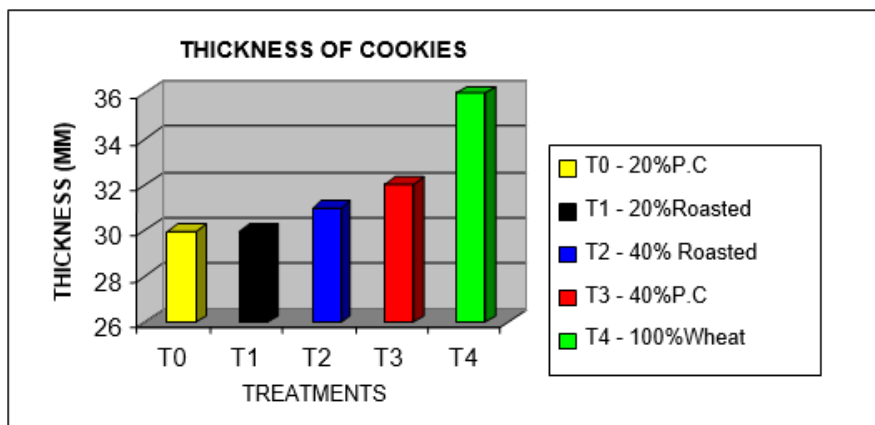


Fig. 1. Thickness of the cookies.

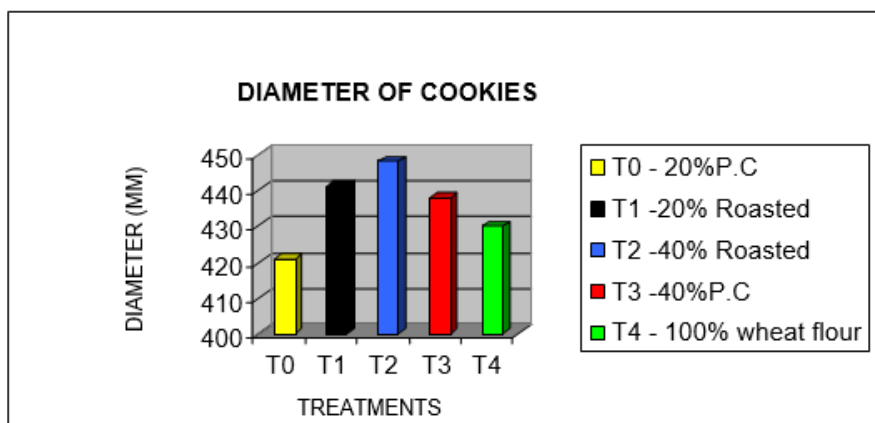


Fig. 1. Diameter of the cookies.

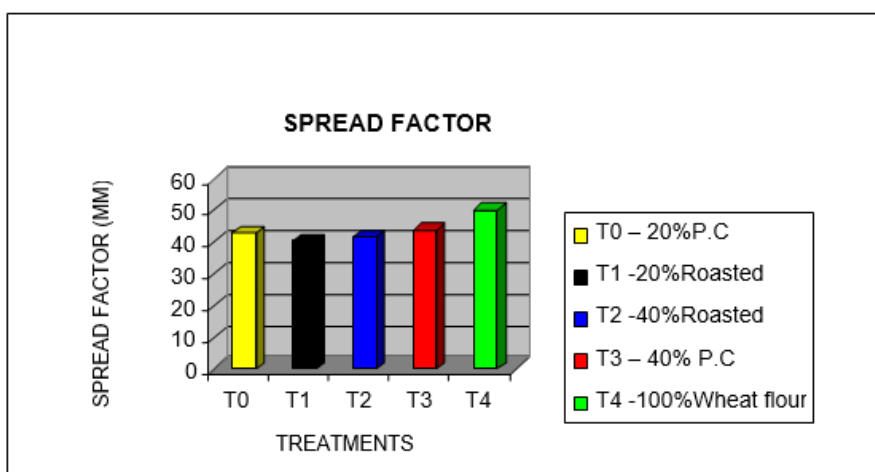


Fig. 3. Spread factor of the cookies.

Table 4. Sensory properties of the cookies.

Parameters (%)	Taste	Colour	Aroma	Texture	Overall Acceptability
Sample A	7.5 ^a	7.7 ^a	7.0 ^b	6.9 ^b	7.3 ^a
Sample B	7.8 ^a	7.6 ^a	7.2 ^a	7.3 ^a	7.9 ^a
Sample C	6.2 ^c	6.5 ^c	6.2 ^c	6.4 ^b	6.9 ^b
Sample D	7.1 ^b	6.9 ^c	7.2 ^a	5.8 ^c	6.7 ^b
Sample E	6.0 ^c	7.3 ^b	6.8 ^c	5.9 ^c	5.8 ^c

All values are expressed as mean \pm SD of three replicate determinations. Sample A: 100% Wheat; Sample B: 80:20 Wheat-jackbeans pressured cooked; Sample C: 60:40 Wheat-jackbeans pressured cooked; Sample D: 80:20 Wheat-jackbeans roasted; Sample E: 60:40 Wheat-jackbeans roasted.

Mean values in the same row with different superscript are significantly different ($p < 0.05$).

Sensory evaluation of cookies

Colour

The result of colour of cookies is showed in Table 4. It is evident from the result that highest score was recorded from sample prepared from 100% wheat flour (7.7), while the lowest score was recorded for cookies prepared from 40% pressured cooked (6.5) cookies substitution. Judges rated cookies prepared from 40% pressure cooked (6.5) and 20% roasted (6.9) with respect to colour.

Aroma

Flavour determine the consumer perception. The quality score showed significant variation in flavour among different treatments. The result indicated that the cookies prepared from 20% pressured cooked and 40% roasted flour was (7.2) respectively, significantly got the highest score for flavour while the lowest score was recorded for sample with 40% pressure cooked (6.2).

Texture

The texture of the cookies containing roasted Jackbeans flour supplement was significantly effect at alpha 0.05. Cookies prepared from 20% pressure cooked got the score (7.3) for texture while the lowest score was obtained in the cookies produced from 40% pressure cooked and 40% roasted respectively 5.8 and (5.9).

Taste

Taste is the sensation of flavour perceived in the mouth and throat according to the result obtained, cookies prepared from 20% pressure cooked and 100% whole wheat has the highest score (7.8) and (7.5) respectively while with 40% pressure cooked and 40% roasted got the lowest score (6.2) and (6.0) respectively.

Overall general acceptability

The overall acceptability of jackbeans and wheat flour is seen as indicated in Table 4. It was mainly sample with 20% pressure cooked and 100% wheat respectively (7.9 and 7.3) and the lowest score was obtained from cookies produced from 40% roasted flour substitution (5.8). The result of this finding shows that the higher the level of substitution the lower the overall acceptability, this is in line with the finding of Gambus et al. (2003), Iqbal (1997), Shearer (2002), Alpers & Sawyer-Morse (1996) Sharma et al. (1999) and Ullah (1990).

Conclusion

The results of this study indicates that jackbeans flour have potential for human feeding, judging from their proximate composition and may prove useful as a functional ingredient in cookies formulation because of their high protein, fat, fibre and ash content. In conclusion, the inclusion of jackbeans flour for the production of cookies tremendously would help to improve its nutritional qualities as this type of food can be accepted by everybody.

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