MIND SOURCING
Engineering

Effect of Moisture Content on Shelling Efficiency of Bambara Nut Using Reciprocating Cracker

Kogh Dantus Asusa, Adadu Comfort Akwonya and Gaydaybu James Flomo

Department of Vocational and Technical Education, Benue State University, Makurdi, Nigeria.

RESEARCH ARTICLE

How to cite this article
Kogh, D.A., Adadu, C.A. and Gaydabu, J.F.(2019),Effect of Moisture Content on Shelling Efficiency of Bambara Nut Using Reciprocal Cracker, ***Mind Sourcing Eng.*, 4** (10), Pp 5.

Received: October 17, 2019

Accepted: October22, 2019

Published: October 24, 2019

Corresponding author
Kogh Donatus Asusa
sixtuskogh@gmail.com

ABSTRACT

This study investigated the effect of moisture content on the shelling efficiency of Bambara nut using reciprocating cracker. The moisture content was varied at 5%, 7% and 9%.A full hopper equivalent to 10 kg of Bambara nut pods at specified moisture contents were fed into the first section of the hopper. The pods were shelled until the shelling chamber was emptied. This process was repeated until the three variations of the moisture content were obtained. Data collected were analyzed using Statistical Package for Social Sciences (SPSS) version 20. Result showed that 8.00kg was obtained at 5% moisture content, 9.78kg was obtained at 7% moisture content and 5.50kg was obtained at 9% moisture content. Result of One Way Analysis of Variance (ANOVA) further revealed that there was a significant difference between levels of moisture content and the performance of the machine ($p<.05$). The result further shows through observation of the mean difference that 7% moisture content (Mean = 2.85; SD = 3.81) was the most suitable moisture content followed by 5% moisture content (Mean = 2.03; SD = 2.66) and 9% moisture content (Mean = 2.40; SD = 1.69). Conclusions were drawn based on the findings and it was recommended that 7% moisture content be used for shelling Bambara nut pods using reciprocating machine and further research should be carried out to ascertain moisture contents of different varieties of Bambara nut pods.

Keywords: Moisture Content, Shelling Efficiency, Bambara nut, Reciprocating cracker

INTRODUCTION

Bambara nut (*Vigna subterranean* (*L.*) *verdict*.) is one of the most commonly cultivated crops across the tropical countries of the world such as Nigeria, Niger, Senegal, Kenya, South Africa and many others because of its nutritive and commercial values. The origin of the Bambara nut in West Africa and the region of cultivation is Sub-Saharan Africa's warm tropics [1].Bambara nut is addressed in different names by different tribes. In Tiv language it is referred to as "IgboughAhi". In Hausa language, it is known as "Gurjiya" or "Kwaruru". In Goemai language of Plateau State of Northern Nigeria it is called "Kwam", Kanuri people refer to it as "Ngangala". In

the eastern Nigeria, it is commonly known as "Okpa" in Ibo language, it is commonly known as "Epa-kuta", while in the Ghana Language, spoken by the people in Greater Accra, Ghana, the Bambara nut is called "Akwei [2].

The gross energy value of Bambara nut is reported to be greater than Cowpea, Ground nut and Pigeon peas [3]. Bambara nut is an underutilized Africa legume which provides security for many farmers as it shows considerable drought resistance. Bambara nut is grown for its edible seeds. Matured seeds are very hard to cook, so have to be soaked in water to soften before cooking. Undehulled seeds are mixed with roots and tubers such as yams, cocoyam and sweet potatoes and cooked into a pottage with the addition of oil, salt, pepper and other spices [4]. The medicinal role of Bambara nut is mainly based on information obtained from communities in several parts of Africa, where this crop is reportedly responsible and useful for treatment of various ailments. As a treatment for diarrhea, a mixture of Bambara nut and water from boiled maize are consumed. Raw Bambara nut seeds are chewed and swallowed by pregnant women to alleviate the nausea associated with pregnancy[4].

The pods are harvested by pulling or lifting the plant manually, sometimes the support of a hoe may be needed. Alternatively, a single furrow ox plough can be used to achieve the same purpose. The pods are manually separated from the vines. After which the pods are washed, used fresh or can be sun dried and stored at a safe storage moisture content between 8 to 12 %moisture content, wet basis [3]. The seed contains about 63% carbohydrate, 19% protein and 6.5% oil. The haul can be used for livestock feed [5].However, the shelling of pods to obtain clean seed is one of the most tedious operations in Bambara nut processing. As a result, it has constituted a bottle- neck to the large scale production and processing of this important proteinous crop.

Shelling of the pod is laborious, time consuming and cost involving operation. The author in [6] recommended that after harvesting Bambara nut, it is dried in the sun to about 8 to 12% moisturecontent (w.b.). The dried seed could be taken as snacks after roasting or milled to flour for other foods. Despite this economic importance, no commercial production and no industrial use of the crop takes place in Benue State. According to [7], research is concentratedonly on the agronomic aspect, while the processingaspects have been neglected.

The pod of bambaranutis very hard and the cracking methods are still traditional.These cracking methods vary from locality to localitydepending on the quantity produced. Some communities like Kwande local government area of Benue State because of high production rate usemortar and pestle to crush the dry pods. Some other communities beat them withsticks on flat ground, others use stones to crush pods on flatground. These methods used have the disadvantage of damagingthe seeds, and are time consuming and tiresome.

[8]developed and tested a sheanutcracker working on the principle of impaction and pneumaticallyseparating the shells from the kernel. They obtainedcracking efficiency of 100% and winnowing efficiency of97%. The authors in [7] determined the optimum impactenergy for shelling bambara nut at pod moisture content ranging from 5-8% (w.b.) and found that the impactenergy ranged from 0.24 to 0.59 J.

This paper seek to examine the Effect of different Moisture Content on Shelling Efficiency of Bambara nut at pod moisture content ranging from 5-9% using Reciprocating Bambara nut Cracker (machine) to project individual Bambara nuts at three differentmoisture levels against the inner surface of a cylindricalcover similar to that described by [8-10].

MATERIALS AND METHOD

A bulk quantity of Bambara nut pods was purchased from Aga market (Jato-aka) in Kwande local government area in Benue state, Nigeria. The pods were cleaned and sampledfor experiment using a multi-slot riffle box divider. Themoisture content of the pods was varied using the methodreported by [8,11]. The method which involved the soaking ofa bulk quantity of the pods in ordinary water at roomtemperature for different periods of time one hour for

sample II and one hour thirty minutes for sample III. Sample I was retained at thestable storage moisture content as a control sample. Aftersoaking the pods were spread out in a thin layer to dry innatural air for about eight hours. The pods were then sealed using marked polyethylene bags and stored in that condition fora further 24 hours. This procedure enabled stable and equal moisturecontent of the pods to be achieved in the bags.

Moisture content of each sample was determinedusing a method described by [8,11,12]. The method involved oven drying of pod samples at130°C with weight loss monitored on hourly basis to give anidea of the time at which the weight startedremaining constant.After oven drying for about 3 hours, the weight of samples was found maintaining constant. After 6 h of oven drying, thepods were weighed using an electronic balance weighing too.001 g to determine the final weight. Then the moisture contentwas determined using the formula [8].

A full hopper equivalent to 10 kg of Bambara nut pods at specified moisture contents were fed into the first section of the hopper. The vibration of the machine enhanced by reciprocating mechanism (hanger) on which the hopper was suspended made the pods to sieve into the predetermined (three) categories of pod sizes. The small size pods were allowed to fall directly into the shelling zone ahead of the large and medium size pods. This was done to optimize the power required to drive the shelling drum. After size sorting of the pods was achieved, the flow rate control devices for large and medium pods were opened and the pods were discharged freely under the influence of gravity and vibration into their respective shelling chamber. The pods were shelled until the shelling chamber was emptied.

The weight of pods that was completely shelled and unbroken (A), weight of completely shelled but broken (B), weight partially shelled pods (C) and the weight of unshelled pods (D),the quantity of shells that was cleaned out was collected. The quantity of shells that was not cleaned but collected with the seeds was separated. This was calculated using the data collected prior to analysis.

Data Collected

N_T = total weight of Bambara nut pods fed into the hopper of the machine = 10kg

N_{CT} = total weight of Bambara nut pods clogged into the screen after machine operation = 0.02kg

A = weight of completely shelled and unbroken seed = 9.78kg

B = weight of completely shelled and broken (damage) seed = 0.09kg

C = weight of partially shelled pods = 0.02 kg

D = weight of completely unshelled pods = 0.09 kg

Therefore,percentage of completely shelled and unbroken seed:

$$p_{CS} = \left(\frac{A}{N_{T-N_{CT}}}\right) \times 100\ \% \quad (1)$$

$$p_{CS} = \left(\frac{9.78kg}{10kg - 0.02kg}\right) \times 100$$

$$p_{CS} = 97.9\%$$

Percentage of completely shelled and broken seed:

$$p_{CB} = \left(\frac{B}{N_{T-N_{CT}}}\right) \times 100\ \% \quad (2)$$

$$p_{CB} = \left(\frac{0.09kg}{10kg - 0.02kg}\right) \times 100\ \%$$

$$p_{CS} = .9\ \%$$

Percentage of partially shelled and unbroken seed:

$$p_{PS} = \left(\frac{C}{N_{T-N_{CT}}}\right) \times 100\ \% \quad (3)$$

$$p_{PS} = \left(\frac{0.02kg}{10kg - 0.02kg}\right) \times 100\ \%$$

$$p_{PS} = .2\%$$

Percentage of completely unshelled:

$$p_{CU} = \left(\frac{D}{N_{T-N_{CT}}}\right) \times 100\ \% \qquad (4)$$

$$p_{CU} = \left(\frac{0.09kg}{9.98kg}\right) \times 10$$

$$p_{CS} = .9\%$$

Shelling efficiency of the machine,

$$E_S = \left(\frac{A+B+C}{N_T - N_{CT}}\right) \times 100\ \% \quad (5)$$

$$E_S = \left(\frac{9.78kg + 0.09kg + 0.02kg}{10kg - 0.02kg}\right) \times 100$$

$$E_S = 97.8\ \%$$

All data recorded was subjected to Analysis of Variance to determine the extent to which moisture content affects the shelling efficiency of the machine at 95% confidence level using SPSS version 20.

RESULTS AND DISCUSSION

Effects of different Moisture Content on Shelling Efficiency of Bambara nut at pod moisture content ranging from 5-9% using Reciprocating Bambara nut Cracker (machine).

Table 1: Data for determination of moisture content

Moisture Content Category	weight (kg)of Bambara nut pods loaded	Weight(kg)of seed obtained after shelling
5% moisture content	10	8.00
7% moisture content	10	9.78
9% moisture content	10	5.50

Results in Table 1 show the categories of moisture content, the weight of Bambara nut pods loaded in each category, the weight obtained after shelling. This result was further used to test the efficiency in terms of moisture content to determine the best moisture content for shelling Bambara nut pods using Reciprocating Cracker(machine) and the result is presented in Table 2.

Table 2: Summary of One Way ANOVA for moisture content and shelling efficiency of the Reciprocating Cracker (machine).

Source	Mean	SD	df	F	P	Remarks
5 % moisture content	2.03	2.66	2, 33	12.852	.013	Sig
7 % moisture content	2.85	3.81				
9 % moisture content	2.40	1.69				
TOTAL	2.42	2.77				

Results in Table 2 show that, there is a significant difference between levels of moisture content and the performance of the machine ($p<.05$). The result further shows through observation of the mean difference that 7% moisture content (Mean = 2.85; SD = 3.81) is the best moisture

content that produces the desired result compared to 5% moisture content (Mean = 2.03; SD = 2.66) and 9% moisture content (Mean = 2.40; SD = 1.69).

CONCLUSION

This study is on the effect of moisture content on shelling Efficiency of Bambara nut using Reciprocating Cracker. A full hopper equivalent to 10 kg of Bambara nut pods at specified moisture contents (5%, 7% and 9%) were fed into the first, second and third sections of the hopper, the pods were shelled until the shelling chamber was emptied, the outputs were collected at different interval of each of the moisture content and analyzed. Based on the finding of the study, it was concluded that 7% moisture content is the best moisture content for shell shelling Bambara nut using Reciprocating Cracker.The researcher therefore recommends that 7% moisture contentshould be used for shelling Bambara nut pods and further research should be carried out to ascertain moisture contentsof different varieties of Bambaras nut.

REFERENCES

[1]. Nichterlein, K., (2011) "*Vigna subterranean* ". Ecoport. Retrieved 16th March, 2018.

[2]. Adedeji, M. A. &Danladi, W. Y. (2016). Modification and construction of motorized Bambara nut decorticating machine. *Global Advanced Research Journal of Engineering, Technology and Innovation,* 5(1): 001-006.

[3]. Goli, A.E. (1997). Bambara groundnut.Bibliographicreview.In Bambara groundnut. *Vignasubterranean (L.) verdict*.Promoting the conservation and use of underutilized and neglected crops.*Proceedings of the workshop on conservation and improvement of Bambara groundnut (Vegan subterranean (L.) verdict.).*

[4]. Enwere, N. J. &Hung, Y. C. (1996).Some chemical and physical properties of Bambara groundnut seeds and products.*International Journal of Food Science and Nutrition*, 47 (6): 469 – 475.

[5]. Tanimu, B &Aliyu, L (1996). Bambara groundnut, country report: Northern Nigeria. In Bambara groundnut.*VegnaSubterranea (L.) verdict*.Promoting the conservation and use of underutilized and neglected crops.*Proceedings of the workshop on conservation and improvement of Bambara groundnut (Vegan subterranean (L.) verdict.)*. Heller, J; Begemann, F. and Mushonge, J. (eds.), 14 – 16 November, 1995, Harare Zimbabwe;IPGCPR and IPGRI, Rome.

[6]. Kay D.E., 1979. Food Legume Crops and Production. TropicalProducts Institute Press, London, UK.

[7]. Akani A.O., Ohanwe C.N., and Omoniyi I.O.**(2000).** Determinationof optimum impact for decortication of bambaragroundnut.Proc. Nigerian Inst. Agric. Eng., 22, 87-89

[8]. Oluwole F.A., Aviara N.A., and Haque M.A.(2004).Developmentand performance tests of a sheanut cracker. J. Food Eng, ., 65, 117-123, 184.

[9]. Dicken J.W.(1961)**.** Kernel Spliter and Inspection Belt for Peanuts. Market Res. Report, No. 452 AMS – USDA.

[10]. Makanjuola G.A. (1975). An evaluation of some centrifugal impactiondevices for shelling melon seeds. J. Agric. Eng. Res.,20, 71-77.

[11]. Aviara N.A., Haque M.A., and Izge I.A. (2002). Physical andfrictional properties of sheanut. AgroSci., 2(1), 19-34.

[12]. ASAE. (1983). ASAE Standards: ASAE 352.1 Moisture measurement.Grains and seeds. St. Joseph, Michigan.